Managing transport challenges when oil prices rise

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An important note for the reader

The NZ Transport Agency is a Crown entity established under the Land Transport Management Amendment Act 2008. The objective of the NZ Transport Agency is to undertake its functions in a way that contributes to an affordable, integrated, safe, responsive, and sustainable land transport system. Each year, the NZ Transport Agency invests a portion of its funds on research that contributes to this objective.

This report is the final stage of a project commissioned by Land Transport New Zealand before 31 July 2008 and is published by the NZ Transport Agency.

Abbreviations and Acronyms

ARPES	Auckland Road Pricing Evaluation Study
BCR	Benefit Cost Ratio
BOP	Bay Of Plenty
BRT	Bus Rapid Transit
CDF	Cumulative Distribution Function
CCTV	Closed Circuit Television
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EEM	Economic Evaluation Manual
EIA	Energy Information Administration
EV	Electric Vehicles
FBT	Fringe Benefit Tax
GB	Giga Barrels
GDP	Gross Domestic Product
HOV	High Occupancy Vehicles
HTS	Household Travel Survey
IEA	International Energy Agency
IMF	International Monetary Fund
LGAAA	Local Government Auckland Amendment Act
LRT	Light Rail Transit
MBPD	Million Barrels Per Day
MED	Ministry of Economic Development
MOT	Ministry of Transport
MUL	Metropolitan Urban Limits
NES	National Environmental Statement
NPS	National Policy Statement
NYMEX	New York Mercantile Exchange
NZD	New Zealand Dollar
NZTA	New Zealand Transport Agency
NZTS	New Zealand Transport Strategy
OECD	Organisation for Economic Cooperation and Development
OPEC	Organisation of the Petroleum Exporting Countries
PKT	Passenger Kilometres Travelled
PNR	Park and Ride
PT	Public Transport
RC	Regional Council
RMA	Resource Management Act
RPS	Regional Policy Statement
RUC	Road User Charges
SOV	Single Occupant Vehicle
TA	Territorial Authority
TMA	Transport Management Association
TOD	Transit Oriented Development
UDA	Urban Development Authority
USD	United States Dollar
VKT	Vehicle Kilometres Travelled

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Executive Summary

This report considers how central government, regional councils, and local authorities may respond to the transport challenges associated with rising oil prices. This research supports the environmental sustainability and economic development objectives of the updated New Zealand Transport Strategy (MOT, 2008b), as well as the specific targets in the recently released Government Policy Statement on transport (New Zealand Government, 2008).

Oil currently plays an important role in the transport system in three primary ways. Firstly, and most obviously, oil provides the fuel that powers the majority of vehicles. Secondly, oil is the major input into the asphalt and bitumen used to construct and maintain road surfaces. Finally, the majority of public transport (PT) services are dependent on diesel – although to a lesser extent than private vehicles.

Thus, when oil prices rise and consumers are faced with higher prices for petrol and diesel, government agencies are also confronted with higher costs for maintaining and constructing road infrastructure as well as higher costs for operating public transport services. The price of oil is therefore a key driver of the cost of using, maintaining, constructing, and operating the transport network.

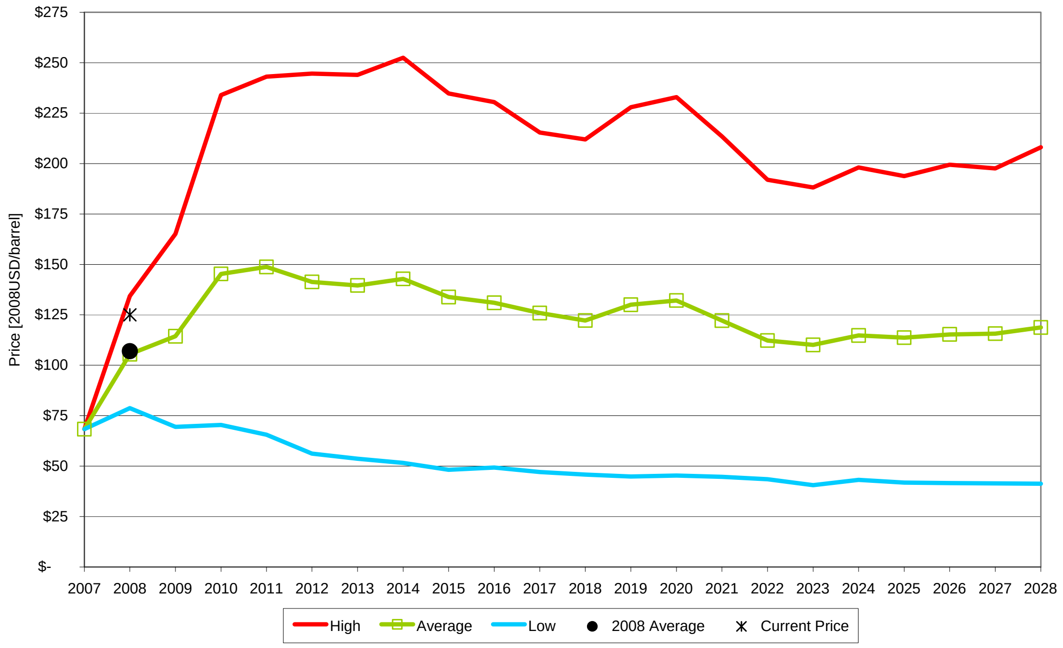
This report aims to help government agencies understand the risks posed by high oil prices and, ultimately, recommend changes that will mean the transport system develops in a way that is less dependent on oil based transport fuels. The results of this research are summarised into four key sections, namely: modelling prices for transport fuels, modelling future travel demands, recommended responses to rising oil prices, and potential impacts of the responses.

Modelling Prices for Transport Fuels

Oil prices hit record highs in the first half of 2008; while prices have dropped in recent weeks they remain at levels that are high by historical standards. This report has found that recent high prices have been driven by a combination of the following four factors:

- Increased demand for oil in developing countries, demand that is fuelled by subsidies that insulate consumers from price signals, particularly in India and China;
- Shifts in the balance of demand towards oil products that require more intensive processing, which is placing pressure on oil refining capacity;
- Laggard production from conventional sources which has led to marginal demand being increasingly met by unconventional and/or synthetic oil sources; and
- Increased production costs associated with unconventional and synthetic sources requires higher prices to justify increases in production (Goldman-Sachs, 2008).

To gain insight into how these factors may affect future oil prices, a model was developed to generate oil price projections for the period 2008-28. This model combined forecasts from a number of different sources to generate representative price projections. This model attempted to capture underlying trends as well as the potential variability around these trends. The figure below illustrates the High, Average (mean), and Lower price scenarios generated by this model.



Thus oil prices are expected to subside from their current level (indicated by the black star) to average approximately $110 USD/barrel for the remainder of 2008. At the time of writing, the current average for this year – as indicated above by the black circle – sits very close to the projected price of $110 USD/barrel. This provides a certain degree of confidence in the short term price projections generated by the model.

Looking ahead, prices may be expected to reach approximately $150 USD/barrel in 2012; this is expected to combine with a depreciating New Zealand Dollar to push petrol and diesel prices up to $2.80 and $2.50 per litre respectively. After this point prices may be expected to plateau and possibly decline, although remain at historically high levels. Declining prices may reflect new supply coming on-stream and/or dampened demand.

The high and low price scenarios are considered unlikely but possible. Higher prices might eventuate if new production or refining capacity is delayed or the rate of decline in mature fields is more rapid than expected. On the other hand, the removal of fuel subsidies in India and China may suppress demand, while OECD countries could respond to sustained high prices by implementing more enduring responses that increase energy efficiency – similar to those discussed in this report. Alternatively, recent credit issues may weaken economic growth and take the wind out of current oil prices.

It is emphasised that the accuracy of the underlying forecasts declines the further into the future one goes; more emphasis should therefore be placed on the short term price projections. Forecasts are constantly being updated as new information comes to hand and more advanced modelling techniques are developed. The price forecasts on which these projections are based are thus likely to be superseded in the near future. In particular, resource depletion could increase beyond that which is currently forecast which would serve to push up prices particularly in the long term.

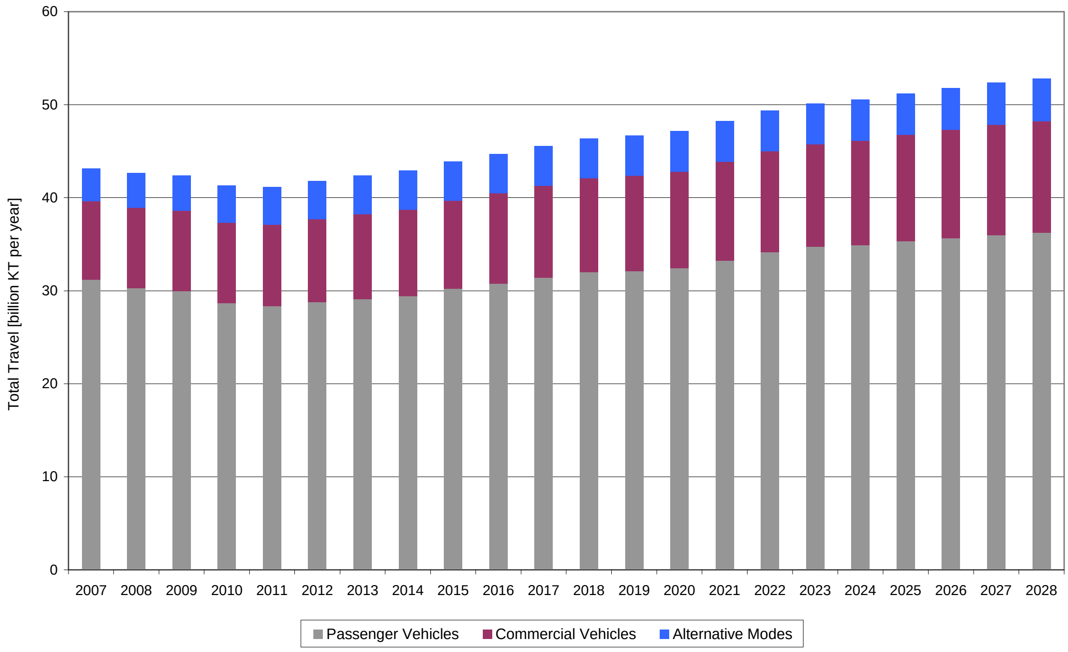
Finally, it should be noted that the price projections illustrated above describe annual average prices. Spot prices are expected to vary substantially around average prices, reflecting the fact that oil markets are dominated by inelastic supply and demand. For this reason unpredictable weather and geopolitical events may cause large spikes in spot prices. This presents specific challenges to consumers and government agencies that should be the subject of further research.

Modelling Future Travel Demands

Future travel demands were modelled with respect to the three fuel price scenarios identified in the previous section, as well as assumed trends in economic growth, vehicle ownership, labour force participation, disposable income, and population growth.

Light passenger travel demands were found to be sensitive to a variety of factors, especially fuel prices and vehicle ownership. Commercial travel demands were found to be substantially less sensitive to fuel prices and more sensitive to economic growth. For this reason the travel demands for light passenger and commercial vehicles were evaluated separately and then combined to provide an overall indication of future travel demands. Cross-elasticities for public transport and active modes were estimated using a combination of local and international studies.

As illustrated below, in the Average fuel price scenario total VKT is expected to remain below 2007 levels until circa 2016, after which the combined effects of economic growth, income growth, and population growth are expected to become dominant.



This should be considered as the Base scenario, onto which the effects of the recommended responses (summarised in the following section) are additional. It is noted that these results are based on a number of assumptions. Particularly important is the assumption that economic growth, workforce participation, vehicle ownership and disposable income are not related to oil prices. This means that aside from the direct fuel prices impacts, oil prices are not considered to impact on economic performance; an assumption that is likely to overestimate actual travel demands.

Despite these caveats, the results of this modelling suggest that the next 5-10 years present an opportunity to reform our current land use and transport practices to ensure that they support the goals of energy efficiency and economic development. The following section recommends a number of responses that support these goals.

Responses to Rising Oil Prices

Previous sections highlighted that oil prices are expected to increase and be sustained at relatively high levels and that these prices are likely to dampen demand for vehicle travel, particularly over the next 5-10 years. In light of these results, this report identifies a toolbox of potential responses that enable government agencies to facilitate the development of a more efficient transport system.

Central to these responses is the understanding that travel and land use have not historically been effectively managed or priced. This has led to structural imbalances that have subsidised private vehicle trips. Rectifying these structural imbalances so that road users are faced with the true costs (both internal and external) of their choices is expected to deliver travel and land use patterns that are significantly more energy efficient and also support increased economic development. Identified responses were grouped under the following five headings.

- *Land Use Management* - addresses some of the major market distortions that increase the need to travel by motor vehicle. Furthermore, they will be necessary to achieve many of the growth objectives of current transport and land use strategies (such as intensification around transport nodes);

- *Direct and Efficient Pricing* supports desired land use changes and provides the economic incentives for the changes to happen more rapidly. Direct and efficient pricing may also raise revenue to assist with the transition, e.g. by investing in more energy efficient transport modes or location-efficient land development;

- *Infrastructure Investment* outlines recommended supply side responses to higher oil prices, including greater emphasis on the quality rather than the capacity of the road network. Land use and pricing responses are expected to generate increased demand for alternative modes, which should be reflected in infrastructure priorities;

- *Behaviour Change and Education* campaigns are important to effectively communicate the need for the paradigm shift that will enable New Zealand communities to adapt to rising oil prices. An information campaign, in addition to other organisational institutions, will further facilitate public acceptance, allow for more rapid progress, and increase the effectiveness of the other responses; and

- *Freight Management* has its own specificities, but the principles of rectifying market distortions through land use policies, direct pricing and infrastructure investment and management remain the same. In general, freight management strategies recognise that heavy vehicle travel is likely to continue to grow in spite of higher fuel prices.

Land use responses provide the greatest medium to long term benefits for energy efficiency due to their ability to reduce the need for travel, while direct and efficient pricing is important to ensure that road users pay the true costs of travel. Taken together, land use management and direct and efficient pricing are expected to generate additional demand for alternative transport modes, demand that government agencies should provide for with new infrastructure. Behaviour change and education recognises that providing early and advanced information may help overcome behavioural inertia and imperfect information that would otherwise impede efficient responses.

Some of the responses will require legislative change and will subsequently take time to implement. Current legislative requirements for public consultation may reduce the ability of government agencies to respond swiftly and effectively in the event that fuel prices rose unexpectedly. New legal frameworks may be required to provide transport agencies with the ability to accelerate strategic infrastructure investment when faced with unexpectedly high fuel prices.

It is noted that the recommended responses are expected to deliver benefits in the medium to long term and therefore do not provide specific guidance for government agencies to deliver short-term relief to communities affected by higher transport costs. This reflects the fact that almost all travel demands and transport costs are derived from medium to long term locational decisions. There are few short-term silver bullets and the most effective responses to sustained high oil prices will require time to take effect.

These responses are intended to illustrate the types of transport outcomes that can be achieved through coordinated actions by local authorities, regional councils, and central government. Fit for purpose solutions will be required to meet local needs and circumstances, but this should not distract from the need for and benefits of strong central government leadership on many of the responses identified in this report. Ultimately, the implementation of this toolbox of responses is expected to prepare households, businesses, and government agencies for the challenges of rising oil prices.

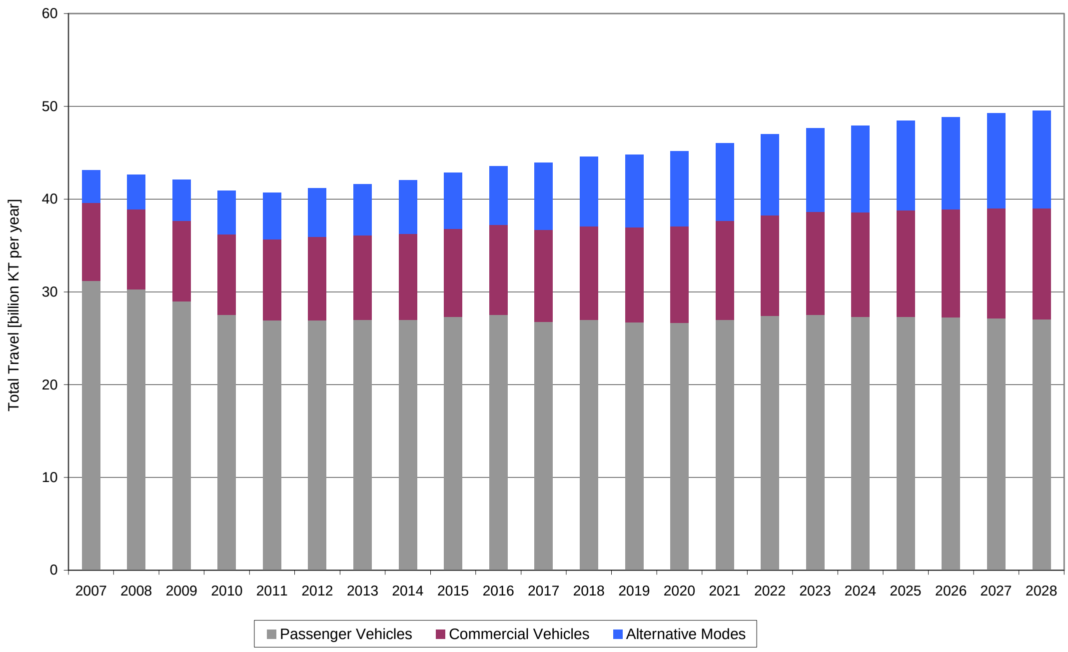
Details on the recommended responses are summarised in the following table.

Category	Response	Details	Time frame	Agency
Land use responses	Parking regulation and management	Minimum parking requirements are removed with public parking priced to reflect the underlying land value and demand.	Short	Central and TAs
	Flexible zoning and urban containment	RCs and TAs adjust zoning regulations to encourage a mix of uses in developed areas. Urban containment should be used to discourage development in remote areas until such time as transport costs are directly and efficiently charged to users (see road pricing below).	Short	Regional and TAs
	Development incentives	Development contributions become more sophisticated so as to stimulate development in identified growth areas.	Medium	Central and TAs
	Urban renewal and Transit Oriented Development (TOD)	Renewal of urban areas is facilitated through increased investment and / or reduced compliance costs.	Medium	Central and TAs
		Identify and invest in existing or potential TOD sites, incorporating parking and zoning responses outlined above.	Medium	TAs
Direct and efficient pricing	Commercial parking rate	Commercial parking rate is used to fund local road maintenance and operations based on the number of car parks provided with non-residential premises.	Medium	TAs
	Road pricing	Progress implementation of national road pricing scheme that fully internalises all transport costs.	Long	Central
	Tax treatments	Ensure tax treatments relating to commercial travel expenses provide incentives for energy efficient choices.	Medium	Central
Infrastructure investment	Transforming roads into streets	Reallocation of road space including shared space and pedestrianisation, prioritising access over mobility.	Short	TAs
		Improve surface treatments so as to provide for more fuel efficient vehicle travel and reduced noise and air pollution in urban areas.		
	Active modes	Increase investment in active mode facilities and investigate plan changes to require new developments to provide shower and locker facilities for employees.	Short	TAs
	Public transport services and infrastructure	Provide high occupancy vehicle/bus lanes on arterial roads corridor by removing parking and / or reallocating existing vehicle lanes.	Short/ Medium	TAs, RCs (Central)
		Invest in public transport services and improve infrastructure as demand increases in response to the land use and pricing measures.		
	Multi-modal integration	Facilitate modal transfers through the implementation of convenient systems and payment technologies.	Medium	RCs
	Taxi services	Central Government update taxi service regulations to reflect energy efficiency goals.	Medium	Central
Behaviour change and education	Travel Plans	Encourage the increased uptake of travel plans at key destinations, such as workplaces and schools, to identify and rectify internal organisational barriers to more sustainable travel choices, such as free car-parks and company cars.	Short	RCs
	Car-sharing / Bicycle-sharing	Facilitate the emergence of car-sharing and bicycle sharing organisations.	Short	TAs
	Transport Management Associations	Facilitate the establishment of Transport Management Associations (TMA) in town centres to coordinate ancillary transport services.	Short/ Medium	TAs
	Public Transport Information	Improve and expand transport websites and route information.	Short	RCs
Freight management	Regional Freight Strategies	Develop Regional Freight Strategies that facilitate mode shift and offer opportunities for multi modal ports.	Medium	RCs
	Home delivery	TAs (with TMA) investigate potential for advertising and coordinating home delivery services.	Medium	TAs
	Active freight	Encourage the use of active freight in town centres, particularly in conjunction with pedestrianisation in town centres.	Short	TAs

Impacts of the Recommended Responses

The impacts of the recommended responses were assessed in terms of their effects on travel demands, energy efficiency, and economic benefits.

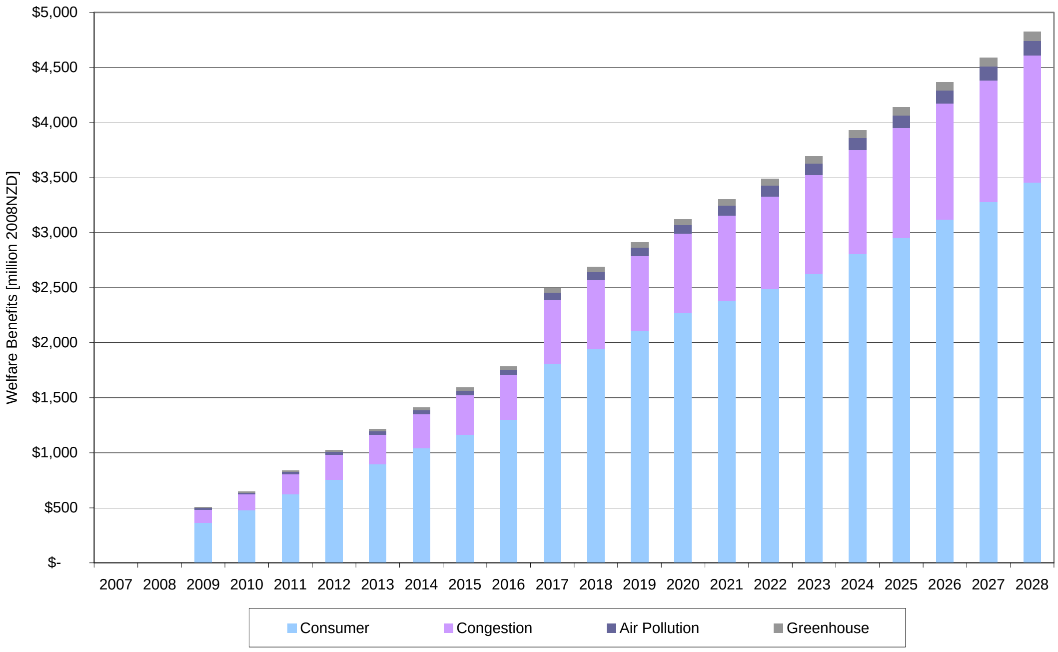
The effect of the recommended responses on travel demands was modelled as a function of their expected coverage (both temporal and spatial) and likely impacts on travel demands. Responses were implemented in a staged way, with the full impacts not realised until 2028. This analysis found that the responses cause a pronounced shift in travel demand growth away from light passenger vehicles to alternative transport modes, as illustrated below.



The responses are thus found to contain future growth in vehicle travel at or below current levels for the next twenty years. Growth in personal travel demands are instead accommodated through increased uptake of alternative transport modes. Commercial travel is expected to remain largely unaffected, although naturally would benefit from the faster and more reliable travel times associated with reduced congestion on the road network, as well as lower operating costs resulting from higher quality road surfaces.

The mode shift motivated by these measures is expected to reduce per capita dependence on oil based transport fuels by approximately 20%. These gains ensure that average consumer expenditure on oil based transport fuels increases only marginally from current levels even under the high oil price scenario. Fuel efficiency gains associated with higher quality road surfaces are not included in this analysis, but may provide for an additional 5% in fuel savings; exact savings should be the subject of further research.

The economic benefits of the recommended responses were evaluated in terms of consumer savings, such as fuel and vehicle operating expenses, and welfare benefits, such as congestion reduction, air pollution, and greenhouse gases. This analysis indicated that a more efficiently managed and priced transport network may deliver annual benefits in the order of $5 billion by 2028, with a net present value of approximately $15 billion, as illustrated below.



In short, the responses recommended in this report are likely to deliver improved energy efficiency and permanent ongoing economic benefits to consumers, business, and public bodies. The recommended responses are considered to provide an effective way to decouple New Zealand's transport system and the wider economy) from the long term risks of higher oil prices.

Conclusions

This research found that high oil prices are likely to be sustained over the next two decades. It suggests these risks are best managed by implementing a package of responses that seek to redress structural imbalances in transportation and land-use planning. Implementing the recommended responses is expected to result in medium to long term improvements in energy efficiency, while also delivering on-going economic benefits. These responses are thus considered to be "no regrets" measures that deliver "win-win" outcomes – regardless of the price of fuel. They are also expected to motivate more innovative market driven responses to transport needs than may be achieved through the current paradigm, which is characterised by underpriced vehicle travel and a focus on supply side capacity expansions of the road network. Ultimately the recommended responses are expected to manage total vehicle travel below current levels and thereby allow government agencies to reprioritise investment in road network maintenance and alternative transport modes.

Abstract

This report provides practical guidance to central, regional, and local government agencies on how to manage the transport challenges associated with rising oil prices. The three main sections of the report are:

- Modelling Prices for Transport Fuels – several oil price forecasts are combined to develop a view on future oil prices. This shows annual average oil prices staying around $110 USD/barrel in 2008, before accelerating rapidly to reach approximately $150 USD/barrel in 2012. After this point prices may stabilise or even decline. Retail prices for petrol and diesel are expected to peak at approximately $2.80 and $2.50 NZD/litre respectively in 2011. Upside and downside risks to these price forecasts exist, particularly in relation to economic growth.

- Modelling Future Travel Demands - travel demand elasticities and cross-elasticities are used to model future travel demands. This considered the effects of fuel prices, economic growth, vehicle ownership, workforce participation, and disposable income on vehicle kilometres travelled (VKT). Under the average fuel price scenario total VKT falls below current levels until approximately 2016, after which the combined effects of economic growth, increases in income, and population growth become dominant.

- Responses to Rising Oil Prices – a range of responses are identified in the areas of land use management, direct and efficient pricing, infrastructure management, behaviour change and education, and freight management. These responses are cumulatively expected to shift travel demands from passenger vehicles to alternative modes, such that total VKT remains at or below current levels. It is recommended that the focus of infrastructure investment shift from peak hour capacity expansion and instead prioritise investment in road network maintenance and alternative transport modes. Both these measures are likely to deliver a transport system that is more energy efficient, as well as realising a range of wider economic benefits.

1. Introduction

This research report provides guidance to central government, regional councils, and territorial authorities on how to manage transport challenges when oil prices rise. This report evaluates the risk of sustained high oil prices and recommends how government agencies may respond to this risk.

In many ways, the results of this research are intuitive and unsurprising to even a casual observer. That is, sustained high oil prices are expected to reduce demand for private vehicle travel and increase demand for other transport modes and more condensed land use. This report attempts to provide a quantitative framework around these intuition observations to assist government agencies manage the future development of New Zealand's transport system.

On a strategic level this report has been primarily guided by the economic development and sustainability objectives of the New Zealand Transport Strategy (NZTS). The following sections introduce the objectives and issues that have motivated this report.

1.1 Our Wheels May Fall Off – Or at Least Stop Turning

In 2007 the International Energy Agency's (IEA) Chief Economist Fatih Birol stated that "if we don't do something very quickly, and in a bold manner, the wheels may fall off. Our energy system's wheels may fall off. This is the message that we want to give" (Birol, 2007). Birol later stated "I expect that for the next years to come, we will have a high price trajectory. There may be zigzags, but I would be very surprised if prices go down to the levels we saw three or four years ago, in the long term" (Birol, 2008).

These statements represent a marked shift in sentiment. Recent prices suggest oil markets have indeed undergone a structural shift in response to surging demand in developing countries, increasing demand for oil products that require more processing, laggard production from conventional sources, and increasing production costs (IEA, 2007, IEA, 2008, Goldman-Sachs, 2008). These factors are discussed in more detail in Section 3.

Oil prices impact on transport planning in three primary ways. Firstly, and most obviously, oil provides the fuel through which most vehicles are powered. Secondly, oil is the major input into the asphalt and bitumen used to construct and maintain road surfaces. And finally, the majority of public transport services are dependent on diesel – albeit to a reduced extent than private vehicles.

Thus, when oil prices rise and consumers face higher prices for petrol and diesel, government agencies are confronted with higher costs for maintaining and constructing road infrastructure as well as higher operating costs for public transport services. The price of oil is therefore a key driver of the cost of using, maintaining, constructing, and operating the transport network.

1.2 The Objective of this Report

The New Zealand Transport Agency (NZTA) is a crown entity formed to manage land transport in a way that promotes sustainability and safety. In carrying out its functions, NZTA seeks to contribute to the five objectives of the updated NZTS; namely (MOT, 2008b):

- Ensuring environmental sustainability.
- Assisting economic development;
- Assisting safety and personal security;
- Improving access and mobility; and
- Protecting and promoting public health.

This report directly supports the economic development and environmental sustainability objectives of the NZTS.

Recent oil prices have placed pressure on central, regional, and local government agencies. This pressure has motivated NZTA to commission this research into:

- The drivers of significant oil price movements;
- Impacts on transport decisions under several oil supply and price scenarios; and
- Recommended network and demand management responses to rising oil prices.

It is noted that various government agencies have roles in the management of travel and land-use patterns. For this reason this report has attempted to adopt a style that is able to communicate with a wide range of stakeholders. Parts of the report are subsequently written so as to introduce broader concepts, rather than merely convey results. The desire for this research to inform transport planning practices 'on the ground' has meant that more detailed technical information is consigned to the appendices.

1.3 Oil and the Domestic Economy

Oil acts as a key input into a variety of end uses, including transport fuels, plastics, pharmaceuticals, and fertilisers. In the year to March 2008 New Zealand imported $6.7 billion worth of petroleum products, which were the single largest commodity import by value (Statistics NZ, 2008d). Approximately 86% of the oil consumed in New Zealand is used for land transport purposes (MED, 2006). The remaining 14% of oil is used for industrial, agricultural, commercial, and residential purposes.

Oil is not only a direct contributor to the economy via imports and exports, but also has a specific and critical role to play in economic activity. Economists since Adam Smith have noted that the economic development of industrialised societies is intertwined with improved labour productivity brought about by the division of labour (Smith, 1776). And a division of labour in the 21st century relies upon what economists call "exchange" of goods and services on a large scale. One of the most important factors that facilitate "exchange" - both in a global marketplace and in the domestic market is an efficient transport system and related infrastructure (other important factors include transparent public institutions and the efficient transfer of information and knowledge). Transport is therefore a pervasive economic activity - higher transport costs tend to increase the costs of almost everything else. Higher transport costs create inflationary pressure that contributes to higher interest rates and lower economic growth, which in some situations may result in "stagflation" – a situation characterised by negative growth and high inflation (IEA, 2004).

The negative economic effects of high oil prices tend to emerge over time, with research suggesting the bulk of the impacts are felt four quarters after the initial price rise (Jiménez-Rodríguez and Sánchez, 2004). This time lag may reflect some degree of economic inertia; stock inventories for example slow the rate at which higher costs flow through into the price of non-perishable goods, while forward hedging by airline companies may serve to reduce price exposure in the short-term. Ultimately, however, sustained high oil prices will be passed on to consumers. High dairy prices, record domestic oil production, and a high New Zealand Dollar (NZD) have tended to buffer the domestic economy from the recent effects of high oil prices. Should either or all of these factors change then the domestic economy may become increasingly vulnerable.

High oil prices also have the potential to directly affect the costs of other energy forms. Oil is the major pillar of an increasingly interlinked global energy market. These linkages mean that the price of oil closely influences the price of other fuels, such as natural gas (MED, 2006). Thus when the price of oil increases the price of natural gas tends to follow. This has potential implications for electricity generation, which contributed approximately 17% of electrical energy generated in 2005 (MED, 2006). Should domestic gas supplies dwindle and be replaced by imported gas then New Zealand's electricity consumers may become increasingly exposed to international gas prices and, by default, global oil prices.

International research suggests that high oil prices suppress overall economic growth, although little research has been conducted into their effects on New Zealand's economy. For this reason, this report has been assumed that domestic economic growth is effectively decoupled from oil prices. For this reason the travel demands modelled in this report, particularly in the Average and High oil price scenarios, are likely to be substantially higher than would eventuate in a situation where the relationships between high oil prices and economic performance was more accurately modelled.

1.4 Divergent Views on Future Oil Prices

Discussions on future oil prices centre around two divergent views – commonly referred to as "peak oil" and "mainstream" perspectives.

Peak oil proponents maintain that world oil production will soon plateau or decline, causing increasingly high and unstable prices (EWG, 2007, Hirsch et al., 2005, USGAO, 2007). Peak oil projections are based on geological models of the historical performance of oil and gas fields, such as the United States and North Sea, which have exhibited sharp peaks in production.

At the other end of the spectrum, mainstream proponents maintain that high oil prices will drive exploration, discovery, production, and innovation at a rate that is sufficient to offset the drawdown in geological reserves, subsequently avoiding sustained high prices (Lynch, 2001). Mainstream sources agree that a peak in conventional oil production is likely to occur within the next two decades (Birol, 2008), but argue that innovation will ameliorate or mitigate the impacts of this peak.

Peak and mainstream views differ less in terms of substance and more in terms of their relative optimism on the accuracy of reserves, the potential for further discoveries, the viability of technological efficiencies, and opportunities for energy substitution. It is suggested that the terms "optimist" and "conservative" would more aptly describe the mainstream and peak oil views respectively.

Both positions provide insight into future oil prices; it is likely that technological innovations and geological realities will exert opposing influences on future oil prices. The question is more about the relative size, timing, and balance of the effects of their effects. This report has incorporated forecasts from both optimist and conservative sources in an attempt to generate a consensus view on future oil prices and identify where the balance of these effects may sit. The model used to generate future oil price projections is discussed in more detail in Section 3.

As opposed to many forecasts that provide a single deterministic forecast, this report develops three possible oil price scenarios – high, average, and low – so as to provide insight into the range of price variability that may be expected. The need for multiple scenarios also reflects that the risks and benefits associated with energy efficiency and resilience may not be captured by simply considering the expected oil price scenario. The importance of uncertainty is discussed in more detail in the following section.

1.5 The Importance of Uncertainty

The need for multiple oil price scenarios recognizes the importance of uncertainty in informing good decision making. This section discusses the concept of uncertainty within the context of oil prices and its potential implications for investment in transport infrastructure.

Land Transport NZ's Economic Evaluation Manual (EEM) guides the economic evaluation of transport projects. Detailed discussion on the merits of the EEM is outside the scope of this report, although a few general comments are warranted insofar as it relates to oil prices. The EEM outlines the process by which Benefit Cost Ratios (BCR) are calculated for transport infrastructure investment. This process considers the sensitivity of the BCR to changes in demand and project costs – however these tests tend to treat these factors independently of each other. As discussed earlier, high oil prices are likely to reduce demand for vehicle travel, increase the costs of road construction and maintenance, and generate higher demands for alternative modes *at the same time*. In other words, it is the combined effects of high oil prices that are important.

From a technical perspective, this reflects the significance of causally related variables, asymmetric risks, and non-linear benefits. This is demonstrated by the following example, which compares BCR associated with two transport projects, A and B, in three different fuel price scenarios. Table 1.1 shows the probability and BCR under three fuel price scenarios for each of the two projects.

Table 1.1: Risk weighted benefit cost ratios

Fuel Price Scenario	Risk	BCR	
		A	B
		Public Transport	State Highway
High	25%	2.50	1.00
Average	50%	1.50	1.75
Low	25%	1.25	1.80
Expected BCR		1.69	1.56

The "Expected BCR" may be calculated by taking the sum of the product of the Risk and BCR columns. This reveals that Project A, on average, delivers higher economic benefits than Project B – a result that is not immediately obvious from inspection of the Average or even Low fuel price scenarios. In other words, it is preferable to invest in Project A even though it delivers below par economic returns 75% of the time, on the grounds that it delivers exceptional economic returns for the balance of the time.

In this example Project A is intended to represent a public transport project that delivers mediocre economic benefits under Average and Low fuel prices but much greater benefits under High fuel price scenarios. In the High scenario Project A is able to cater for additional demand through relatively inexpensive modifications, such as the removal of seats to provide additional standing room. Higher load factors increase fare revenues and provide direct savings to transport funders. The small reduction in BCR for Project A under the Low price scenario reflects the fact that a reasonable proportion of public transport patrons are "captive" and as a result relatively insensitive to lower fuel costs.

In contrast, Project B is intended to represent a state highway capacity expansion that delivers reasonable economic benefits under Average and Low fuel prices. The increase in benefits when moving from a Average to Low fuel prices is only marginal, however, due to the fact that peak hour capacity constraints limit the highway's ability to accommodate additional vehicle travel. Under the High fuel price scenario the BCR drops significantly as modest reductions in vehicle volumes flow through to undermine the congestion reduction benefits associated with the project. Moreover, the High fuel scenario increases road construction and maintenance costs, which reduces the BCR even further.

Decision making under uncertainty has well developed applications in other fields, such as the management of hydro electric generators under uncertain supply and demand conditions (Philpott et al., 2000). Regardless of the application, the general thrust remains the same – performance under average operating conditions may not define the optimal investment strategy. More specifically, undertaking Cost Benefit Analysis (CBA) without accounting for the correlated impacts of oil prices may underestimate the economic benefits delivered by alternative transport projects, albeit only under certain conditions.

It is acknowledged that BCR are but one of several factors considered in the allocation of transport funds - and that their primary purpose is to rank similar classes of projects, rather than discriminate between different types of transport investment. Despite these caveats, it is important to acknowledge that BCR influence the funding applications local authorities are prepared to develop and also shape public and political perceptions of the value delivered by different types of transport investment. For this reason, it is important that the EEM is sufficiently sophisticated to realise the true economic benefits associated with investment in alternative transport modes. Further discussion on the EEM is contained in Appendix B.

1.6 Oil Spikes versus Sustained High Prices

This report draws a distinction between oil shocks and sustained high prices. A spike is defined as a large transient increase in price which subsequently subsides. Sustained high prices are, by contrast, a large and persistent increase in price. These two events differ in terms of what responses people are prepared to take and also in terms of what responses government agencies are able to provide.

The responses of individual households to an oil shock are likely to be dominated by short term measures, such as telecommuting. These decisions are typically made in the knowledge that reversion to standard travel patterns will be possible in the near future (IEA, 2005). In contrast, when exposed to sustained high fuel prices individuals are likely to opt for more permanent and enduring responses, such as locating closer to their usual destinations.

Government responses to an oil shock are likely to be dominated by measures designed to manage the fuel supply so as to maintain the integrity of essential services and the rule of law. This may require the implementation of heavy handed measures, such as fuel rationing programmes (IEA, 2005). In contrast, government responses to sustained high oil prices may more reasonably focus on accommodating long term changes in demand for certain travel and land use patterns.

The former generally falls under the responsibility of the Ministry of Economic Development (MED) which has developed the Oil Emergency Response Strategy to minimise the effects of a short term but severe oil supply disruption, and to ensure that New Zealand is able to meet its obligations as a member of the IEA. The measures outlined in the Strategy would only be used in circumstances where an industry response is unlikely to be sufficient (MED, 2008c).

In contrast, this research report primarily focuses on developing policy responses to sustained high oil prices, as opposed to oil shocks. Nevertheless, the recommended responses are also expected to improve the resilience of the transport system to oil spikes. In other words, preparing for sustained high prices will leave New Zealand's transport system better able to negotiate unexpected spikes.

1.7 Improved Vehicle Technology

Improvements in vehicle technology may be expected to mitigate the impacts of rising fuel prices by reducing the sensitivity of travel demands to increasing fuel prices. Improvements in vehicle technology generally fall into one of two key categories: improvements in fuel economy and alternatives to oil.

Fuel economy describes the amount of transport fuel consumed to travel a certain distance, often in litres of fuel consumed per 100km travelled. Technological improvements have resulted in sustained improvements in fuel economy. Uptake of these vehicles tends to be related to the price of transport fuels – with the period immediately following the oil shocks of the late 1970s and early 1980s seeing hitherto unmatched improvements in average fuel economy of approximately 1.4% per annum (MED, 2006).

This trend has been somewhat counter-acted in recent times by the increased prevalence of large vehicles. To some degree this trend may reflect a type of arms race whereby the increased prevalence of large vehicles increases the vulnerability, either real or perceived, of smaller vehicles (Levinson and Krizek, 2008). Despite the element of 'market failure' associated with recent trends towards larger vehicles, the economic incentive provided by sustained high oil prices may be expected to prevail over consumer preferences and drive increased uptake of more efficient vehicles.

New Zealand's current vehicle fleet is estimated to have an average fuel economy of 10.7 litres/100km (MED, 2006). Given that many new vehicles have fuel economies in the range of 5-6 litres/100km, increased uptake of existing technology will certainly assist consumers to offset the impacts of sustained high fuel prices. Mopeds and motorcycles provide even greater fuel economies and have indeed seen rapid growth in numbers in the wake of recent fuel prices (MOT, 2008c).

Alternative transport fuels are also receiving increasing attention as a means to decouple motorised travel from oil based transport fuels. These fuels include technologies such as electric vehicles (EV), hydrogen fuel cells, and compressed air (MED, 2007b, MDI, 2008). EV, particularly plug in hybrids are expected to be available to New Zealand consumers within the next 5-10 years. Ministry of Transport (MOT) estimates that approximately 6% of the vehicle fleet will be electric by 2028 (MOT, 2008c) – although recent high oil prices may be expected to accelerate this uptake.

Aside from EV, hydrogen fuel cells and compressed air technology may allow for the substitution of oil based transport fuels with electrical energy. Both technologies require technological developments that are likely to limit their deployment within the timelines considered in this study (MED, 2007b, MDI, 2007). Compressed air uses comparatively more established technology than hydrogen fuel cells but further investment in research, development, and distribution infrastructure is required before it will constitute a viable alternative to internal combustion engines.

This report has not considered the effects of improved vehicle technology, primarily because this is a market driven response over which government agencies - particularly at the regional and local levels - have little influence. Should the uptake of improved vehicle technology reduce the sensitivity of travel demands to high fuel prices then the results of this report may need to be re-evaluated, particularly in regard to the sensitivity of travel demands to higher fuel prices. It is noted, however, that the responses identified in this report are designed to affect the use of vehicles per se, regardless of what fuels them.

For this reason the recommendations contained in this report are considered to apply independently of improvements in vehicle technology. In other words, the economic benefits delivered by these measures means they are worth pursuing despite the uncertainty surrounding future fuel prices and vehicle technologies.

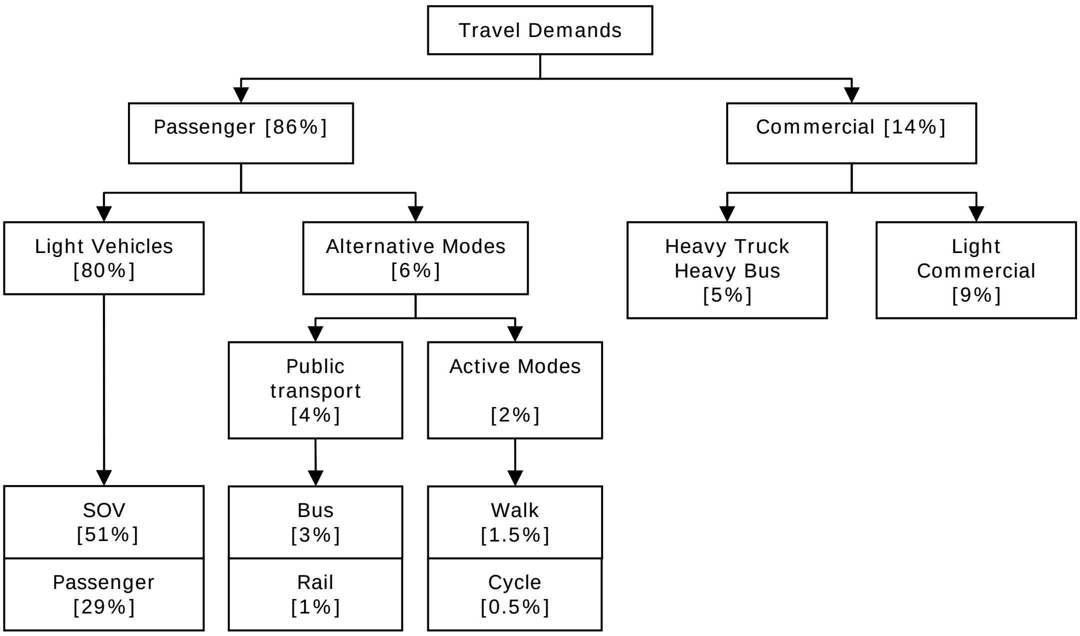
2. Background

Travel patterns describe the means and ways in which people, goods, and services are moved around. This section provides a background to New Zealand's current and emerging travel patterns and quantifies their reliance on oil based transport fuels. This section concludes with a list of key studies that have informed this research.

2.1 Current Travel Demands

Travel demands are generated by a variety of different users. Figure 2.1 outlines travel demand categories and the transport modes typically associated with these categories. The estimated mode share for each travel category is indicated in brackets, where mode share is measured in passenger kilometres travelled (PKT).

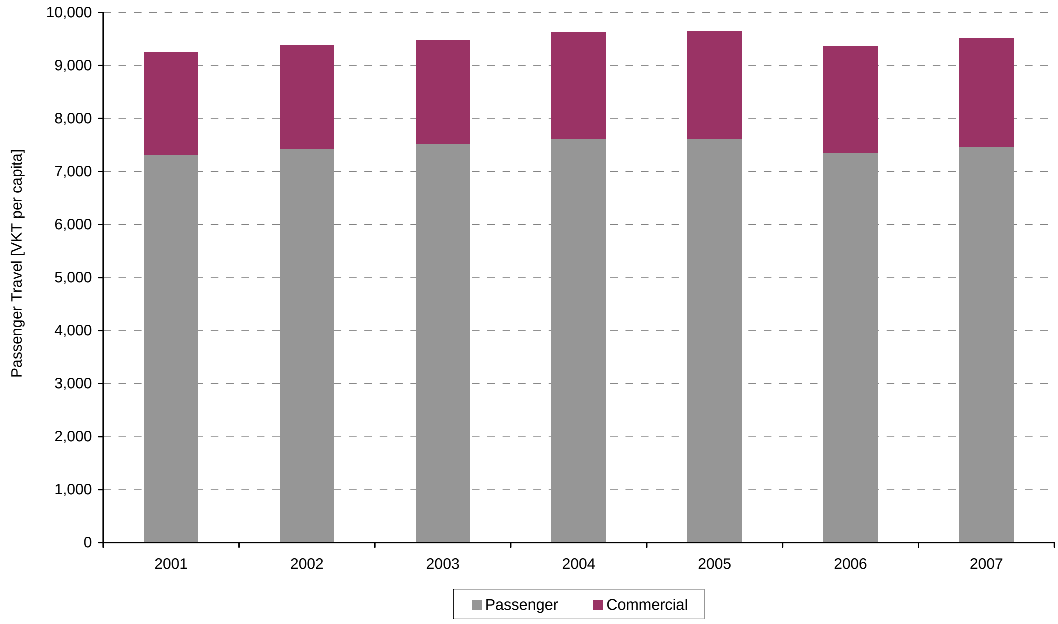
Figure 2.1: Travel Demand Categories and Estimated Current Mode Share [PKT]



Derived from MOT (2008a) and MOT (2008c), with some rounding of results.

This research focuses primarily on the second and third tiers – that is, the split in travel demands between light passenger vehicles, alternative modes, and commercial vehicles. It is noted the mode share indicated above does not include kilometres travelled by air, rail, or coastal shipping. Figure 2.2 illustrates per capita vehicle kilometres travelled (VKT) in the period 2001-07, broken down between light passenger vehicles and commercial vehicles. Total per capita travel increased from 9,250 to 9,500 VKT/year, which equate to annual average growth of 0.5%. Total VKT on New Zealand's road network increased from 35 billion in 2001 to approximately 40 billion in 2007, at an annual average increase of 1.9%. Light vehicle and commercial travel grew by 1.8% and 4.5% per annum respectively. This discrepancy in annual growth rates highlights the fact that the travel demands associated with light passenger and commercial vehicles are generated by different factors. This is discussed in more detail in Section 4.

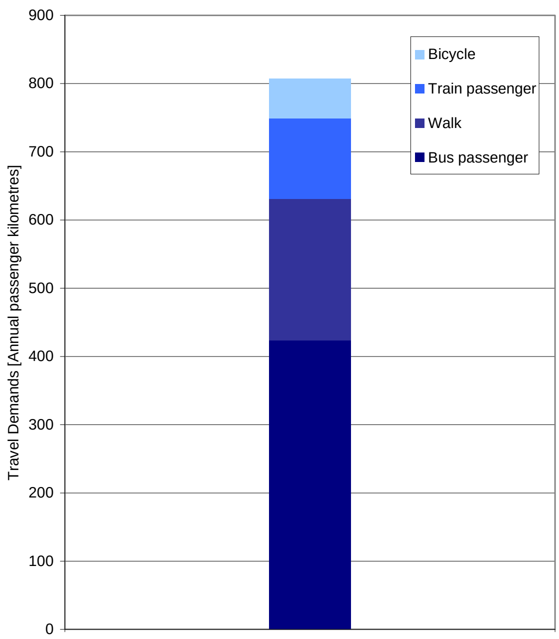
Figure 2.2: Total VKT 2001-07



Derived from MOT (2008c)

The MOT's Household Travel Survey (HTS) provides information on time spent travelling by all modes, which is summarised in Figure 2.3 in terms of passenger kilometres travelled (PKT) travelled.

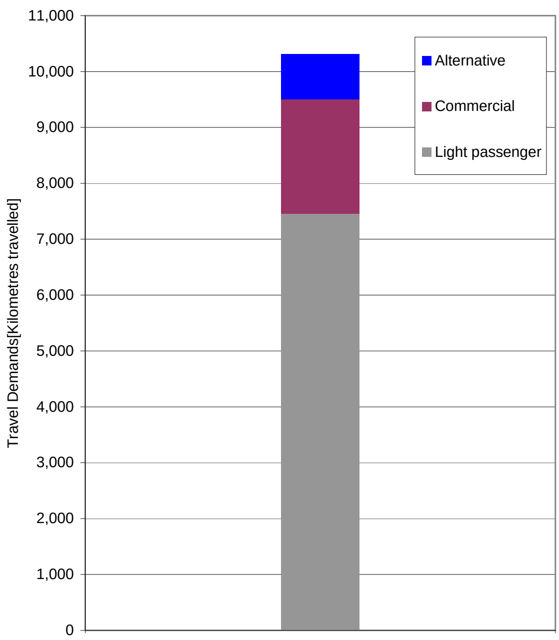
Figure 2.3: Per capita Travel by Alternative Modes 2007



Derived from (MOT, 2008a)

It is important to note that when discussing travel demands for vehicles the most appropriate measure of demand is VKT, while for alternative transport modes the most appropriate unite of measurement is PKT. Figure 2.4 illustrates the breakdown of for travel demands associated with for light passenger vehicles, commercial vehicles, and alternative transport modes.

Figure 2.4: Total travel demands by mode in 2007



2.2 Trends in Passenger Travel

Figure 2.1 defines passenger travel as that undertaken by either light vehicles or alternative modes. This section considers trends in passenger travel in more detail.

Mode share for the home to work journeys of the 15+ population is collected each census. The 2006 census saw increases in the use of single occupant vehicles (SOV) and public transport, with reduced levels of car-pooling, walking, and cycling. Of people who travelled to work on census day, almost 79% drove SOV. Despite starting from a small base, rail experienced the largest relative increase in mode share – a result that reflects increased investment in Auckland's rail network.

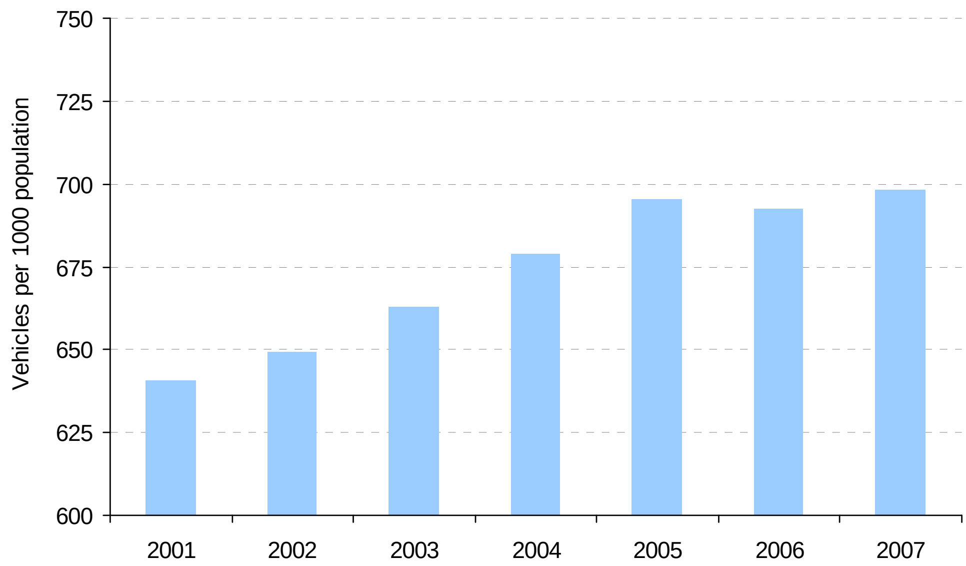
Due to its focus on home to work patterns the census is unlikely to reflect overall travel patterns and, in particular, will underestimate the role of walking and cycling – much of which is undertaken for education and recreational travel purposes. Other transport surveys are able to supplement census data in this regard. The HTS shows a somewhat lower vehicle mode share of 54% of all trip legs (MOT, 2008a). Both census and HTS data indicates that private vehicle mode share increased from 1996-2006.

The HTS also provides insight into demographic factors affecting travel patterns: those outside the 40-59 age group drive significantly less than average, while women are found to drive significantly less than men in all categories. An ageing population may therefore be expected to result in reduced demand for private vehicle travel (O'Fallon and Sullivan, 2003).

New Zealand's per capita vehicle ownership rates increased steadily until 2005, since which time they have increased more slowly (MOT, 2008c). A number of factors may have contributed to this growth, including growth in disposable income, the high value of the NZD, changes in vehicle licensing standards, and sustained low fuel prices. Figure 2.5 illustrates vehicle ownership rates in New Zealand per thousand people for the period 2001-07.

The slow down in growth since 2005 may reflect the fact that ownership is approaching saturation (Dargay and Gately, 1999). Alternatively, higher fuel prices in 2006 may have reduced the attractiveness of vehicles and the amount of disposable income available to purchase them.

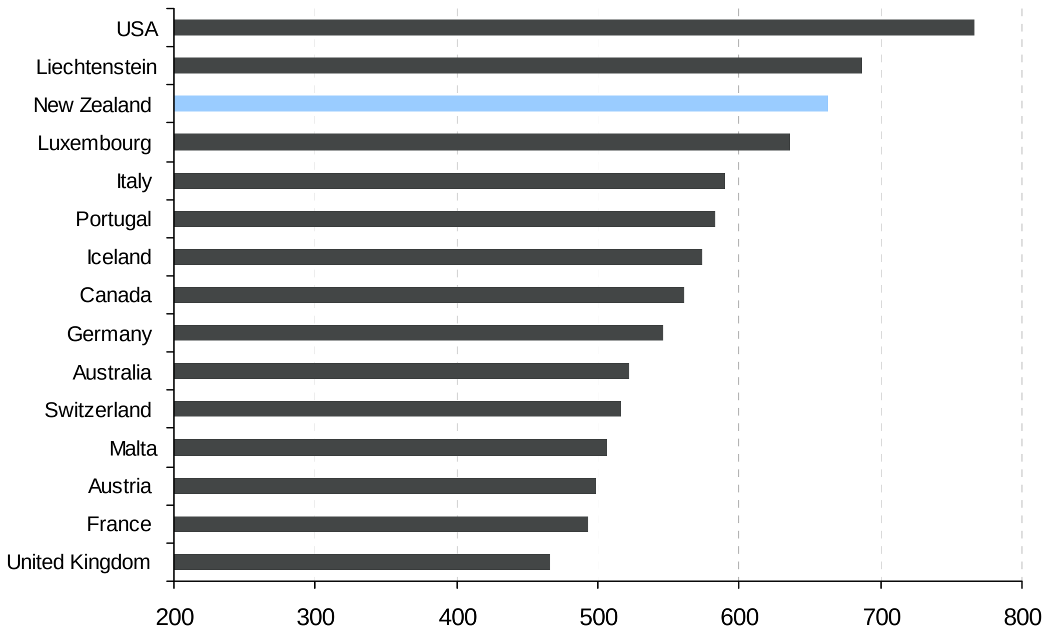
Figure 2.5: Rates of Vehicle ownership in New Zealand 2001-2007



Source: MOT (2008c)

The distribution of vehicles by household is likely to have a major influence on the extent to which increasing vehicle ownership generates additional vehicle travel. For example, the impacts of a household moving from zero vehicle to one vehicle is likely to have a larger influence on VKT than the impact of moving from one vehicles to two vehicles etc (Corpuz, 2007). Analysis of census data reveals a steady decline in the percentage of households without access to a vehicle – from 11.4% in 1996 to 7.8% in 2006. Figure 2.6 compares New Zealand's vehicle ownership rate in 2004 to a range of other countries.

Figure 2.6: International Comparison of Vehicle Ownership Rates 2004

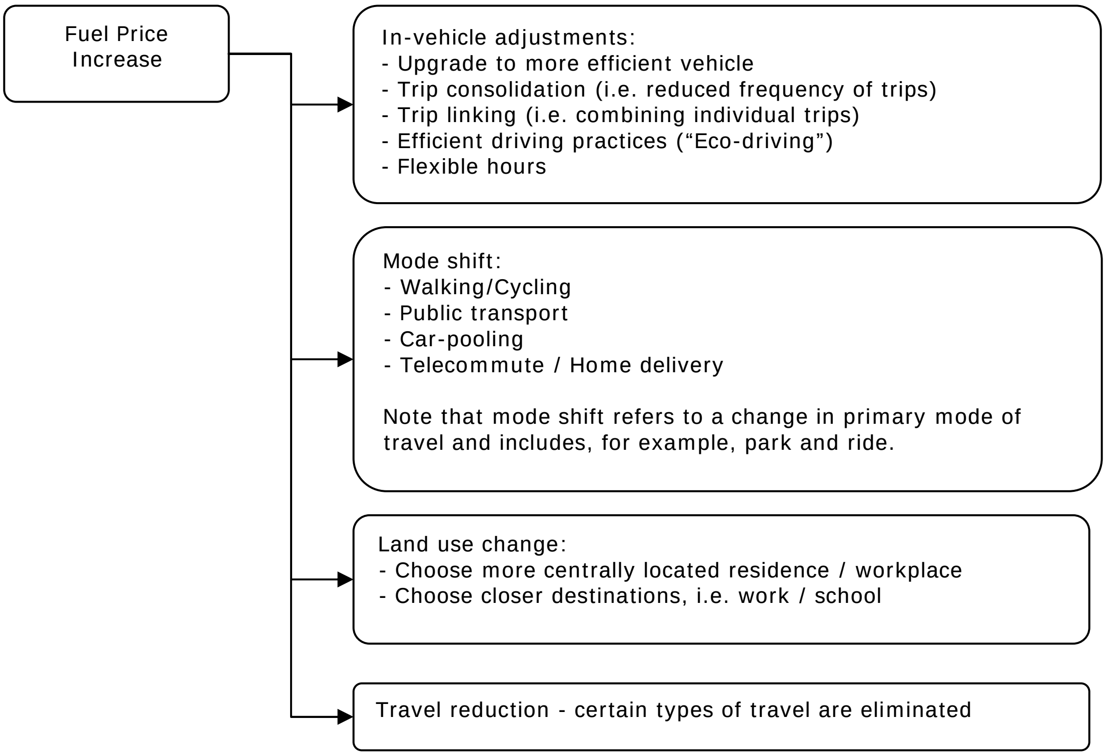


Source: MOT (2008c)

Despite historical growth in vehicle ownership, demographic trends towards an older and increasingly urbanised population, high fuel prices, and more stringent safety and environmental conditions on imported vehicles may suggest that historical growth is not necessarily an indication of future trends. Moreover, historical growth in vehicle ownership is likely to have been partially supported by underpriced vehicle travel, particularly regulations and subsidies related to parking. This is discussed in more detail in Section 5, but it is important to note at this point that a combination of factors may that peak vehicle ownership will be reached in the near future.

For the households that currently do have access to at least one vehicle, responses to higher fuel prices are likely to fall within one of the following four categories: in-vehicle adjustments; mode shift; land use changes; and travel reduction. These categories, and examples of the types of responses they include, are illustrated in Figure 2.7.

Figure 2.7: Personal Travel Demand Responses to Fuel Price Increase



These categories provide a simple behavioural framework through which the effects of higher oil prices may be interpreted. It is important to note that only one of the potential responses – that is public transport - is exclusively associated with urban areas. For this reason, this framework applies almost as equally to rural areas as it does to urban.

2.3 Trends in Commercial Travel

Commercial travel includes travel demands associated with light commercial vehicles, heavy trucks, and heavy buses. Heavy trucks and buses are primarily used for relatively infrequent but regular point to point bulk deliveries, while light commercial vehicles tend to be associated with the high frequency and dispersed travel patterns attributable to the delivery of high value goods and services.

Four modes compete for domestic freight: air, ship, road, and rail. This research has focused on trends in commercial travel undertaken on the road network but considered where appropriate MOT targets designed to lift the freight mode share of rail and costal shipping (MOT, 2007, MOT, 2008d). The trend towards these modes is likely to be reinforced by sustained high oil prices.

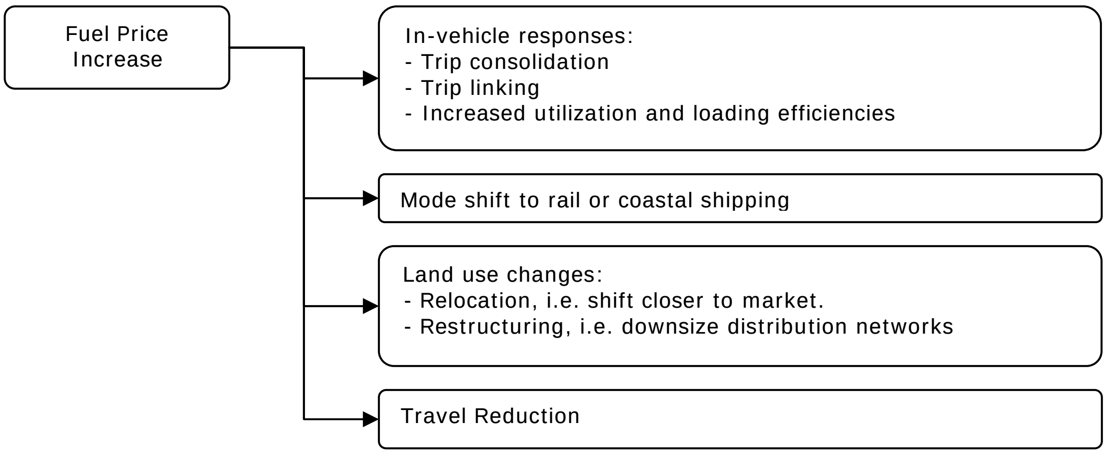
Travel demand responses for commercial vehicles vary significantly depending on the type of activity it supports. In areas where access to alternative modes exists and high volumes of non-time critical goods are travelling long distances, substantial opportunities exist to shift to rail and shipping.

It is often not feasible to relocate the point of production of some natural resources and primary products. For these goods a lack of accessibility to alternative modes leaves in-vehicle efficiencies as the primary responses to mitigate higher fuel costs. Accessibility to alternative modes is likely to be more adequately addressed at the regional level and is thus not considered within the scope of this report.

Commercial travel demands are expected to be less sensitive to oil prices than light passenger travel demands. This reflects the latter's higher economic utility as well as the fact that fuel represents only a small component of overall operating costs. Commercial travel demands are thus more strongly linked to economic growth (Mackie et al., 2006).

This research has combined light commercial vehicles, heavy trucks, and buses. In reality, light commercial vehicles are likely to exhibit price sensitivity somewhere between light passenger vehicles and heavy vehicles. Commercial travel demand responses to rising fuel prices are summarised in Figure 2.8. This is similar to that previously considered for passenger vehicle.

Figure 2.8: Commercial Travel Demand Responses to Fuel Price Increase



Discussion of international freight movements is outside the scope of this report. Some trends, however, are relevant to commercial travel undertaken on the road network.

High oil prices may be expected to give international shipping an increased price advantage over air for the movement of non-time critical international freight. This is likely to reinforce the importance of ports as the origin and destination of international freight movements, as well as increase the importance of high capacity terminals able to both physically accommodate and rapidly unload large ships.

High fuel prices may also drive consolidation in international freight movements around fewer larger terminals located close to markets, increasing the potential benefits of coordination, cooperation, and specialisation between individual port companies. In terms of domestic shipping, where physical size and unloading capacities are possibly less important, there may be a trend towards use of local ports.

Sustained high oil prices may have specific implications for major airports, which may be expected to suffer from lower volumes of air passengers. Auckland International Airport, for example, is the single largest traffic generator in the Auckland Region. For this reason the travel demands in the south western sector of the region may be more sensitive to sustained high fuel prices, all other things being equal.

2.4 Oil Intensity as a Benchmark

The term "oil intensity" is used to describe the quantity of oil based transport fuels required to support certain travel patterns. Oil intensity combines data on mode share, fuel economy, and travel distances into a simple measure of energy efficiency. The individual oil intensity [I_{Mode}] for each mode is calculated as: $I_{Mode} = M_{Mode} * F_{Mode} * D_{Mode}$. The total oil intensity [I] is then calculated by summing these individual oil intensities for each mode. Travel by active modes, such as walking and cycling, do not rely on oil and are thus excluded from this analysis; their ability to reduce oil intensity is implicitly accounted for via mode share factor. Table 2.1 illustrates the individual oil intensities on census data for 2006 and improvements in fuel economies.

Table 2.1: Oil Intensity [litres/trip] 2006[1]

Mode	Parameter			
	M_{Mode} [%]	F_{Mode} [litres/km]	D_{Mode} [km]	I_{Mode} [litres/trip]
Car	51	0.108	9.11	0.50
Car passenger	30	0.058	11.2	0.19
Bus	3	0.046	11.7	0.02
Train	1	0.015	29.4	0.00

Derived from: MOT (2008a), MED (2006), Kenworthy (2003)

The total oil intensity [I] therefore is equal to the sum of the final column in Table 2.1, or 0.71 litres/trip. This analysis highlights that improvements in energy efficiency arise in one of the following three ways:

- Increased uptake of energy efficient travel modes, such as bus and train;
- Improved fuel economy; and
- Reduced travel distances.

Technological improvements are expected to be driven by the private sector, where social preferences and energy prices are expected to be key factors. These improvements are likely to be driven by international factors more than local policy. For this reason the focus of this report is on those areas where government agencies, particularly at the regional and local levels, may affect energy efficiency. This lends itself to a focus on

[1] It is important to draw a distinction between average and marginal oil intensities. Average values represent the fuel consumed divided by the total passengers travelled, whereas marginal values represent the fuel consumed for each additional trip. Table 2.1 presents average values, which are typically greater than marginal values. Shared modes, such as bus and train, are likely to have extremely low marginal values – as most of the fuel consumed is associated with vehicle operation rather than the weight of additional passengers.

facilitating uptake of energy efficient modes and encouraging locational decisions that lead to reduced travel distances.

HTS data indicates that the average person undertakes approximately 1500 trips per year. Combining this figure with the oil intensity calculated previously (0.71*1500) suggests that approximately 1,000 litres of oil-based petroleum fuels are required to support the travel patterns of the average New Zealander per year.

In the year to the June 2008, average petrol prices rose from $1.51 to $2.11 per litre. Assuming an own-price elasticity of fuel consumption with respect to price of -0.15 in the short term, recent price rises have cost the average person just over $400 per year all other things being equal (Kennedy and Wallis, 2007).

Urban areas that are characterised by access to multi-modal transport systems, mixed land use patterns, and younger populations are likely to be less vulnerable to rising oil prices. In contrast, vehicle dependent rural areas that support older populations are likely to consume more energy for transport purposes. Table 2.2 illustrates the oil intensity for the Bay of Plenty (BOP), Wellington, and Otago regions based on home to work mode share data from the 2006 census.

Table 2.2: Regional and Local Oil Intensities 2006

	National	BOP	Wellington	Otago
Oil Intensity	0.71	0.74	0.53	0.61
% Difference	-	5%	-25%	-14%

Table 2.2 reveals how Wellington and Otago, with their high alternative mode share, have oil intensities 25% and 14% lower than the national average respectively. BOP supports active mode share far less than Wellington and Otago, despite enjoying a more hospitable climate, such that its oil intensity is higher than the national average.

The socio-economic burden of higher oil prices is expected to vary in relation to travel patterns and household income. Dodson and Spie (2006) suggest that these factors are correlated – such that areas with more oil intensive travel patterns also tend to have lower disposable income. Further research could investigate these local variations in more detail, identifying those areas at greatest risk from sustained high fuel prices.

2.5 Summary of Key Texts

Key texts that have informed this research are summarised in Table 2.3. More detailed information on these texts is contained in the references to this report.

Table 2.3: Summary of Key Texts

Document		Relevant Fields			Context	Notes
Reference	**Title**	**Energy**	**Economics**	**Transport Planning**		
IEA (2007)	World Energy Outlook 2007 – China and India Insights	✓			Global	IEA assessment of global energy outlook with particular focus on trends in China and India.
EWG (2007)	Crude Oil – The Supply Outlook	✓			Global	Provides a conservative perspective on trends in oil discovery and production.
IEA (2008)	Medium Term Oil Market Report	✓	✓		Global	Discusses the confluence of factors that have contributed to recent prices and identifies how these factors may track over the medium term.
CSIRO (2008)	Fuel for Thought: The future of Transport Fuels – Challenges and Opportunities	✓	✓	✓	Australia	Models peak oil and technology scenarios so as to inform planning and policy decisions.
MED (2007b)	New Zealand Energy Strategy to 2050 – Powering our Future	✓	✓	✓	Local	Outlines the Government's energy vision for New Zealand and discusses anticipated energy efficiency gains in the transport sector.
Dantas et al (2007)	Energy Risk to Activity as a Function of Urban Form	✓	✓	✓	Local	Quantifies the ability of several land use patterns to sustain travel demands in an energy constrained situation.
IEA (2005)	Saving Oil in a Hurry	✓	✓	✓	Global	Analyses the potential for saving oil using a variety of demand management responses.
Ewing et al (2007)	Growing cooler the evidence on urban development and climate change	✓	✓	✓	Global	Investigates relationships between climate change, land use, and travel demands and identifies the potential for a combination of pricing and land use mechanisms to reduce travel demands.
Levinson and Krizek (2008)	Planning for Place and Plexus – Metropolitan Land Use and Transport		✓	✓	Global	Challenges current transport and land use planning policies within a neo-classical economic framework – provides examples of market failures and auto-catalytic[2] processes.
Litman (2006b)	Win-win Transportation Solutions – Mobility Management Strategies that Provide Economic, Social, and Environmental Benefits		✓	✓	Global	Evaluates various demand side management transportation strategies within a comprehensive multi-criteria framework.
Litman (2007a)	Market Principles - TDM Impacts on Market Efficiency and Equity		✓	✓	Global	Discusses the principles of an efficient market and how they relate to various travel demand management strategies.
Shoup (2005)	The High Cost of Free Parking		✓	✓	Global	Highlights the inefficiencies associated with current parking management practices – in particular minimum parking requirements and the provision of free-parking.
Genter (2007)	Economic evaluation and transport planning in New Zealand: assessing all potential costs of new motorway projects in the Auckland Region		✓	✓	Local	Investigates the application of Land Transport New Zealand's EEM to a state highway project and considers areas where costs may not be adequately evaluated.
Jakob et al (2006)	Transport cost analysis: a case study of the total costs of private and public transport in Auckland		✓	✓	Local	Compares the cost ($ per km) associated with private vehicle and public transport in Auckland, highlighting the large external costs borne by society to support vehicle travel in urban areas.
Dodson and Spie (2006)	Suburban Shocks: Assessing Locational Vulnerability to Rising Household Fuel and Mortgage Interest Costs			✓	Australia	Analyses economic and travel data to identify areas with high vulnerability to increasing oil prices.

[2] Auto-catalytic processes are also known as 'positive feedback loops' – they are self-reinforcing effects that are typical of complex and unstable systems, such as transport and land use.

3. Modelling Prices for Transport Fuels

This section provides a background to oil markets and identifies risk factors affecting oil prices. It then develops three oil price scenarios that are used to determine the future price of petrol and diesel in the period 2008-28.

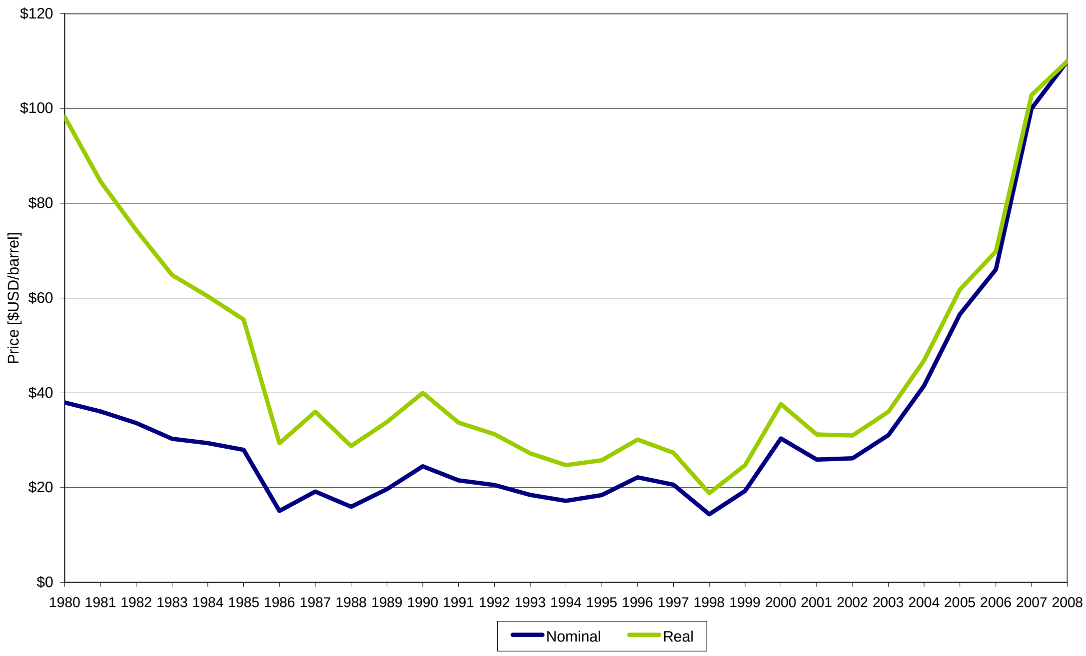
3.1 Background to Oil Markets

This section provides a background to oil markets. Most of the data used in this section are sourced from the BP Statistical Review of World Energy (2007). The material is not intended to provide an exhaustive discussion on oil markets, but to introduce the historical performance of oil markets and provide a context for subsequent discussion. Further discussion on oil markets is available in the MED's recently released introduction to oil (MED, 2008b).

3.1.1 Introducing Oil Prices

Figure 3.1 illustrates recent trends in real and nominal prices for oil.[3]

Figure 3.1: Nominal and Real Price of Oil 1980-2008



Source: BP (2007)

Figure 3.1 demonstrates that recent increases have driven the real price of oil above that experienced in the early 1980s. Recent prices are notable both for the size and rate of the increase – they have increased five fold over the last decade.

[3] Real prices are adjusted for inflation and more indicative of historical prices in today's terms.

The annual average prices illustrated above obscure significant short term variability that characterises oil prices (Krichene, 2008). This variability is primarily a reflection of low supply and demand elasticities. In other words, there is little leeway to increase or reduce oil production in response to changes in demand such that price becomes the primary mechanism for controlling demand at a level commensurate with product availability.

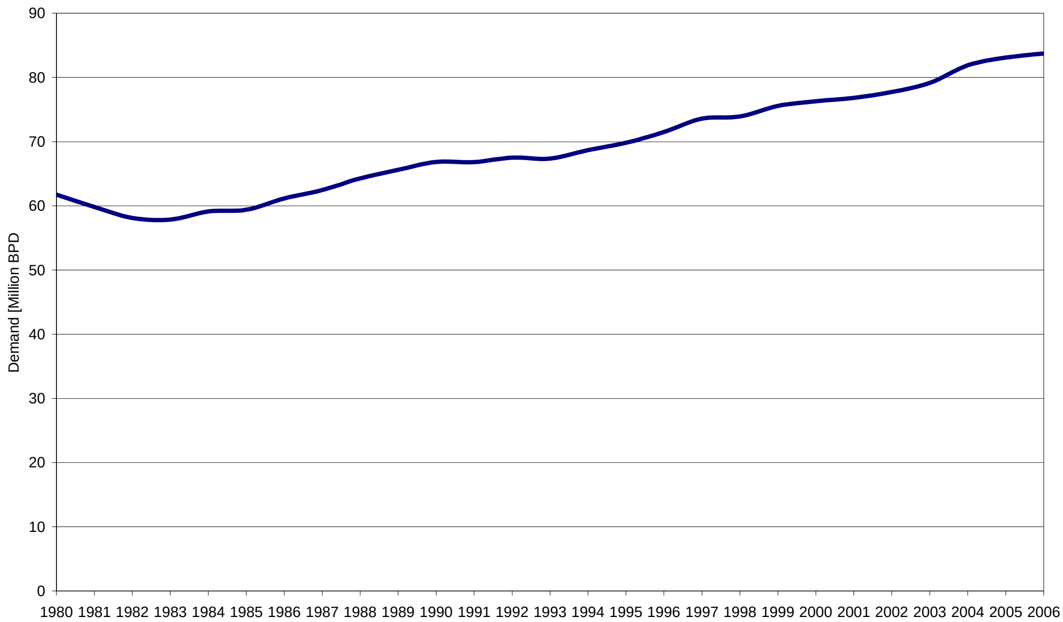
Demand is also relatively slow to respond to respond to price because much of the equipment that depends on oil is sunk. High prices also indicate a high willingness to pay; oil is required for the production of a number of high value products, such as transport fuels, plastics, pharmaceuticals, and fertilisers. Consumers of such value added products are willing to pay high prices in times of resource scarcity.

Oil prices are therefore set within a market characterised by producers and consumers that are relatively insensitive to price. This on its own would be expected to result in large prices swings, but added volatility is introduced by unforeseen events, such as geopolitical uncertainties, that unexpectedly disrupt supply chains. More detailed discussion on these events is provided in Section 3.2.

3.1.2 Demand

The demand for crude oil for the period 1980-2006 is illustrated in Figure 3.2. This shows demand declining in the first half of the 1980s in response to the oil shocks of the late 1970s and early 1980s. From this point, demand has grown steadily to reach approximately 85 million BPD in 2006.

Figure 3.2: Total demand for crude oil 1980-2006



Source: BP (2007)

Looking ahead the IEA expects demand for oil to grow from 86 million BPD to approximately 96 million BPD by 2012. This represents an average annual growth rate of just over 2%. Demand growth has increasingly been driven by developing countries, such as India, China, and the Middle East. This growth is not solely the product of economic development but also a result of price controls and subsidies that shield consumers from increases in fuel prices, at least in the short term (IEA, 2008). In economic terms, this means that the drivers of marginal demand growth are effectively decoupled from prices, such that the swings required to manage the market (i.e. supply and demand) are that much more brutal.

Rapid demand growth in developing countries has occurred in tandem with shifts in demand towards lighter, more intensively processed products, such as transport fuels (IEA, 2008). Increased demand for lighter oil products has coincided with laggard growth in production from conventional oil sources, requiring increased production from unconventional and heavier oil sources. Thus demand and supply for refined oil products is diverging, placing additional pressure on the supply chain, which are discussed in more detail in the following section.

3.1.3 Supply

Supply is used to define both the production (discovery and extraction) and processing of oil products.

Oil supply is typically broken into conventional, unconventional, and synthetic sources. Unconventional sources include oil produced from oil sands, heavy oil, and oil shale, while synthetic fuels includes coal liquefaction, gas to liquids, and bio-fuels. A plateau in production from conventional sources has seen the role of the swing producer shift to unconventional and synthetic sources (IEA, 2008).

Production costs associated with unconventional and synthetic oil are substantially higher than that of conventional oil, particularly if carbon emission charges are included (Birol and David, 2001, MED, 2007a). Industry data suggests that production costs have increased substantially in recent times with the price required to provide return on investment rising steadily from approximately $20 USD/barrel in 2000 to approximately $90 USD/barrel in 2008 (EIA, 2008a, Goldman-Sachs, 2008).

Not only are the costs of oil production increasing, but spare capacity within the oil supply chain is tight by historical standards. Research by Goldman Sachs (2008) indicates that the immediately deliverable spare capacity of OPEC is expected to remain at approximately 2 Million Barrels Per Day (MBPD) until 2010 – in comparison to the average of 6 MBDP spare capacity that existed during the 1980s and 1990s. The already limited supply response is therefore pushing up against the physical limitations of the supply chain. In other words, the ability to pump more oil is even tighter than normal.

The risk posed by tight supply chains is noted by the IEA in their World Energy Outlook 2007:

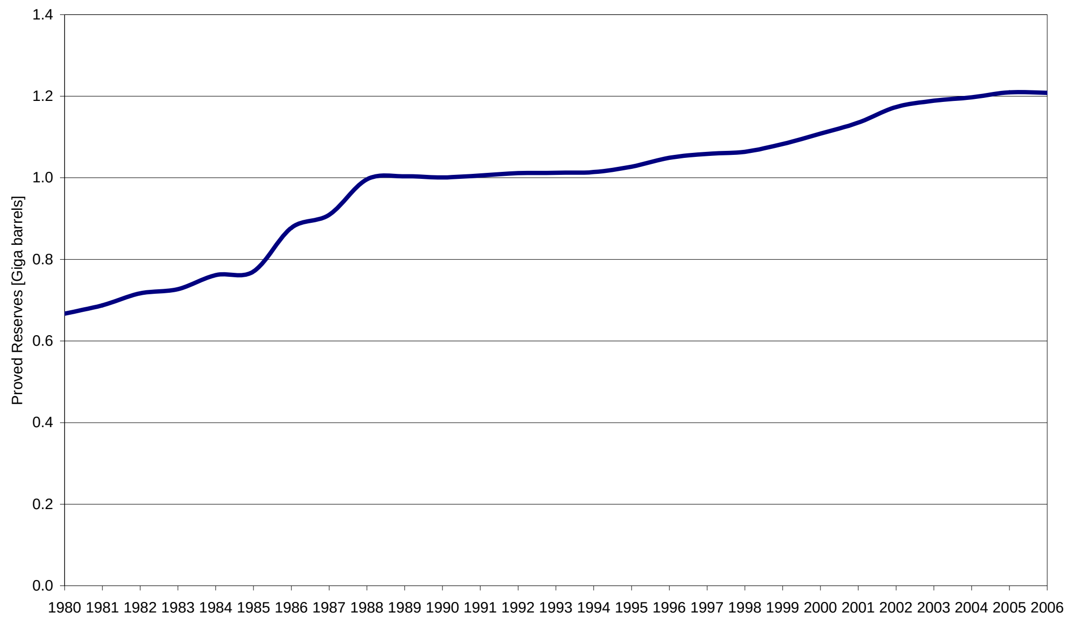
Although new oil-production capacity additions from greenfield projects are expected to increase over the next five years, it is very uncertain whether they will be sufficient to compensate for the decline in output at existing fields and keep pace with the projected increase in demand. A supply-side crunch in the period to 2015, involving an abrupt escalation in oil prices, cannot be ruled out (IEA, 2007).

This warning reinforces the fact that resource availability is not equivalent to product availability – especially given the restricted markets within which a large proportion of the world's oil is produced. Various risk factors that affect oil supplies are discussed in more detail in Section 3.2. The following section discusses the issue of resource availability in more detail.

3.1.4 Reserves

Approximately 1 Giga Barrels (GB) of oil has been produced thus far, with another 1-2GB of conventional oil sources remaining (MED, 2007a). Proved reserves are defined as the amount of oil that is economic to extract using existing technologies. Figure 3.3 indicate that proved reserves have increased since 1980, although recently appear to have reached a plateau.

Figure 3.3: Proved Reserves 1980-2006



Source: BP (2007)

It is worth distinguishing between proved reserves and ultimately recoverable reserves (URR). The latter describes, quite simply, the amount of oil considered to exist in the ground that is able to be recovered and produced. This includes unconventional sources, such as oil sands, heavy crude, and oil shales. Studies have indicated that URR may be up to five times greater than proved reserves – approaching 5-6GB (SAUNER, 2000, MED, 2007a).

Thus URR are an effective upper bound on total oil production, while proved reserves represent what is known to exist and feasible to extract under current conditions. Over time, the amount of oil that becomes proved reserves may be expected to increase until URR is reached. Estimates of URR are, of course, highly uncertain. There is no way to know how much oil is in the ground without actually drilling for it.

It is noted that the accuracy of the proved reserves illustrated in Figure 3.3 is highly disputed. Some commentators have questioned the validity of rapid increases in proved reserves attributed to OPEC states in the mid 1980s (ASPO, 2008). These commentators stress that OPEC's production quota system provides incentives for member countries to over-represent their proved reserves; countries with declining proved reserves may expect a reduction in production quota and subsequent reduction in oil revenues. These commentators note that the quota system was established in 1983, immediately prior to the rapid increases in stated reserves evident in the mid-1980s.

There may be other incentives for oil producing countries to overstate their proved reserves – major investment decisions require some degree of certainty of resource availability. Awareness of lower reserves and/or limited supply may catalyse increased technological efficiencies and/or substitution that would serve to reduce long term demand and thereby weaken the economic position of oil producing countries. In this situation, oil producing countries may indeed have an interest in blaming high prices on external factors (such as speculation) rather than internal resource or production limitations that would tend to result in more enduring market responses. The lack of commercial transparency surrounding the activities of OPEC's national oil companies mean that uncertainty over the accuracy of proved reserves is likely to persist as a major upside risk.

Should OPEC's proved reserves be found to be lower than stated there will be a need for more rapid ramp up in production from unconventional and synthetic sources; whether such a ramp up is feasible remains to be seen.

3.1.5 Summary of Oil Markets

Previous sections have provided a brief background to the key factors driving oil prices in recent times. It has highlighted the importance of:

- Low short term elasticities of supply and demand, which are structural realities of international oil markets and the main driver of large short term price movements;
- Demand growth that is both accelerating and shifting, placing pressure on the capacity of the oil industry to produce and process the volumes that are required;
- Static production from conventional sources has resulted in that marginal demand being increasingly met by more expensive unconventional and synthetic oil sources;
- Higher supply costs associated with unconventional and synthetic sources mean that high prices are required to provide return on investment (Goldman-Sachs, 2008); and

- Proved reserves appear sufficient in the short to medium term, although there are risks over the veracity of OPEC reserves.

The recently released Medium Term Oil Market Report from the IEA summarises the outlook as follows (IEA, 2008):

> *Despite a considerable downward revision to our global oil demand forecast due to weaker economic growth projections and a doubling of oil prices over the past year, structural demand growth in developing countries and ongoing supply constraints continue to paint a tight market picture over the medium term. Oil demand remains concentrated in developing economies, with 90% of the growth spread between Asia, South America and the Middle East, reflecting the improving wealth and accelerating energy use in several high-population countries. In spite of a considerable increase in investment, non-OPEC crude supply will remain at or below 39 mb/d over the next five years, with the majority of the 1.2 mb/d of non-OPEC liquids growth coming from NGLs, condensates and biofuels. Refining investments continue apace, but with costs doubling over the past five years, planned expansions are put under regular financial scrutiny and projects are subject to ongoing slippage and are vulnerable to changes in refining margins. As such, with 48% of global product demand growth over the next five years concentrated in middle distillate fuels, generating sufficient product to meet demand will continue to be a challenge. Further, investment in upgrading capacity will lead to tighter fuel oil markets and will expose the heavy end of the barrel to strong additional pressures from tight LNG and coal markets.*
>
> *Poor supply-side performance since 2004, in the face of strong demand pressures from developing countries, has forced oil prices up sharply to curb demand. These pressures have been exacerbated by refinery tightness, which limits the flexibility of the industry to meet the structurally strong demand growth for middle distillate fuel. While recognising that speculation can have a day-to-day impact on price moves, the fact that all producers are working virtually flat out and that there is no sign of any abnormal stock-build gives a strong indication that current oil prices are justified by fundamentals. Similarly, while high forward prices may reflect concerns about peak oil or sustained demand growth, they too could only impact spot prices if they started to create a forward price premium sufficient to encourage stock-building.*

For this reason there would appear to be a number of market factors that point towards a risk of sustained high oil prices, particularly in the short to medium term. Other more pervasive risk factors are discussed in more detail in the following section.

3.2 Risk Factors

A number of factors may affect the supply and demand for oil at any point in time. Some of these are internal to oil markets while other risks are more pervasive, and reflect the uncertainties associated with the discovery, extraction, production, processing, and delivery of a valuable resource in challenging natural and political environments. These uncertainties are referred to in this report as “risk factors.”

Table 3.1 outlines risk factors, identifies their various components, and discusses instances when they may arise. Table 3.2 then outlines examples of historical events that have caused supply disruptions, including the magnitude of the disruption and estimates of the subsequent impacts on price.

"Supply disruption" generally refers to a loss of oil from a particular country or group of countries relative to a preceding month or months. The full extent and impact of a disruption or loss depends on a variety of factors, including replacement production from other, unaffected, countries; the level of oil inventories; and level and growth rate of demand. Definitions of "oil supply disruptions" are not entirely consistent from one case to the next, in part due to differing views of such events over time and amongst analysts.

Table 3.1: Risk factors

Factor	Component	Discussion	Examples
Geostrategic Uncertainties	Stability of oil producing nations	Political insecurity arising from instances of coups and civil unrest. This may be self-reinforcing, in that rising oil prices inflate food/energy prices and thereby further increase instability within oil producing countries.	Strikes in Venezuela 2003, unrest in Iran and Indonesia
	Security of oil producing facilities	Potential attacks (successful or otherwise) from disaffected groups may target vulnerable links in oil supply chain.	Unrest in Iraq
	Hegemonic Adventurism	Increasing tendency for states to undertake aggressive international actions to secure access to oil resources, from which the ensuing war/occupation may destabilise oil production.	US Occupation in Iraq
	Embargos and Sanctions	Foreign policy tensions may see an oil producing state retaliate with embargoes on oil exports.	Iran Oil Embargo
	Ethnic conflicts and strife	Internal ethnic disagreements over the control of oil production and the resulting revenues may disrupt activities.	Niger Delta
	Natural disasters and accidents	Natural events, such as earthquakes and hurricanes, have the potential to disrupt oil production and distribution. Accelerating global warming and increased reliance on off-shore oil production may increase vulnerability to these events.	Hurricane Katrina
Investment Factors	Domestic policy	Countries with regulated energy markets, balance of payments shortfalls, or high levels of subsidies for oil and gas, may be vulnerable to rapid changes in the price of oil and internal policies. Resource nationalism threatens to restrict the amount of oil flowing to international markets	Oil subsidies in China, India, Indonesia, and Malaysia
	Spare capacity of oil producing counties	Ability and willingness of oil producing countries to balance the market in response to fluctuations in supply and demand	OPEC resistance to raising production in face of higher prices
	Increasing costs of production	Production cost estimates are dated and do not account for costs associated with the advanced technologies and oil recovery techniques required to find and uplift oil from difficult locations, as discussed in Section 3.4.2.	Deep sea oil rigs have 4-5 times higher operating costs
	Investment in sustaining and expanding production	Oil producing nations may not invest sufficient amounts in exploration and new production capacity. The dissemination of best practice production methods is also slower to infiltrate countries with insular oil industries.	Iran and Kuwait
	Investment in sustaining and expanding processing	Appropriate mix of investment in processing capacity will shift as reliance on unconventional oil increases. Investment in refineries usually incurs a 3-5 year time lag before additional capacity comes on stream.	Current diesel prices are driven by lack of investment in diesel refining capacity
	Uncertainty reduces investment	Infrastructure required to find, drill, produce, refine, and distribute oil products is typically long lived and uncertainty over future production may reduce willingness to invest in oil infrastructure.	
	Supply and demand	Alternative energy sources of energy may substitute demand for oil, but time lags, investment costs, and delivery prices are uncertain.	EV and unconventional oil sources
Nature of Resource Risks	True nature of reserves	Incentives for individual OPEC countries to inflate proved reserves to secure production quota and sustain perception of long term oil supply. Non-backdated reserve history may overstate proved reserves.	Spikes in known reserves in OPEC post 1983 quota system cause erroneous predictions of peak oil production date by IEA and USGS
	Technological challenges	Ageing oil fields may suffer from higher water cuts and an inability to use vertical wells while enhanced Oil Recovery techniques may or may not result in desired production efficiencies.	North Sea and Mexico
	Super-giant fields	Approximately 50% of total oil production is derived from ageing super-giant and giant fields discovered in the 1950s. Recent discoveries are supplements to, rather than substitute for, these fields. Failure to replace these fields may predicate an earlier peak than otherwise expected.	Gharwar
	Rate of decline in peaked fields	Uncertainty in field behaviour post peak production. Rate of decline may observe geometric or linear profiles.	USA production declined approximately 8% per annum following 1970 peak while North Sea has seen a 14% decline rate
	Exploration coverage	Major areas of the world's potential oil producing regions remain largely unexplored, although recent estimates indicate the Arctic may hold only 3 years worth of additional supply.	Arctic and Siberia

Adapted from Cordesman and Al-Rodhan (2005) and Vail (2007).

Table 3.2: Historical influences of non-economic risks (EIA, 2008b, EIA, 2008a)

Date	Duration [months]	Average Gross Supply Shortfall [Million BPD]	% of World Production	Price Increase [%]	Price Increase [2008USD]	Reason for Oil Supply Disruption	Risk		Notes
							Factor	Component	
3/73-5/73	2	0.5	0.0%	0.0%	$0.00	Unrest in Lebanon; damage to transit facilities	Geostrategic Uncertainties	Stability of oil producing nations and Security of oil producing facilities	Saudi Price fixed, not part of spot market yet.
10/73-3/74	6	2.6	4.7%	364.8%	$44.90	October Arab-Israeli War; Arab oil embargo	Geostrategic Uncertainties	Stability of oil producing nations and Embargos and Sanctions	
4/76-5/76	2	0.3	0.5%	-1.8%	-$0.93	Civil war in Lebanon; disruption to Iraqi exports	Geostrategic Uncertainties	Ethnic conflicts and strife and Security of oil producing facilities	
01/05/77	1	0.7	1.2%	2.4%	$1.21	Damage to Saudi oil field	Geostrategic Uncertainties	Security of oil producing facilities	
11/78-4/79	6	3.5	5.7%	14.2%	$6.65	Iranian revolution	Geostrategic Uncertainties	Stability of oil producing nations	
10/80-12/80	3	3.3	5.8%	0.6%	$0.56	Outbreak of Iran-Iraq War	Geostrategic Uncertainties	Stability of oil producing nations	
06/90-10/90	5	1.8	3.0%	91.6%	$27.73	Iraq invades Kuwait	Geostrategic Uncertainties	Hegemonic Adventurism	Not on EIA list of disruptions
12/02-2/03	3	2.1	3.1%	34.6%	$10.82	Venezuela strikes and unrest.	Economic Factors	Domestic policy	Venezuelan total oil production fell from 3.3 MBPD in November 2002 to less than 700,000 barrels per day in January 2003, increased to 2.6 MBPD in March 2003, and has now stabilized at around 2.8 MBPD. Although Venezuelan output has not returned to pre-strike levels, for purposes of this table the "disruption" period is defined as the period between December 2002 and February 2003, when the crisis was at its peak.
3/03-12/03	8	1.1	1.7%	-10.9%	-$4.59	Iraq Occupation & Nigeria unrest.	Geostrategic Uncertainties	Hegemonic Adventurism and Ethnic conflicts and strife	Iraq Occupation. (10 mo.) Combined with the shorter (6 mo.) disruption to Nigerian output, the effect was actually that of a modest linear recovery from the Venezuelan strikes, leading to price drops as Iraqi production gradually recovered. The next sequence is a similar combination of Iraqi and Nigerian unrest. Also note that Saudi Arabia boosted production by 0.5 MBPD in parallel with the invasion, substantially replacing the short term losses from Iraq.
10/04	1	0.06	0.0%	14.0%	$6.64	Hurricane Ivan	Geostrategic Uncertainties	Natural disasters and accidents	
1/04-5/08	53	0.06	0.1%	182.9%	$15.78	Continued Iraq and Nigerian unrest.	Geostrategic Uncertainties	Hegemonic Adventurism and Ethnic conflicts and strife	Combining the surpluses and shortfalls of Iraqi and Nigerian production since the end of the initial Iraqi conflict against their respective recent historical averages reveals that there has been in fact a negligible shortfall in production, despite what the EIA reports. Often the EIA figure is a shortfall measured against capacity rather than against any historical production level. This clearly indicates that supply from Iraq and Nigeria in particular does not underlie the dramatic price increases since 2004.
5/05-07/08	?	?	0.0%	6.1%	$57.00	Temporary World Production Plateau	Nature of Resource Risks	Production uncertainties	Work is pending regarding the predicted demand versus the actual production. (Failure of market expectations causing steady price rises, rather than declaring any kind of peak.) This data exists from the IEA.
Totals 424					$8.19	Average risk premium			Excludes temporary world production plateau

Note the average risk premium is calculated by taking the sum of the products of the "Duration" and "Price Increase" columns, divided by the number of months affected by the events, i.e. 424, resulting in a risk premium of $8.19 USD/barrel. The average real price for oil over the period considered was $45.50, which suggests such events have added an 18% premium to average oil prices in the period considered.

How this risk premium tracks in the future is not immediately apparent. It is clear that the vast majority of actual and potential supply of oil has been effectively nationalised by or is owned by national oil companies of countries whose governments view oil through a strategic and political lens. In such an environment, oil prices may be expected to be more volatile and attract a higher premium than in the past.

3.3 Modelling Future Oil Prices

Future oil prices were modelled on the basis of several oil price forecasts. The model is referred to as the "Meta Model" – where Meta refers to the fact that it generates future price projections on the basis of a number of individual forecasts, including:

- NYMEX (NYMEX, 2008);
- Goldman Sachs (Goldman-Sachs, 2008);
- EIA (EIA, 2007);
- MED (MED, 2006);
- CSIRO (CSIRO, 2008); and
- LOPEX (Rehrl and Friedrich, 2005).

It is noted that the assumptions and methodology underlying these forecasts is not necessarily transparent – only the CSIRO and LOPEX forecasts discuss their methodology and assumptions, which restricts the ability to evaluate their robustness. For this reason the Meta Model is based on a Monte Carlo simulation that moulds individual forecasts into a statistically representative distribution of prices over time. The advantage of this approach is that it considers all the information associated with the individual forecasts, but gives the most weight to prevailing trends. It also provides insight into extreme possible price scenarios that may eventuate under rare circumstances.

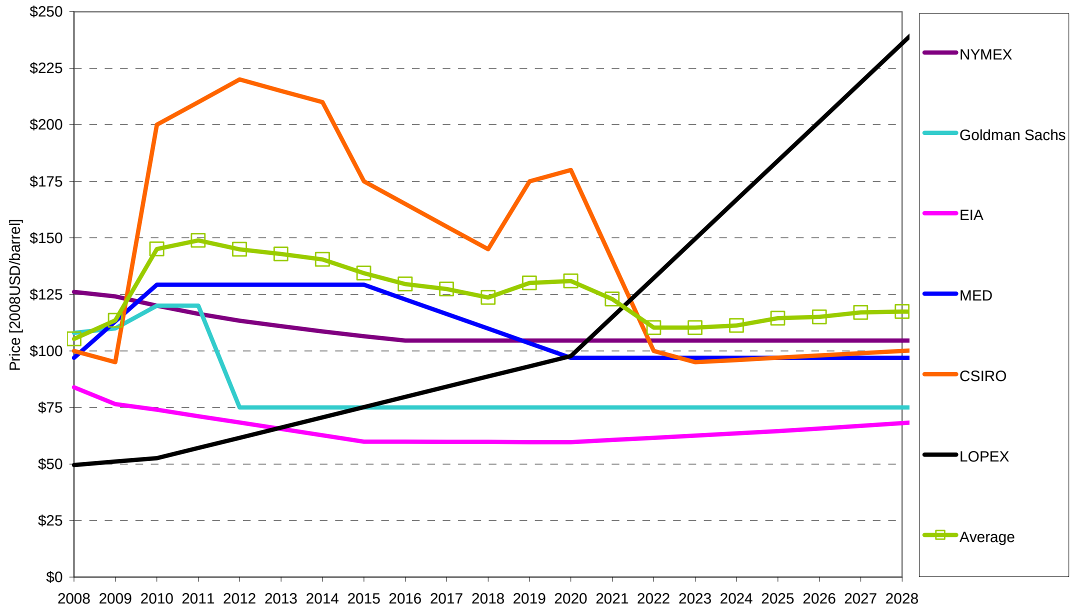
Recent experience has demonstrated the uncertainty around oil price forecasts. For example, the US Energy Information Administration's official 2007 prediction indicated that even in the high-price scenario, oil prices would not exceed $100 USD/barrel until 2030, and in early 2008 predicted that oil prices would not exceed $100 USD/barrel until 2018 (EIA, 2007). Forecasters seem to predict on a "business as usual" basis – various risk factors (summarised in the previous section) do not appear to be accounted for even though they clearly have a significant effect on the price.

Recently there has been a shift from forecasts that assume a sufficient supply of oil in the long term to those that explicitly model known reserves, discovery, and depletion. The older forecasts often have a mean-reverting shape, while the newer ones have price profiles that seem to increase exponentially – their modelling of the substitution of oil with new technology tends to be limited. The notable exception is the CSIRO forecast which combines a conservative supply side picture (i.e. peak oil perspective) with an optimistic demand side response (i.e. fast rate of technological substitution). This produces a relatively peaked price forecast that contrasts with others in the sample.

The forecasts listed above vary in their predictions of the price of oil in 2028 from a low of $70 USD/barrel to a high of $240 USD/barrel. Goldman Sachs predicts oil at $120 USD/barrel by 2010; the EIA 2008 forecast, made in late 2007, never has the price exceeding $90 USD/barrel (EIA, 2007, Goldman-Sachs, 2008). Naturally the accuracy of the individual forecasts may be expected to reduce at longer time periods. This means that the variation, or error, between the predicted price and the actual price is likely to increase the further into the future one predicts. The results of the Meta Model should be interpreted accordingly, with a greater emphasis placed on the near term price projections.

The Meta Model generates annual prices and is therefore not intended to provide an indication of short term price variability. Further research could seek to quantify this short term variability in the context of the overall annual trends generated by the Meta Model (Krichene, 2008). Intuitively, high prices are likely to be causally linked to variability, which may increase the difficulties associated with understanding demand response. The individual forecasts and the “Average” price projection are illustrated in Figure 3.4, with adjustments for global consumer price inflation and different grades of crude oil made to the individual forecasts as required (IMF, 2008). More technical discussion on the methodology underlying the Meta Model is contained in Appendix C.

Figure 3.4: Oil Price Forecasts 2007-2028



Source: NYMEX (2008), Goldman Sachs (2008), EIA (2007), MED (2006), CSIRO (2008); and LOPEX (2005).

It is noted that the "Average" forecast generated by the Meta Model represents the mean of the distribution of prices generated by the Monte Carlo simulation, rather than the simple average of the sample forecasts. It is also noted that variability in forecasts is skewed to the upside due to the fact that prices are not allowed to be negative. On the other hand, high prices are only bounded only by consumer willingness to pay, which has not been explicitly modelled. This could be an area for further research, which is discussed in more detail in Appendix C.

Figure 3.5 illustrates the average price projection along with the 75th percentile confidence intervals. The black circle and star indicate the 2008 average price and the current price respectively (MED, 2008d).

Figure 3.5: Oil price scenarios generated by the Meta Model 2007-28

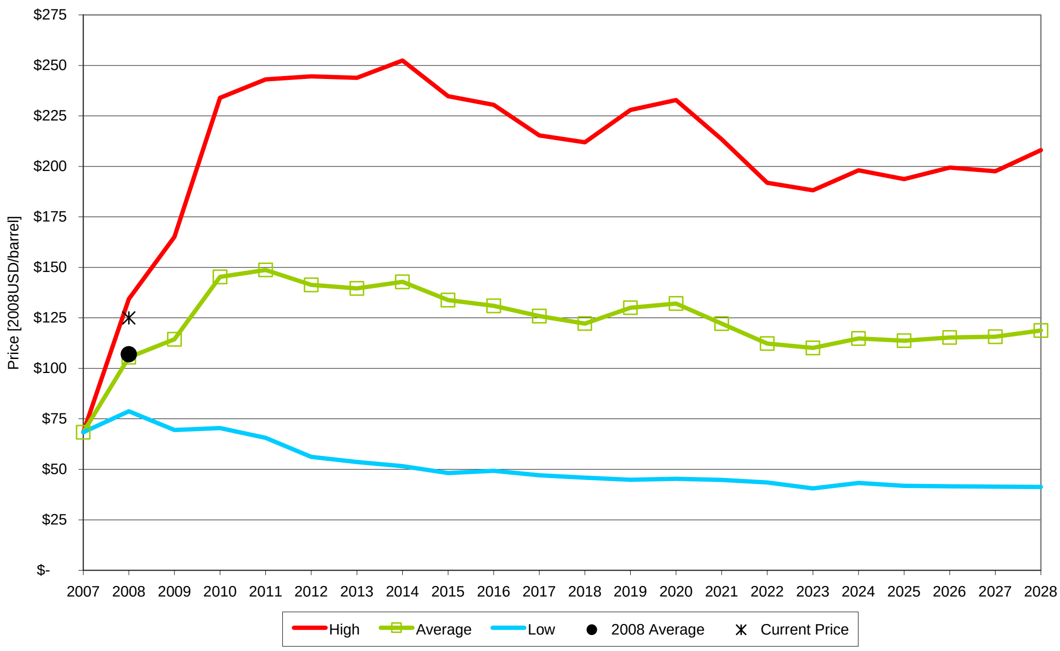


Figure 3.5 illustrates that the current price is substantially higher than the Average price predicted for 2008. This suggests that a short term drop in the price of oil is likely – indeed, the last few weeks of July 2008 have seen a drop of approximately $15 USD/barrel. Results suggest that the average price for 2008 will lie around $110 USD/barrel, which aligns well with the current average for 2008 of $107 USD/barrel.

Looking ahead, the oil price is projected to increase rapidly to exceed $150 USD/barrel by 2010, with the rate of increase almost as steep as that experienced in 2008. After 2010 the Average price plateaus and gradually declines – suggesting that a combination of demand destruction and technological substitution may cap the price around $150 USD/barrel.

The expectation that prices may drop in the second half of 2008 requires an important caveat. The Meta Model includes a number of older forecasts that predicted prices would currently be around $60 USD/barrel - namely the LOPEX and EIA forecasts. As a result, short term prices are expected to reside between the Average and upper price projections illustrated in Figure 3.5.

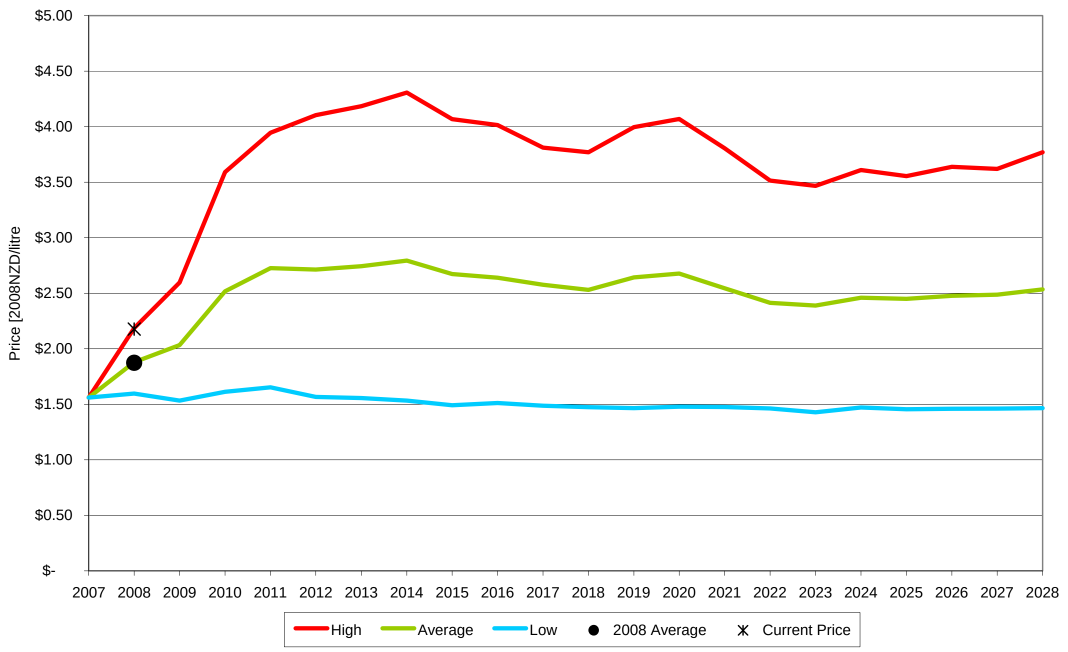
3.4 Retail Fuel Price

The international price of oil and the value of the NZD are the primary factors influencing the retail fuel price paid by motorists. The price of oil (in NZD per barrel) was found to provide a reasonable proxy (R-squared of 95%) for estimating the retail price of transport fuels (in NZD per litre). This relationship is discussed in more detail in Appendix D.

3.4.1 Retail Price of Fuel

Retail fuel prices are presented in 2008 NZD per litre. Figure 3.6 and Figure 3.7 illustrates the price scenarios for petrol and diesel respectively. The average fuel prices for the first six months of 2008 are also indicated by the black circles. The high degree of convergence between the Average price and the actual price (black circle) provides confidence in the validity of the modelling process.

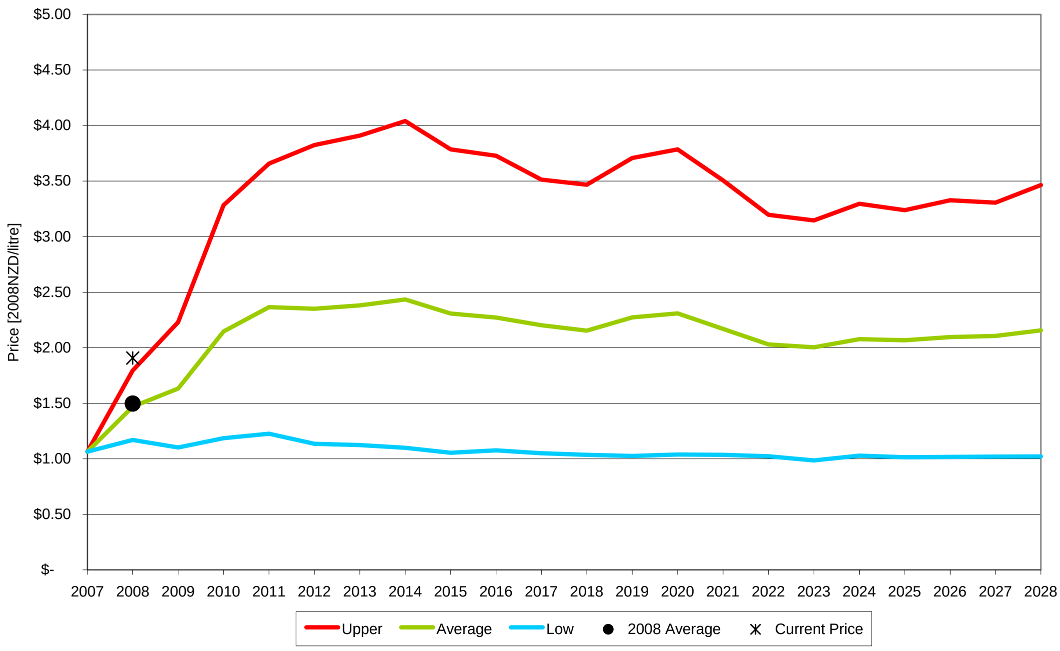
Figure 3.6: Retail Price of Petrol 2007-28



Source: MED (2008d)

The lower excise component in diesel results in larger relative increase in price – in other words diesel is comparatively more susceptible to changes in the price of oil.

Figure 3.7: Retail Price of Diesel 2007-28



Source: MED (2008d)

These figures illustrate that by 2011 petrol and diesel prices are expected to approach $2.80 and $2.50 per litre respectively (remembering that all prices are in constant 2008 NZD). After 2011 prices are expected to plateau and marginally decline, but remain at relatively high levels for the remainder of the time horizon.

3.5 Seriousness of Sustained High Fuel Prices

This analysis of future oil prices has found that the price of transport fuels is expected to stabilise for the remainder of 2008 but then increase rapidly for the next 3-4 years.

Both upside and downside risks exist. Higher prices might eventuate if new production or refining capacity is not brought online or the rate of decline in mature fields is greater than expected. The nature of the Meta Model also introduces some upside risks – with some of the older forecasts expected to drag down projected prices in the short to medium term. By contrast, downside risks include the potential for greater than expected demand side response. For example, the removal of fuel subsidies in India and China may deflate demand growth, while OECD countries may exhibit a greater degree of technological substitution. Alternatively, global credit issues may cause reduced economic growth and demand for oil, thereby taking the wind out of high prices.

Ultimately this modelling suggests that there is a serious and urgent need to understand and potentially address the impacts of sustained high oil prices on the performance of New Zealand's transport system. These impacts are investigated and discussed in more detail in the following sections.

4. Modelling Future Travel Demands

This section models future travel demands on the basis of the fuel price scenarios developed in the previous section.

It firstly introduces and explains the concept of elasticity. It then analyses transport and energy data from a number of OECD countries to provide initial insight into energy consumption with respect to prices and economic development. Although New Zealand itself has not yet experienced sustained fuel price increases, other economies with higher fuel tax regimes have and may provide an indication of likely outcomes.

This analysis is supplemented with reviews of local and international studies of elasticities and cross-elasticities. Analyses of local VKT data are used to generate elasticities for a range of additional factors, including vehicle ownership, workforce participation, and income. The identified elasticities are then applied to back-cast VKT data, with the model demonstrating a high degree of accuracy (R-squared of between 0.93 and 0.96).

These elasticities are applied to model future trends in travel demands. Travel demand models for light passenger vehicles, commercial vehicles, and alternative modes are modelled separately and then combined to provide an overall measure of expected travel demand growth.

4.1 Introduction to Elasticities

There is little doubt about the general direction of the effect of a sustained and substantial increase in the price of almost anything: people will use less of it. Also we will use less of items that are linked to use of the increased-price commodity. So, if fuel prices go up we will use less fuel and so also use fewer fuel-using vehicles. We say that two commodities or items linked in this way are *complements* in consumption or demand.

On the other hand, a sustained fuel price increase is likely to encourage the use of *substitutes* for fuel or fuel-using equipment: sales of bicycles, walking shoes and bus tickets will go up, and so too may the total sales of smaller, fuel-efficient motor vehicles, at the expense of the demand for “gas-guzzlers.”

Also, a large increase in any important component of the household shopping basket may leave significantly less money for purchases on even intrinsically unrelated consumer items. This, the *income effect* of higher prices, is probably of little direct concern to transport planners, but should as it will affect the macroeconomic benefits of a given transport project to the economy.

Responses to higher prices in general take time to work through. Economists believe - on very good evidence, as we shall see – that, so long as the price increase is expected to persist, private and business users of fuels will cut back their use more after a few years than they will in the first months. This is because it takes time to, for example, replace the vehicle fleet with smaller, more economical vehicles; it takes time for automobile manufacturers to respond to the situation with innovations that improve the fuel economy of all vehicles, and it takes time for governments agencies to make the infrastructure changes (bus lanes, new rail capacity) that become viable when the price structure undergoes a semi-permanent shift.

All these responses can be summarised quantitatively with the very useful concept of *elasticity*. The elasticity of some variable Y with respect to some variable X is defined as the percentage change in Y induced by a one percent change in X (holding all other prices and relevant factors constant), with the imputation that, up to a point, a larger percentage change in X would yield a proportionally larger change in Y. The beauty of the elasticity concept is that it is "unit-free" - being defined in terms of percentage changes.

So, for example, if "X" is the price of petrol, and "Y" is the annual consumption of petrol at the pump measured in volume terms, and if we say that the most likely or reasonable mid-range estimate of the "price elasticity of demand for petrol" is -0.3, then we mean that a sustained ten percent increase in the price of petrol would induce eventually a three percent fall in the "demand" (actual consumption).

The size of any commodity's price elasticity of demand is determined by its customers' willingness and ability to, in a sense, "escape" from the commodity if its price goes up, and this is in turn determined by the availability and attractiveness of substitutes, as well as the time span available for adjustment. A good point to bear in mind is that elasticity estimates are therefore likely to be smaller for more broadly defined commodities.

For example, the elasticity of demand for "transport fuels" (petrol and diesel) will be smaller than the elasticity of demand for just one of these fuels by itself. This is because if just, say, petrol prices increased but diesel prices did not, then many consumers would take the opportunity to switch to (substitute) diesel-fuelled cars, whereas if both petrol and diesel prices go up together, then there is, in a sense, nowhere to go, except to cut back on vehicle use overall, which is more difficult.

The X and Y example given above is for what is called the "own-price" elasticity of demand – that is, the effect on a commodity's demand (quantity - not value – purchased) of a change in its own price. The "cross-price" elasticity is the effect on demand of a change in the price of a related good, defined mathematically the same way. So, the cross-price elasticity of demand if the other good is a substitute is always a positive number and of a complement is negative: if the price of a substitute goes up, the original good becomes more popular; if it is the complement of which the price has risen, then the demand for the original good will fall (the sign of the cross-price elasticity is actually used to determine whether two goods are substitutes or complements for each other).

Note that although each elasticity is defined "holding all other prices and relevant factors constant" - because they would be meaningless otherwise - the fact that in practice usually more than one factor changes within the same time period can easily be handled by considering all the relevant elasticities together to net out the effects.

4.2 International Comparison of Fuel Prices

Our recommended estimates for transport fuel price elasticities are drawn from surveys of dozens of studies. But the basic force that these studies uncover - the strong responsiveness of demand to price – is so powerful that it can readily be spotted in available data. For example, Table 4.1 presents data on energy use and related economic and demographic variables for 27 OECD economies.

The first column shows the average price of premium grade petrol as observed in November 2004, when the world price of Brent Crude Oil was $US43. Note the substantial variation in retail prices, just about all of which is due to differences in governments' tax and/or subsidy policies, because of course all these countries faced essentially the same price for oil. In particular, note that in several European countries the retail price was around $2 per litre, and this is almost three times the price in the US.

Thus, these variations in retail prices can be taken as a natural experiment to enable us to estimate the likely impact of sustained high fuel prices on a country like New Zealand for which the 2004 and earlier prices were much lower. And, the results of this experiment are fairly clear from just inspecting the second column of data, which measures total energy consumption for transportation uses (most of this being petrol or diesel): low-price countries consumed more; high-price less.

We can also discern another correlation, between energy use and per capita incomes or GDP (gross domestic product): richer countries use more energy. If we plotted these pairs of variables on graphs to get scatter diagrams, and then drew lines 'fitting' the scatters of points as closely as possible, the line linking petrol price and energy consumption would slope down, and the line through the scatter of energy consumption and GDP data points would slope up. But of course it would be even better to plot energy consumption against both incomes and price, which can be done accurately and conveniently through an econometric regression model.

The slopes of the 'lines' from the model generate estimates of elasticities, which are estimated to be -0.71 for the own-price elasticity of energy demand and +1.15 for the income elasticity.[4] These elasticities imply that countries which for a long time have faced prices at the pump, say, twice as high as prices in the United States and which are at a similar per capita income level will consume about 70% less energy per capita in their transportation systems. A country with the same prices as the United States but only half the income will consume rather less than one half as much energy per capita.

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[4] The OLS regression model is: log(energy consumption) = -3.84 – 0.71log(petrol price) + 1.15log(per capita GDP): t-statistics for the coefficients are -7.39 and +16.90; R^2 = 0.938.

Figure 4.1: Transport and Energy Statistics for a number of OECD countries

Country	Price[USD/Litre]	Transport Energy Consumption [per capita]	Population [1000]	GDP [per capita]	Rail Freight [Million tonnes / year]	Rail Passengers [millions/year]	Area [km^2]
Australia	$0.85	1.47	20 111	32.9	166	11.3	7713
Austria	$1.32	0.96	8 175	33.6	179	8.3	84
Belgium	$1.50	1.00	10 399	32.5	8	8.7	31
Canada	$0.68	1.72	31 946	33.6	298	1.4	9971
Czech	$1.08	0.60	10 211	20.2	15	6.6	79
Denmark1	$1.51	0.94	5 401	34.4	2	5.7	43
Finland	$1.42	0.88	5 228	31.4	10	3.4	338
France	$1.54	0.91	60 200	30.2	45	74.3	549
Germany	$1.46	0.78	82 491	29.8	86	72.6	357
Greece	$1.14	0.73	11 060	23.2	1	1.7	132
Hungary	$1.30	0.38	10 107	17.2	9	10.5	93
Ireland	$1.29	1.14	4 044	39.2	0	1.6	70
Italy	$1.53	0.77	57 553	28.5	23	45.6	301
Japan	$1.26	0.73	127 687	30.5	23	385	378
Korea	$1.35	0.72	48 082	21.9	11	28.5	100
Netherlands	$1.62	0.93	16 275	34.2	5	14.7	42
New Zealand	$0.77	1.38	4 061	25.3			270
Norway	$1.61	1.05	4 592	43.2	2	3.1	324
Poland	$1.20	0.30	38 180	12.8	52	18.6	313
Portugal	$1.38	0.70	10 509	19.9	2	3.6	92
Slovakia	$1.17	0.41	5 382	15	10	2.2	49
Spain	$1.21	0.90	42 692	27.3	12	20.4	506
Sweden	$1.51	0.94	8 994	32.7	21	8.7	450
Switzerland	$1.29	0.96	7 391	36.2	10	14.9	41
Turkey	$1.44	0.19	71 789	8.1	9	5.2	779
UK	$1.56	0.90	59 778	32.1	21	41.8	245
USA	$0.54	2.18	293 655	41.9	2341	8.9	9629

This data yields another interesting insight: we predict that in countries which price their petrol high consumers will be keener to use public transport, and, presumably, their governments will make such facilities more available, and so it proves. If we do a simple regression of annual rail passengers (divided by country population) on petrol prices we get a large elasticity estimate of +2.78. This actually means that, across the OECD, countries with petrol prices twice those of the United States use rail transport nearly *seven times* more often than do Americans.[5]

[5] $2^{2.78}$ = 6.87. The regression equation is: log(rail passengers) = -8.2 + 2.78log(petrol price), with a t-statistic on the petrol price coefficient = 4.53 and an overall R^2 = 0.461.

4.3 Using Elasticities to Back-cast Travel Demands

This section applies and develops elasticities to predict historical travel demands – a technique referred to as back-casting. Back-cast describes the application of a model to historical data to assess how well it is able to predict changes in the relevant variable – in our case this is VKT. Modelling future travel demands requires an expansion in the range of factors beyond fuel prices and economic growth. Travel demands are also likely to be particularly affected by changes in vehicle ownership, workforce participation, and disposable income.

The following two sections present the result of back-casting VKT elasticities for light passenger and commercial travel demands. Only the main results of the modelling process are presented here, with detailed discussion provided in Appendix E. Back-casting light passenger travel was first undertaken by applying "best-estimate" elasticities for fuel price and economic growth as summarised in Table 4.1.

Table 4.1: Elasticity of Personal Travel Demands in response to Fuel Price and GDP

Measure	Elasticity	
	Short	Long
Fuel price	-0.12	-0.24
Economic growth	+0.3	

Source: Kennedy and Wallis (2007)

These elasticities are referred to as the "Base" model. It is noted that rapid increases in fuel prices may solicit more elastic consumer behaviour. Further research could seek to quantify this trend. Modelling was undertaken to assess whether the additional factors described above were able to further explain changes in the underlying VKT data. This model is referred to as the "Expanded" model. Results from the Base and Expanded models are summarised in Table 4.2.

Table 4.2: Comparison of elasticities associated with Base and Optimised VKT model

Factor	Elasticities	
	Base	Expanded
Fuel price	-0.24	-0.27
Economic growth	+0.3	+0.21
Vehicle ownership	N/A	+0.62
Workforce participation		+0.38
Income		+0.14

Sources: MED (2008a), Statistics NZ(2008a), MOT (2008c), Statistics NZ (2008b), and Statistics (2008c).

The Expanded model reduces the positive travel demand effects attributed to economic growth and includes the effects of vehicle ownership, workforce participation, and disposable income. The R-squared associated with the Base and Expanded models (61% and 96% respectively) suggests that the latter is more able to explain trends in the underlying data. The primary caveat on these results is the limited sample size - only seven data points were available. Access to a larger data set was not possible within the timelines associated with this study, but should be the subject of further work.

The elasticities associated with the Expanded model appear reasonable in comparison to international studies; the marginally higher fuel price elasticity sits well between international studies which tend to converge around -0.3 (Graham and Glaister, 2002, Graham and Glaister, 2004) and the local values of -0.24 recommended by Kennedy and Wallis (2007). The magnitude of the elasticities attributed to the other factors considered also appears reasonable. For these reasons and in spite of the small sample size, the elasticities generated by the Expanded model are considered to provide the best basis on which to predict future trends in the travel demands for light passenger vehicles.

Elasticities for commercial travel demands were generated in a similar way. These elasticities are summarised in Table 4.3.

Table 4.3: Commercial Travel Demand Elasticities

Factor	Elasticity
Fuel price	-0.06
Economic growth	+0.55
R-Squared	93%

Table 4.3 shows that commercial vehicles have a much smaller elasticity with respect to fuel price and larger elasticity with respect to economic growth. No evidence was found to support a relationship between commercial travel demands and vehicle ownership, workforce participation, or income.

Little reliable local data exists for back-casting demand for alternative modes. Elasticities were instead selected from a combination of local and international studies. In their study of Wellington public transport patronage, Booze Allen Hamilton (2001b) identified a public transport cross-elasticity with respect to fuel price of +0.18. For active modes Litman (2007c) suggests VKT cross-elasticities with respect to fuel price of +0.13. Further research should seek to plug the gap in local knowledge on demand elasticities and cross-elasticities associated with alternative modes.

Section 4.4 applies the elasticities developed in this section to model future travel demands for light passenger and commercial vehicles.

4.4 Modelling Future Travel Demands

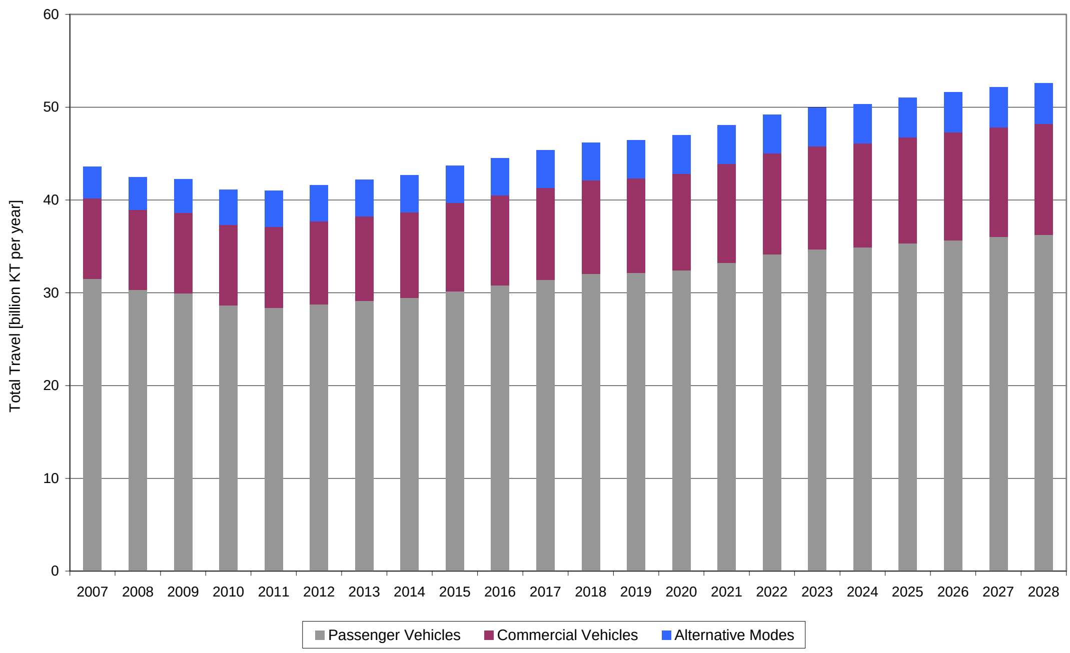
Future travel demands were modelled using the elasticities developed in the previous section. This modelling was based on the following assumptions:

- Petrol and diesel price were weighted according to expected changes in the make-up of the vehicle fleet (MOT, 2008c, MED, 2006);
- Future population growth occurs as per the medium scenario modelled by Statistics New Zealand (Statistics NZ, 2007);

- Economic growth (GDP/capita) is assumed to grow at the average rate of 2.4%, which reflects the average rate from 200-08 (Statistics NZ, 2008a);
- Vehicle ownership was assumed to remain at the 2007 rate of 700 vehicles per 1000 people (MOT, 2008c);
- Workforce participation rates were assumed to vary in accordance with models of the future composition of the workforce (Treasury, 2008a); and
- Disposable income (excluding transport expenditure) was assumed to grow at a constant rate of 1.35% - the average for the period 2001-07 (Statistics NZ, 2008c).

Light passenger and commercial travel demands were modelled separately and then summed to give total VKT. The travel demands associated with light passenger vehicles, commercial vehicles, and alternative modes under the average fuel price scenario are illustrated in Figure 4.2.

Figure 4.2: Total travel demands 2007-2028



It is important to note that this analysis is unable to account for major investment in new transport infrastructure. Such investment is likely to induce additional demand for travel above and beyond that considered in this analysis. Holmgren (2007), for example, found public transport travel demands were highly elastic in response to deliberate service improvements – recommending an elasticity of 1.05. It is also suggested that the assumption of average per capita growth of 2.4% per year is likely to be optimistic in a situation of sustained high oil prices. For this reason these travel demands are considered to be conservative and lie at the upper end of what may be expected.

Figure 4.2 illustrates total travel demands increasing from 45 to 54 billion KT per year, while travel demands placed on the road network are found to increase from approximately 40 billion to 48 billion VKT. It is noted that total VKT is not expected to exceed current levels until 2016, after which the positive effects of economic growth and increases in disposable income dominate the fuel prices rises expected in the period 2008-11.

Annual average growth in travel demands is approximately 0.9%, with light vehicle and commercial travel growing at approximately 0.7% and 1.6% per year respectively. Travel demands for alternative modes are also expected to grow at 1.2%. This suggests that total travel demands may be expected to grow at a lower average rate than in previous years. It is noted that after 2016 VKT growth averages approximately 1.5%, which is possibly slightly lower than historical experience due to the assumed plateau in vehicle ownership rates.

Growth may be visualised by allocating the total demand growth from 2007-28 amongst light passenger vehicles, commercial vehicles, and alternative modes, as illustrated in Figure 4.3. Results for the other fuel price scenarios are summarised in Table 4.4.

Figure 4.3: Marginal Travel Demand Growth under Average Fuel Price 2007-28

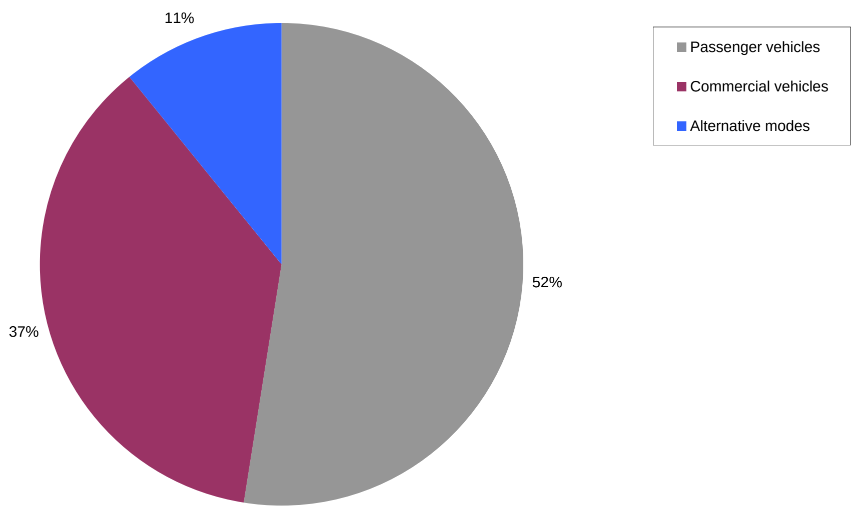


Table 4.4: Marginal Travel Demand Growth under Different Fuel Price Scenarios

Travel Category	Fuel Price Scenario		
	High	Average	Low
Light passenger vehicles	17%	52%	71%
Commercial vehicles	58%	37%	25%
Alternative modes	25%	11%	4%

Figure 4.3 illustrates that of the growth in travel demands that does occur, a larger proportion is attributable to commercial vehicles and alternative modes than would be suggested by their overall current mode share.

Table 4.4 illustrates that future demands for light passenger vehicles and alternative modes is highly variable across the various fuel price scenarios, particularly for alternative transport modes.

In summary, this analysis of future travel demands indicates that the challenges associated with managing transport challenges are likely to revolve around two key areas: the effects of growing commercial travel demands on the structural integrity of the road network and increased demand for alternative modes as a substitute for light passenger travel.

It is also found that high fuel prices are likely to suppress total VKT below current levels until approximately 2016. This suggests that the next 8 years may provide the ideal opportunity to shift the focus of transport planning onto more energy efficient and enduring practices. Examples of such practices are discussed in more detail in the following section.

5. Responses to Rising Oil Prices

This section identifies responses to the risk of sustained high oil prices.

Previous sections have identified that New Zealand's land use patterns and transport system are energy intensive. Many of the assumptions and priorities that underlie current transportation planning and funding decisions have unintentionally exacerbated vulnerability to high oil prices. Transport and land use planning must therefore undergo a paradigm shift.[6] That is to say, to ensure that the transport system is more resilient to sustained high oil prices, government agencies will need to fundamentally change the way in which transport problems are defined and solutions delivered.

This section provides a toolbox of potential solutions that will facilitate the development of a more efficient transport system. In many ways this section provides new perspectives on old assumptions. Central among these is the understanding that travel and land use have not historically been effectively managed or priced. This has led to structural imbalances that have subsidised private vehicle trips. Rectifying these structural imbalances so that road users are faced with the true costs (both internal and external) of their choices is expected to deliver travel and land use patterns that are significantly more energy efficient. A background explanation of transportation market distortions is discussed in the following subsection.

5.1 Transportation Market Distortions

The steady decline in the price of oil following the second oil shock of the 1980s (see Figure 3.1 on page 34) provided little financial incentive to increase energy efficiency for approximately 20 years. However, transport and land use planning have also contributed to a number of substantial market distortions that encourage vehicle use well beyond that which is economically optimal. In other words, New Zealand's transport and land use resources have been managed and priced in ways that directly undermine economic and energy efficiency. This relates not only to negative externalities, such as air pollution, but also to direct costs that are not usually paid by road users, such as parking (OECD, 2008).

When users are not charged directly for a resource, the resource tends to be exploited beyond the optimal point of economic efficiency (Litman, 2007b). As many of the costs of motor vehicle use have been externalised or charged indirectly, current demand for private vehicle travel in New Zealand is now higher than it would be if users were charged completely and directly (Jakob et al., 2006, Booz Allen Hamilton, 2005).[7] Common transportation market distortions are outlined in Table 5.1.

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[6] "A paradigm refers to how people think about problems and develop solutions." (Kuhn, T. 1962, cited in LITMAN, T. (2003) Reinventing Transportation: Exploring the Paradigm Shift Needed to Reconcile Transportation and Sustainability Objectives. Victoria Transport Policy Institute.)

[7] The Sustainable Transport Discussion Paper refers to the need for road users to pay true costs MOT (2007).

Table 5.1: Key requirements and distortions affecting travel decisions (Litman, 2007b)

Market Requirements	Common Transport Market Distortion
Economic neutrality. Public policies (laws, taxes, subsidies, and investment policies) must not favour one economic activity over others, unless specifically justified.	Many public policies favour automobile use including dedicated road funding, automobile-oriented planning and investment practices, and zoning rules that require generous parking.
Cost-based pricing. Consumer prices reflect marginal costs. There should be no significant external costs unless specifically justified.	Automobiles use is underpriced: most costs are either fixed or external. Lower-density, automobile dependent land use patterns are also underpriced.
Choice. Consumers need viable choices, and information about those choices.	Consumers often have few viable alternatives to owning and driving an automobile, and living in automobile dependent communities.

Many of the recommended responses in this section can be understood in terms of addressing these market distortions. This will be necessary to support the development of a land use pattern and transport system that is more energy efficient and closer to that which is economically optimal. It will be less costly (and more energy efficient) in the medium and long term to create economic conditions that allow for increased *accessibility*, rather than provide ongoing subsidies for *mobility.*[8]

The role of pricing reform in increasing accessibility can be best illustrated by an anecdotal example. Recently a newspaper reported that as fuel prices have been increasing, residents of the rural East Cape region have been suffering from the increased costs of travel (Tahana, 2008). When fuel prices were lower, most rural households found it advantageous to drive into town (separately) and purchase goods at the supermarket. As most households have not shopped locally, it has not been financially viable for a local shop to stock a wide range of goods, and, because there is no local competition or economies of scale, prices are significantly higher at the local shop, which further motivates households to drive to larger commercial centres. While households appear to benefit from reduced prices in larger commercial centres, there are external and indirect costs engendered by each household making a round-trip into a central area to purchase goods, and it is not energy efficient. Moreover, residents of the rural area who cannot drive have very few options for accessing goods and services.

There are two possible responses to solve the problem of reduced access to goods due to high fuel prices. One is to continue subsidising mobility – e.g. central government could reduce fuel taxes or regional authorities could organise a public transport service at subsidised rates from the area to town. However, these responses still cost tax payers and rate-payers money, just not directly. As the price of fuel increases, continuing these subsidies would become unsustainable. The other option is to increase accessibility by reforming land use policies and charging motor vehicle users directly for all the costs incurred by motor vehicle use. This has the effect of increasing private transport costs. But, one may ask, how does increasing the direct costs of private vehicle use increase accessibility?

[8] This is particularly important in the context of NZTS objectives to improve "access and mobility." MOT (2002).

Residents of the East Cape told the newspaper that high fuel prices had motivated them to buy goods at the local shop, even though it was more expensive. Over time, if the perceived cost of travelling to the supermarket increases, most households may find it advantageous to patronise the local shop. As the demand for and revenue of the local shop increases, there is greater incentive for the shop to provide a wider range of goods. Eventually, as demand grows it creates an opportunity for a competing shop to set up in the area, thereby offering greater choice and lower prices, in addition to creating local jobs. Above all, one delivery truck visiting the rural area with goods is more energy efficient than each household driving to town every week.

As oil prices rise, public bodies may wish to provide short term solutions to reduce the costs of travel for households and businesses. However, reform of land use and transport policies and practices will create opportunities for businesses and households to relocate in ways that are less energy intensive, and which will shelter them from higher fuel prices in the medium and long term. Failure to rectify structural distortions will only slow the emergence of improved land use patterns, thereby increasing the risk to high oil prices. It is also noted that providing a level playing field by removing subsidies for vehicle use is the best means of encouraging solutions that are responsive to specific local needs and circumstances.

It must be emphasised that the expectation of sustained high oil prices is not an effective substitute for policy reform, because oil prices fluctuate and cannot provide certainty to households and businesses. The upper and lower price projections discussed in Section 3 show oil prices ranging from approximately $250 to $50 USD/barrel respectively - in the face of such potential variability households and businesses may need to make long term changes. Increasing some transportation costs in a measured, predictable and managed way will be more beneficial than relying on volatile oil price fluctuations to deliver strategic transport objectives. Moreover, it will enable authorities to raise revenue that can be used to invest in alternatives.

The value of the recommended responses lies in the long-term structural incentive that they provide to motivate more efficient travel and land use choices. It is the certainty associated with the recommended responses that will allow for enduring decisions. Such certainty is not delivered by oil price forecasts – including those developed in this report.

5.2 Introducing the Recommended Responses

The following sections identify a number of recommended responses. While these responses have been motivated by the risk of sustained high oil prices, they are not solely justified on these grounds – as to do so would fail to realise the potential of holistic solutions that deliver a wide range of benefits. In other words, although energy efficiency is the driver of these responses, other objectives of the NZTS, such as economic development, have been considered in developing the recommended responses.

Recommended responses have been broken into the following five categories:

- *Land Use* - addresses some of the major market distortions that increase the need to travel by motor vehicle. Furthermore, they will be necessary to achieve many of the growth objectives of current strategies in New Zealand (such as intensification around transport nodes);

- *Direct and Efficient Pricing* will support desired land use changes and provide the economic incentives for the changes to happen more rapidly. Direct and efficient pricing may also raise revenue to assist with the transition, e.g. by investing in more energy efficient transport modes or location-efficient land development;

- *Infrastructure Investment* outlines recommended supply side responses to higher oil prices, including greater emphasis on the quality rather than the capacity of the road network. Land use and pricing responses are expected to generate increased demand for alternative modes, which should be reflected in infrastructure priorities;

- *Behaviour Change and Education* campaigns are important to effectively communicate the need for the paradigm shift that will enable New Zealand communities to adapt to rising oil prices. A well managed and funded information campaign, in addition to other organisational institutions, will further facilitate public acceptance, allow for more rapid progress, and increase the effectiveness of other responses; and

- *Freight Management* has its own specificities, but the principles of rectifying market distortions through land use policies, direct pricing and infrastructure investment and management are the same. In general, freight management strategies recognise that heavy vehicle travel is likely to continue to grow in spite of higher fuel prices.

The responses described in this report can be understood in terms of software changes, i.e. those that affect information, regulations, or behaviour, and hardware changes, i.e. those that affect infrastructure and the built environment. These approaches are complementary.

Figure 5.1: Timing and nature of responses

	Software	Hardware
Short term **Next 3 years**	Parking regulation and pricing Flexible zoning and urban containment Development incentives Commercial parking rates Tax treatments of transport expenses PT information Travel plans Transport Management Associations Regional Freight Strategies	Transforming roads into streets Investment in active modes Taxi services PT services Car-sharing and bike sharing Home Delivery Active Freight
Long term **5 to 10 years**	Road pricing Multi-modal integration	PT Infrastructure Urban renewal and TOD

Each policy response on its own may be considered effective, and will have a more beneficial outcome than doing nothing (business-as-usual). However, it is considered that the adoption of a comprehensive programme of action will result in far better outcomes than a few policies implemented in isolation. For this reason, it is important that a number of responses are progressed concurrently and implemented in a coordinated fashion by the agencies concerned. For example, investment in HOV and bus lanes is likely to deliver benefits in some areas, although this investment is likely to be most effective when combined with priced parking and park and ride (PNR) located on urban fringes so as to both incentivise and facilitate increased car-pooling.

Most of the responses are revenue neutral or low cost and thus achievable within the bounds of currently forecast land transport budgets. Most importantly, this package is considered to comprise of "no-regrets" strategies that deliver widespread economic benefits as well as improved energy efficiency. Some of the recommended responses will require long timeframes for appropriate policy development, consultation, and legislative processes. Regulatory and legislative delays are compounded by long time frames associated with land use development; it may be several decades before truly efficient land use patterns emerge. For this reason and in light of the uncertainty associated with future oil prices, it is recommended that progress on these responses be initiated without delay.

It is recognised that the reforms required to achieve the desired transition may seem politically difficult to implement – there is no doubt that New Zealand is a highly vehicle dependent nation, and the public may not immediately understand how increases in the perceived cost of private vehicle travel will improve land use options and transport system resilience. For example, current public opinion tends to see improved public transport as a pre-requisite for the implementation of road or parking pricing. Instead, this report argues that it is in our interests to manage demand for vehicle travel efficiently, regardless of what alternatives are available. Indeed, experience suggests that reformed land use policies and direct and efficient pricing are pre-requisites for efficient public transport and increased accessibility.

The need for increased energy security justifies substantive reform of New Zealand's transport system, responsibility for which is shared between government agencies, business, households, and individuals. Inaction, while initially convenient, is likely to result in more discomfort than would be experienced in a well-managed transition to a more energy intensive transport system.

5.3 Land Use Management

Land use management has the greatest potential to reduce vulnerability to rising oil prices in the medium to long term. Travel demand is in large part a function of land use patterns and access to a variety of destinations, markets and services. Changes in land use development that improve accessibility by alternative modes will therefore reduce the need to travel by private vehicle and thus improve resilience to sustained high oil prices.

For most of the second half of the 20th century in New Zealand (and many similar countries, including the United States, Canada and Australia), land use planning and the public provision of transportation infrastructure were not well coordinated. This resulted in settlements that are sprawling and required transportation infrastructure solutions aimed at reducing congestion by increasing road capacity.

Transportation research in the 1990s began to question the ability and utility of public infrastructure providers to continually react to developer-led growth. Thus for the past decade, a desire to coordinate the provision of public infrastructure in advance of private development has led to increasing attempts to avoid urban sprawl with urban containment. Infrastructure-led development recognises that uncontrolled development on the fringe of urban areas incurs large infrastructure costs while also imposing high external costs on society in terms of environmental effects, such as vehicle accidents, air pollution, and noise (Jakob et al., 2006, MOT, 2005b).

Awareness of the need to integrate land use planning with transportation is reflected in the New Zealand Transport Strategy, Regional Growth Strategies, and regional and district transportation strategies. The Metropolitan Urban Limits (MUL) in the Auckland Region are one example of new policies that seek to manage and stage growth within designated areas, where investment in the requisite transport infrastructure can be provided in a timely and efficient fashion.

The following responses present different tools to assist with the transition to integrated land use patterns that efficiently reduce the need to travel by private vehicle.

5.3.1 Parking Regulations and Management

Recommendations:	Central Government facilitate the removal of minimum parking requirements and the institution of pay parking policies. This would ideally be implemented through either a National Environmental Statement or a National Policy Statement. TA's implement priced parking and increased enforcement.
Responsibility	Central Government, Territorial Authorities

Parking regulations have had a huge and often overlooked impact on our urban form, and have significantly contributed to sprawl and vehicle use. Indeed, parking may be the single most important transport – land use connection. In a review of parking policies Marsden (2006) describes parking as the "glue between the implementation of land use and transport policies."

The supply of car parking that has accompanied increased urbanisation is in large part due to district plan regulations called minimum parking requirements.[9] Minimum parking requirements are based on standards that assume each individual development should provide on-site parking to cater for its peak demand for free parking. Parking demand is assumed to be generated by the size and type of land use, which ignores other (more relevant) factors such as ease of access to the site by other modes and existing capacity on nearby sites that have complementary peak demand hours. The cost of providing the

[9] It is noted that Auckland and Wellington District Plans have not applied minimum parking requirements for at least a decade within their CBD areas. In Wellington certain inner-suburban retail centres have even instituted parking maximums. Despite these measures a large surplus of parking seems to exist – demonstrated by car parks that are not used for significant portions of the day and fairly low hourly rates compared to property values for other uses. This experience suggests that the residual and path dependent effects of minimum parking requirements may take time to work through. This experience adds urgency to the need for substantial and comprehensive reform of the way that parking resources are regulated and managed.

land to meet parking requirements is not charged directly to the users of car parks, but is bundled in the cost of the development, thereby favouring SOV trips over other modes.

The OECD describes the regulated provision of parking as follows (OECD, 2008):

> *The provision of free parking (or parking at below market rates) is a form of government support that is almost universally recognised to be inefficient. Many authors have referred to it as a perverse subsidy. Whether it ought in fact to be classified as a subsidy, is not important. It is clearly a government policy that reduces the costs of driving … If drivers had to pay fair market price for parking spots, it would make driving more expensive for them. There is no reason for governments to subsidise them yet further with the provision of cheap parking on city streets.*

In addition to subsidising SOV trips and increasing the vulnerability of the transport system to high oil prices, minimum parking requirements have a wide range of negative impacts including: inflated demand for land and increased costs of living, particularly for medium to high density dwellings; increased costs of redevelopment in existing urban areas, particularly town centres and historic buildings; reduced urban densities that result in an autocatalytic cycle of motor vehicle dependence;[10] and fragmented and inefficiently utilised parking areas (Litman, 2006a, Shoup, 2005).

Territorial authorities need to be aware that their parking regulations are a significant driver of low density urban sprawl, out-of-centre retailing, traffic congestion, and low alternative transport mode share. Minimum parking requirements have been responsible for a large portion of the compliance costs for redevelopment of urban areas and have driven many large developments to the fringes of urban area where land is cheaper, thereby undermining compact city development (Cervero, 1985).

Parking requirements drive higher demand for land, for which the costs are distributed throughout the remainder of the economy in the form of higher prices for rents, goods and services (Shoup, 2005). Moreover, as motorists do not pay directly for parking, SOV trips are effectively subsidised, which induces extra vehicle trip, worsening congestion, and reducing optimal public transport patronage (Shoup, 2005). Vehicles circulating looking for "free" car parks are responsible for moderate (in the order of 20%) of the congestion in busy town centres (Shoup, 2005). Pricing on-street parking more accurately to reflect demand may discourage such unnecessary circulation, thereby reducing congestion in town centres.

For these reasons it is urgently recommended that minimum parking requirements be rolled back nationwide so that parking is managed in a way that does not place undue demands on the transport system and inhibit compact growth. Given the national scale of this issue, there is merit in car parking being addressed as part of an integrated national

[10] Auto-catalytic refers to the process by which minimum parking requirements reduce land use densities and thereby increase travel distances. This increase in travel distance stimulates increased use of vehicles that is reflected in increased minimum parking requirements. Thus land use densities are lowered even further and the cycle begins anew. In this way minimum parking requirements initiate a positive feedback loop that culminates in excessive vehicle use.

response on energy matters. The advantage of making changes to the policy framework at the national level is that time frames can be set that require the subsequent integration of regional and district planning documents by the respective authorities.

An integrated and robust planning framework requires a consistent set of policies at the national, regional and district level that deal with energy conservation, land-use and transport matters – including car parking. This is because District Plans (which contain the relevant car parking standards) are ultimately subject to appeal either during the plan change process itself, or the subsequent resource consent process, and are the instrument that is most often challenged by developers at the time of development.

In addition to rolling back minimum parking requirements, it is important that demand for public parking be well managed. Most concerning is the practice of territorial authorities to fund public parking facilities through general rates, a practice that is likely to be regressive for those on low incomes. Priced parking is a crucial mechanism for rationalising increased demand for parking. Priced parking not only manages demand but incentivises more efficient use of vehicles, including car-pooling, trip-linking, and trip-consolidation, but also increased use of alternative modes, such as walking, cycling, and public transport. It is important to note that the value of and demand for parking spaces provides the motivation from pricing parking.

Prices provide a signal for the emergence of market-led responses that reduce the need to travel and/or own a vehicle, such as home delivery and car-sharing organisations (more information on car-share and home delivery is provided in Sections 5.6.2 and 5.7.2). These types of market-led responses may also increase accessibility to goods and services for those members of the population who are unable or cannot afford to drive.

Most importantly, in the medium and long term, direct charging for parking will ensure more efficient use of land. In many instances, management practices can reduce demand for parking by up to 30% in the short term, with even larger gains in the future as land currently used for parking is redeveloped into other uses (Litman, 2006a). Reducing land required for parking could be a boon to local authorities who could increase the value of their land holdings by allowing them to be developed as dwelling, offices or retail shops/kiosks. The latter is an example of the type of adaptive re-use than may occur when the value of the land used by parking is able to be realised.

Ultimately, the removal of minimum parking requirements and the implementation of efficient pricing are essential steps towards the development of a market for parking resources. Expansion of the parking supply is driven by demand where the cost of additional parking is paid fully and directly by users. It is important that the implementation of parking management measures, particularly pricing, is coordinated so as to minimise the risks of retail leakage and therefore ensure win-win outcomes. Moreover, there will be an increased reliance on enforcement to ensure efficient and equitable implementation of pricing and time restrictions; parking enforcement is typically revenue neutral.

5.3.2 Flexible Zoning and Urban Containment

Recommendation:	Regional and territorial authorities amend regional and district plans to: 1) Adjust zoning regulations to encourage a mix of uses in developed areas, with appropriate provision for amenity; and 2) Implement stricter zoning or MUL to discourage residential or commercial development in areas that require private automobiles for access.
Responsibility	Regional and Territorial Authorities

Zoning is a planning instrument that has previously been used to separate land use activities so as to minimise many of the negative external effects of commercial and industrial activities, such as pollution and noise. Many zoning regulations now place a large number of restrictions on land use activities, particularly type of activity, bulk of building, and density.

In attempting to manage the negative external impacts of development, some zoning regulations have contributed to a need for increased vehicle travel. One of the unintended consequences of zoning for single land use activities is the need to use vehicles to get from wholly residential areas to access the goods, service, employment, education and recreation provided on wholly commercial areas. Zoning for low density and single development inhibits the provision of efficient public transport services to these areas, by creating dispersed and highly tidal flows.[11] Ironically, much of the noise and air pollution generated in urban areas is now directly attributable to the use of vehicles – in other words zoning regulations have partly perpetuated the very issues that they were designed to solve.

High fuel prices can be expected to generate demand for higher density and more diverse urban areas, rather than homogenous tracts of single-uses. Transportation optimisation models suggest that high fuel costs are likely to support a larger number of smaller more evenly distributed nodes so as to reduce total travel costs (Gosier et al., 2008). For this reason territorial authorities should be encouraged to create more flexible zoning regulations that allow for higher densities and a variety of uses to occur in developed areas. It is recognised that mixed-use zones have been tentatively introduced in some urban district plans – which allow for combinations of retail, commercial, and residential development – although this process tends to be haphazard.

It is acknowledged that density and diversity alone cannot ensure sustainable settlements. Urban design standards, noise and light regulations, and sufficient green space requirements will need to be introduced concurrently with mixed-use zoning to ensure that urban areas are developed in a way that preserves or improves standards of living and general amenity, to address the negative effects of development. Detailed

[11] Tidal refers to the direction of travel. Single use zoning results in unbalanced travel demands, flowing from residential areas to business areas in the AM peak and vice versa in the PM peak. This means that public transport services tend to experience low occupancies in the counter peak direction, significantly increasing the capital and operating expenses they incur.

inquiry into appropriate and effective urban design standards is outside the scope of this report, but a short discussion of the relationship between urban design and density is included in Appendix A. Industrial uses also have specific demands and thus may be better isolated from some land uses.

Another instrument to be used in conjunction with flexible zoning is that of urban containment. That is, limiting growth to current urban areas or adjacent to planned transport nodes, such as rail stations. This will likely be necessary to transition from a low to a high oil price environment. Sustained high oil prices could limit urban sprawl in the medium and long term irrespective of planning regulations; however it would take much longer for the market to respond appropriately because of price fluctuations and imperfect information on the future direction of oil prices. While the market can be expected to respond with innovations and adaptations, it often cannot look further into the future than six months to a year, and therefore is overly sensitive to short term variations in oil price. The role of public authorities must be to keep long term trends in sight; provide stability and certainty for development decisions; and thereby facilitate development in a way that will be resilient over its entire life cycle.

Urban containment needs to be signalled at both the regional and territorial authority (TA) level to ensure that a robust planning framework is in place. As discussed earlier an example of urban containment already in place is the MUL that are currently applied in the Auckland region. In this instance the extent of the MUL is set out in the regional policy statement (RPS) and urban zonings (as provided for in territorial authorities' district plans) are consistent with the extent of the MUL. Proposed extensions to the MUL are considered in a co-ordinated manner between the regional council and respective territorial authority.

It has been argued that MUL is responsible for higher house prices, and therefore, a just and equitable affordable housing policy would allow development to sprawl out, unimpeded by regulation. However, this view implies a very narrow concept of housing affordability – one that does not include transportation costs. An example of how this argument can be misleading is seen in the census household expenditure surveys. While housing costs are slightly higher in the central Wellington area compared to Auckland, the household expenditure survey demonstrates that those in central Wellington spend the lowest proportion of their income on transportation by a considerable amount.

The concept of urban containment, as exemplified by MUL, is a blunt but necessary tool that reduces the incentive for urban sprawl resulting from a transport system that has historically valued mobility over accessibility. As travel and land use patterns are more efficiently priced and managed there may be a reduced need for some land use regulations, which are really "second best" measures designed to redress short-comings in other areas. Direct and efficient pricing is discussed in more detail in Section 5.4.

5.3.3 Development Incentives

Recommendation:	Central Government commission research into sophisticated developer and financial contribution schemes that will stimulate less oil intensive growth and support other planning objectives.
Responsibility	Central Govt / Territorial Authorities

A further tool available to territorial authorities to stimulate and guide development in a less oil intensive fashion is the use of economic instruments, such as developer and financial contributions.

By reducing developer contributions for mixed use developments that meet appropriate amenity standards and reduce parking supply, TA's can encourage development that will assist communities to become more energy efficient and thereby help undo adverse effects arising from single use low density zoning, minimum parking requirements, and auto-centric infrastructure planning. Within urban areas, additional requirements for developers to provide active mode infrastructure and green space can be offset by eliminating the requirements to provide car parking, and can help reduce the costs of traffic and storm water management for TA's.

5.3.4 Urban Renewal Projects and Transit Oriented Development

Recommendation:	Promote development in existing urban areas through plan changes and structure plans that develop and facilitate urban renewal and TOD.
Responsibility	Central Government and Territorial Authorities

Urban renewal projects convert strategically located areas that are currently underutilised (often previously industrial, but this could also include areas previously used for parking) into mixed-use precincts, usually by way of "up zoning." In many cities, such as Brisbane and Portland, successful urban renewal projects have transformed the local economy by establishing a new cultural, recreational or educational centre supported by balanced commercial and residential development that has led to an increase in jobs and in property development in adjacent neighbourhoods.

Urban renewal projects may take several years to result in benefits, but they are long lasting and have significant flow on effects that ultimately increase the prosperity of a community. Investment by local authorities can be recouped through the substantial increase in rating base. Concentrating development in this fashion will result in economies of scale for local government services and ultimately can reduce the burden of infrastructure provision. Ideal urban renewal projects are typically located on brown-fields sites, such as those formerly used for industrial purposes.

Transit oriented development (TOD) is usually defined as development that is located within a 10-minute walk, or approximately 1km from a rail station, heavily used bus corridors and stations, or ferry terminals (American Planning Association, 2006). It has been touted as a new approach to development that can help reduce the need to travel by vehicle by concentrating residences, services (such as crèche and dry-cleaning facilities), and work places within walking distance of public transport hubs. TOD have higher than average densities to support the public transport services and the pedestrian oriented design that permeates the area. It is essential that minimum parking requirements are not applied to TOD, and perhaps that parking maximums are applied, to ensure that the development makes best use of land and is not unduly influenced by the vehicle dependent nature of contemporary land use development.

TA's should be encouraged to actively allow and plan for TOD around planned high frequency public transport nodes. Some TA's may want to lead the way, by using a re-location of their offices to catalyse a TOD, following the example of Waitakere City Council in downtown Henderson in the Auckland Region. Public / private partnerships have been successfully used to deliver TOD overseas. A high degree of community involvement is often helpful to ensure the success of the project and a high quality outcome (American Planning Association, 2006).

5.4 Direct and Efficient Pricing

This section outlines several pricing and regulatory mechanisms designed to improve the way New Zealand's transport system is priced. These mechanisms are largely designed to redress subsidies and imbalances in the way that transport costs are levied. Current pricing mechanisms are not direct or efficient and, when all costs are considered, appear to subsidise the use of vehicles to a higher degree than alternative modes (Jakob et al., 2006). Indirect and incomplete charging for vehicle use has resulted in a sprawling land use pattern that is difficult to access by alternative transport modes, and this in turn reduces the ability of individuals, households, and government agencies to adequately prepare for the challenges of rising oil prices (Litman, 2002b, Litman, 2002a, Boarnet and Chalermpong, 2002, Boarnet and Crane, 2001, Litman and Laube, 2002). This is most evident in the case of parking, which has already been discussed in Section 5.3.1.

It is crucial to level the economic playing field so that land use and derived travel demands are not overly reliant on motor vehicles, i.e. not reliant on vehicles beyond the point of optimal economic efficiency. In 1963 William Vickrey wrote "in no other major area are pricing practices so irrational, so out of date, and so conducive to waste as in urban transportation" (Vickrey, 1963). The inefficiency associated with current transport system pricing is thus not a new observation – with its slow implementation primarily due to the intricacies associated with communicating the potential for direct and efficient pricing to advance common economic, social, and environmental objectives (Litman, 2006b). A more direct and efficiently priced transport network is certain to be more energy efficient.

5.4.1 Funding Local Roads through a Parking Rate

Recommendation:	TA's implement a system that seeks to partly fund local road improvements from a rate on the number of parking spaces provided with commercial and industrial properties. This should be implemented in conjunction with the removal of minimum parking requirements so as to allow flexibility for redevelopment of parking spaces as a means to reduce the rates burden for these properties, and reduce demands on TAs to increase the capacity of the road network.
Responsibility	Territorial Authorities, with Central Government and Regional leadership

The construction and maintenance of local roads is generally funded from general rates on property values. Such a funding mechanism is highly inefficient because road users are not charged directly and as such there is no incentive for individuals to use the least costly mode. More importantly, higher value properties located in dense town centres generate less vehicle traffic but are subject to higher rates – such that they are subsidising energy inefficient development on the urban fringes.

It is recommended that the contribution from commercial and industrial properties to the local road network be rated on the basis of the number of car-parks dedicated to their operation. Such a rating scheme funds the local road network in a way that is more commensurate to the traffic demands placed on it by individual developments and ensures that higher density, mixed-use, multi-modal developments are not subsidising traffic generated by travel intensive developments, such as large format retail. Moreover, when coordinated with the removal of minimum parking requirements, such a rating system introduces incentive for commercial developments to consider adaptive reuse of under-utilised parking areas.

It is acknowledged that such a rating system, while an improvement on the status quo, does not directly charge for the use of the road. It is however more direct than the current system and particularly effective when implemented in conjunction with the removal of minimum parking requirements. This response is recommended as a short to medium term response that will eventually become superfluous at a later point in time, when a true cost road pricing system (described below) is able to be implemented.

5.4.2 Road Pricing

Recommendation:	A road pricing scheme is implemented nationally, with an aim to recover full costs of vehicle use. Price per km would ideally be a function of distance travelled, vehicle weight, time of day, and environmental externalities generated by their use.
Responsibility	Central Government

Road pricing charges a direct fee for the use of the road network. It has been implemented in a number of different settings to serve different objectives; a) cost recovery for the initial provision of a facility, b) cost recovery for the ongoing maintenance of a facility, or c) to directly charge the cost of additional vehicle travel in congested conditions.

Road pricing should be an integral response to sustained high oil prices. These prices may be expected to drive consumers towards substantially more fuel efficient vehicles and thereby over-time reduce revenue from fuel excise tax at a time when government agencies are facing spiralling costs for road construction, network maintenance, and public transport services.

Road pricing is effectively a more sophisticated fuel excise tax that charges the cost of providing road infrastructure to those who use it. An effective and comprehensive road pricing programme should aim to internalise all costs associated with road use. The imposition of congestion charges may be determined on a typical volume threshold that reflects road capacity. In some situations sufficient congestion charges may be levied to justify roadway capacity expansions. A balance is to be struck between the sophistication of the pricing scheme and the need for easily communicated charges. To avoid geographical discontinuities and benefit from economies of scale, road pricing is likely to be most effective and equitable if applied at a national scale, to all vehicle trips.

New Zealand has past experience with some elements of road pricing. For example, tolls have been used to partially or completely fund new dedicated motorways and bridges, such as the Auckland and Tauranga Harbour Bridges, which were then removed. In New Zealand, heavy freight vehicles are charged road user charges (RUC) targeted to internalise the increased costs of road maintenance they incur. Linking road pricing to fund specific infrastructure and the operating characteristics of individual vehicles are but two examples of the types of nuanced infrastructure charges that become possible with a comprehensive road pricing scheme.

A road pricing evaluation study of the Auckland region was published in 2006, which considered various options. Parking charges were also considered as part of a congestion pricing programme. The study found that different charging schemes would have different costs and benefits, but that congestion and a reduction in vehicle travel could be achieved to an extent that delivered overall benefits to the region.

Overseas experience is more similar to the type of road pricing recommended in this study, such as that implemented in London, Stockholm and Singapore. These charges recognise that the use of vehicles generates time specific costs – both direct, such road capacity expansion, and indirect, such as congestion, air pollution, and storm-water run-off. The efficiency of road pricing has been greatly improved through technical advancements that allow for pricing to occur in a more accurate and convenient fashion, as illustrated most evidently in Stockholm (Hugosson and Sjöberg, 2006).

Opposition to road pricing generally is typically based on concerns over social equity and civil liberties. Concerns over civil liberties are typically overcome through providing an option for non-electronic payment. Such an option may incur higher transaction costs that are passed onto the user. Concerns over social equity may apply in some specific areas to which targeted assistance may be appropriate. It is emphasised that income growth tends to be associated with vehicle ownership and use, such that high income households tend to place higher demands on the road network. Low fixed income households may also have more flexibility to shift their travel to off-peak times and subsequently benefit from reduced travel costs at those times. Road pricing is therefore not as inequitable as it first appears, although further more localised research should be undertaken before its implementation.

5.4.3 Tax treatments of Transport Expenses

Recommendation:	Central government investigate reforming tax laws to ensure that the use of vehicles is not favoured over other forms of transport. This may involve: 1) Incentives for fuel efficient vehicles; 2) Excluding employee benefits for alternative modes from FBT or, alternatively, levy FBT on parking provided to employees.
Responsibility	Central Government

Under New Zealand Income Tax Act 2007 ("IT'07") businesses are able to deduct expenses from taxable income. Fuel costs are legitimate business expenses if the expenditure is sufficiently related to the income earning process (incurred in the course of work activities) and are therefore deductible. Neutral tax treatment for fuel consumption fails to provide incentives to reduce consumption or switch to more efficient vehicles, however alteration to the amount of deductions available and introducing differential deductions would create such incentives.

It is important that tax practices do not inadvertently encourage vehicle use over other alternatives. For example, Fringe Benefit Tax (FBT) applies to public transport benefits but not employee car parks, under an Inland Revenue Department ruling. Tax reform should seek to reconcile treatments of transport modes to ensure that businesses are not incentivised to encourage the use of one transport mode over another.

5.5 Infrastructure Investment

Travel demands increased steadily during the second half of the 20^{th} century, while alternative mode shares fell. This trend is attributable to a number of factors that have been discussed in previous sections.

Continued growth in travel demands resulted in a “predict and provide” transport planning paradigm; the provision of infrastructure was prioritised for the sole use of private vehicles. Previous discussion has also demonstrated how the trend towards increased vehicle ownership and use has been exacerbated by a number of inequitable and inefficient approaches to land use management and transport pricing. This has highlighted why “manage and price” must predicate “predict and provide.”

In the first years of this decade, even before the dramatic rise in oil prices from 2004 through 2008, vehicle ownership and use was beginning to plateau in comparably automobile dependent countries overseas (Litman, 2006b). In New Zealand, the rate of growth in traffic volumes has, at least on a national level, been decreasing even as population is increasing, and vehicle ownership has remained static over the last three years (MOT, 2008c).

Previous sections have outlined recommendations that are designed to ensure that the use of private vehicles occurs in a more economically neutral environment. These responses are expected to further slow the rate of growth in vehicle ownership and use, as well as generate increased demand for alternative modes. The following sections outline the types of infrastructure responses that may be required in a future characterised by sustained high fuel prices.

5.5.1 Transforming roads into streets

Recommendation:	Transform roads into streets through reallocating road space, improving surface treatments and prioritising access over mobility. In town centres, shared space design and full pedestrianization should be implemented to improve accessibility by alternative modes and free up space for alternative land uses.
Responsibility	Territorial Authorities (Central Government leadership)

Transport planning in New Zealand has typically sought to reduce or avoid vehicle congestion primarily through expanding capacity. This focus has tended to underestimate the effects of induced traffic, as well as the impacts of increased vehicle volumes have on mobility and accessibility for alternative modes.

The following paragraphs discuss ways in which roads designed primarily for vehicles may be transformed into streets catering for a wider range of modes and activities. Streets are really a combination of multi-modal transport corridors and public space that are able to safely cater for a diversity of activities and land uses. Streets are environments in which the overall amenity (sounds levels and air quality) is preserved such that the use of alternative modes and land uses are not adversely affected by vehicle volumes.

Examples of simple traffic engineering practices that will enhance New Zealand's street environment and allow for increased uptake of alternative modes include:

- Pedestrian crossings on all approaches to signalized intersections, unless alternative crossing arrangements are available nearby;
- Coordination of pedestrian phases at signalized intersections, i.e. scramble crossings, so as to allow for diagonal pedestrian movement;
- Elevating the road surface at intersections to be flush with the footpath, which serves to increase accessibility and reduce vehicle speeds through intersections;
- Avoid slip lanes and free left hand turns that widen the footprint of the intersection, reduce accessibility, and increase vehicle speeds; and
- Develop well connected fine-grained street networks that avoid no-exit cul-de-sacs, particularly those that do not allow for pedestrian through traffic.

Transport engineering practices effectively need to be rebalanced to ensure that the provision of capacity does not unduly detract from amenity or reduce accessibility for alternative modes.

Street environments may more safely cater for pedestrians and cyclists if the volume and speed of motor vehicles are reduced. Thus, measures to reduce the speed and volume of motor vehicle traffic should be the greatest priority, and expanding or improving infrastructure secondary. Simple measures, such as regular street cleaning and debris removal and enhanced pedestrian-oriented street lighting can greatly enhance the ambiance of the journey, and can be undertaken in a relatively short period of time over a large area.

It is emphasised that vehicle speed should not be controlled solely through reduced speed limits. A particularly useful tool for reducing traffic volumes and speeds while improving the built environment for other modes is the “shared space” traffic design concept pioneered by Dutch traffic engineer Hans Monderman. By redesigning roads for shared use by all modes, removing curbs, signs and traffic signals, significant reductions in traffic speeds and accidents have been realised, along with improvements in travel times (Hamilton-Baillie, 2008, Hamilton-Baillie and Jones, 2005).

Rather than increasing regulation and traffic control signs, research suggests that soliciting a driver’s sense of personal responsibility, and increasing awareness and engagement with other road users, may reduce speeds and improve safety (Hamilton-Baillie and Jones, 2005, Transport Research Laboratory, 2005). This concept is most useful in town centres that may require some vehicle access, but could benefit from reduced vehicle volumes and speeds. The shared space design should be investigated for town centres that are zoned for intensification and areas where a large portion of vehicle trips are less than 5km.

Full pedestrianisation of streets in areas with high mixed-use densities should also pursued as a means to stimulate further re-development in town centres, encourage alternative modes, and ensure that land is used for the most optimal economic purpose. An example of how pedestrianisation increases accessibility and thereby drives increased commercial opportunities and economic activity is evident in areas such as Queen Street in Brisbane. The central area of the street is leased by the council to private operators to provide undercover and outdoor seating for café’s, bars, and merchandise kiosks that increase commercial activity, provide direct revenue to fund Council activities, and increase passive surveillance in the Downtown area.

These responses may be expected to contribute to increased uptake of alternative modes, reduced fuel consumption, lowered vehicle speeds, reduced vehicle volumes, reduced vehicle accidents, improved accessibility, and valuable use of road space in town centres.

5.5.2 Investment in Active modes

Recommendation:	Territorial Authorities increase investment in active mode facilities. District Plan changes should be investigated for the provision of end of trip facilities, such as showers and lockers. Infrastructure investment should be coordinated with parking reform and road pricing so as to maximise benefits.
Responsibility	Territorial Authorities

Walking and cycling are by far the least oil intensive means of transport, and are the least costly forms of transportation in every measure except time; including resource use and pollution, infrastructure requirements, operating and ownership costs, safety risks, and health and fitness benefits.

Despite being slower, walking and cycling have the most reliable travel times. In urban areas where peak congestion is a problem, average walking and cycling speeds can be comparable to other modes, particularly if entire journey time (including walking to PT or looking for parking) are considered. More important than travel time, however, is journey quality and ambience. Nelson, Marlborough, West Coast, and Otago enjoy some of the highest active mode share despite minimal congestion (Statistics NZ, 2006).

Low active mode share may also be partially due to subsidised vehicle use, such as abundant "free" parking at most destinations, which artificially lowers the cost of driving for short trips. In addition to economic incentives, research suggests that mode choice is partially determined by the built environment. Transport infrastructure that has been allocated in priority to motor vehicles has resulted in barriers to the uptake of other modes. The first barrier is due to development occurring in patterns that are spread out and therefore increase the distances that need to be travelled. The second is that it has created an environment that is highly unpleasant and perceived to be unsafe for walking and cycling, especially within dense urban areas.

Many urban vehicle trips, even those that are part of longer trip chains (that is trips with multiple links) appear short enough distances to be considered appropriate for active modes (O'Fallon and Sullivan, 2005). Based on the experience overseas in areas with high rates of walking and cycling, New Zealand's climate and topography is not considered a major impediment to uptake of active modes. As mentioned earlier, some of the highest active shares are associated with Wellington, West Coast, and Otago regions, all of which have somewhat challenging climates and topography.

5.5.3 Investment in Public transport

Recommendation:	Territorial Authorities and Regional Authorities increase investment in public transport. Investment should prioritise high quality long term solutions that are able to influence land use development
Responsibility	Territorial Authorities and Regional Councils (Central Government leadership)

The following paragraphs identify opportunities for implementing cost-effective improvements to public transport.

HOV and Bus Lanes

Reallocating existing road space to alternative modes is a sound means of providing for additional demand at low cost. Rather than widening road corridors to add new High Occupancy Vehicles (HOV) and/or bus lanes along key arterials, converting one lane in each direction from regular traffic or on street car parking will achieve much higher capacity. Examples of HOV/Bus lanes carrying a greater number of passengers in peak hours than original traffic lanes already exist in New Zealand, such as Onewa Road in Auckland.

Expanding capacity for HOV and buses, while simultaneously reducing capacity for SOV, further boosts the viability of car pooling and public transport by reducing travel times without expending additional resources to expand road capacity. HOV/Bus lanes on their own may not generate significant mode shift; their potential is more fully realised when applied in conjunction with other recommendations such as road and parking pricing.

Modelling should accurately account for the potential of new HOV/Bus lanes to avert traffic and cause modal shift. This is particularly important in the medium and long term, when the provision of new infrastructure and the implementation of demand management measures may encourage sustained behaviour change.

Park and Ride supported by Bus and HOV lanes

Park and ride (PNR) provide a short to medium term opportunity to integrate the road network with HOV and/or Bus lanes. As oil prices rise and parking and congestion costs are internalised, PNR is likely to become very attractive to those who commute from automobile dependent areas, in advance of more enduring transport and land use responses.

PNR should ideally be combined with HOV and dedicated bus lanes so as to maximise peak hour carrying capacities. This can be for a dedicated bus service, or a casual car pool pick-up point. Casual carpool has evolved in places like the San Francisco Bay Area, and allows people to take advantage of HOV lanes and waived bridge tolls through an informal and flexible arrangement (Taylor, 2005). Drivers and passengers queue at a designated location at peak hour travel times and usually form carpools of 3 people per car. There is no exchange of money between drivers and passengers; the mutual benefit is simply the ride and the use of the HOV lanes to avoid congestion or tolls. While casual car-pool is not usually run by public transport authorities or any other organisation, it is logical for it to be encouraged and supported by allowing it to evolve at PNR stations. Safety issues should be addressed in the design of such facilities, such as installing CCTV cameras; however there are no known instances of untoward events in several decades of casual carpooling in the United States (Taylor, 2005). Websites exist for established casual carpool sites that allow users to comment on drivers or passengers to avoid.

PNR stations should be located near main arterials and away from town centres, where land is inexpensive. Ideal locations include land that would otherwise be unsuitable for high intensity development, such as land situated on flood plains and beneath high voltage power lines. If demand for PNR grows to fill available capacity, then pricing should be progressively increased so as to internalise costs and encourage the use of more efficient modes, such as alternative modes, car-pooling, or bus feeder services, to access the PNR station.

Public transport and Rapid Transit Systems

Demand for public transport is expected to increase as oil prices rise. Research in the United States suggests that consumers who live in automobile dependent suburbs are less price sensitive than those who have alternative means of transportation available (Congressional Budget Office, 2008). The more public transportation options that are provided, the less vulnerable to rising oil prices the New Zealand transport system will be.

The table below displays the least oil intensive public transport services appropriate for different land use densities and travel distance.

Table 5.2 Least oil-intensive public transport in different densities (Kenworthy, 2003)

Area	Appropriate infrastructure
Rural	Car and van-pooling offer greatest flexibility to service dispersed origins for small numbers of passengers
Low density suburbs	PNR for public transport (rail or high level of service bus) or carpool
	Bus and HOV lanes (where there is congestion)
Urban	Bus and dedicated bus lanes
	Electrified buses and light rail
	Electrified heavy rail and elevated rapid transport systems
Intercity	Electrified heavy rail

A detailed examination of the merits of individual public transport modes lies outside the scope of this report, but it is important to consider the potential for high quality rapid transit systems to influence land use and encourage higher density development.

Quality of service is important, and can be cost effective to improve in comparison to other infrastructure investment. Recent research into the value of comfort and convenience of public transport service suggests that transport funding should take into account more than one value of time when evaluating investment in services (Litman, 2007e).

When a service is comfortable and users are able to work while travelling, for example, their time is less valuable than if they are waiting or having to stand in a crowded bus. This suggests that improvements to level of service of transport and reliability may be more cost effective and beneficial to users than improvements that seek only to reduce travel time. A service may thus be greatly improved if it targets and enhances the ability to productively use and enjoy time spent on public transport services. By targeting convenience and comfort, transportation authorities can seek to reduce the costs of travelling (as is now done through efforts to reduce congestion by expanding capacity) without inadvertently increasing the oil intensity of the transportation system.

It is noted that subsidies for motorised travel, by whatever mode, generate less energy efficient travel and land use patterns. Subsidies for public transport are currently provided for both capital infrastructure and operating subsidies. Given the pervasive nature of the subsidies for private vehicles and their large external costs, continuing subsidies for public transport is recommended. However, the responses outlined in this report are expected to result in substantially increased demand and subsequently reduce the costs of operating public transport services in New Zealand, stimulating increased investment from private operators as well as reducing operating subsidies and thereby freeing up regional funds for additional capital investment.

Overseas experience has shown that public transport systems are able to operate at full cost recovery, particularly for major investments that deliver step changes in both accessibility and mobility to public transport networks. For example, Dublin's recently completed light rail transit (LRT) system – the Luas – carried 26 million passengers and returned an operating profit in 2006, which was only its second year of operation. An excerpt from the transport agency's annual report is repeated in full below due to its relevance to this report (RPA, 2006):

> *RPA earned a surplus of €5.6 million in 2006 on the provision of Luas infrastructure, reflecting the continuing growth in passenger numbers travelling on Luas during the year. Total passengers reached almost 25.8 million, an increase of 16% on 2005, the first full year of passenger service. A feature of Luas that has attracted much interest among transport specialists is the popularity of the service in the time of day traditionally regarded as off-peak. By offering a high frequency service, with high reliability, people within the catchment area of Luas have embraced the service to a greater extent than would be suggested by the economic modelling, which is based largely on the savings in journey time relative to other modes of transport. This high quality service for passengers, which has resulted in high capacity utilisation at all times of the day, has in turn contributed to the financial success of RPA.*

The optimal public transport mode will vary significantly depending on the context. Bus Rapid Transit (BRT) may help minimise capital costs in the early stages of system development as well as provide for increased service frequency. LRT may support higher capacities and be more suited within existing town centres. Ultimately, the coordinated deployment of rapid transit systems and the other responses identified in this report is expected to catalyse a step change in the performance of New Zealand's public transport networks.

5.5.4 Multi-modal integration

Recommendation:	Regional Councils work with Central Government to integrate transport modes.
Responsibility	Regional Councils (Central Government leadership)

Sustained high fuel prices will increase the need for linked multi-modal journeys. Such journeys may, for example, use vehicles to access a bus PNR station, after which a walking trip is involved to the final destination.

In a vehicle dependent landscape where trips are dispersed, a combination of active transport, PNR, and public transport is likely to be the most energy efficient means for individuals to arrive at their destination. The ability to bring bicycles on trains and buses, and/or park them securely at public transport stations, should also be universal and convenient.

Public transport terminals need to become a highly visible focal point of surrounding footpaths, cycle networks, and land use development. Integration between alternative transport modes will thus assist travel patterns that do not use a private vehicle for most if not all of the trip.

Integrated electronic ticketing should be a priority to enable flexible use of public transport services, more flexible payment options, and more rapid boarding. Where PNR incurs charges, this should be able to be paid using a public transport card. Additional services could include using such cards to pay for taxi services where public transport does not provide a viable option.

It is noted that some work is already underway in this area and the establishment of the NZTA may accelerate progress towards an integrated transport system.

5.5.5 Taxi services

Recommendation:	Central Government update taxi service regulations to reflect energy efficiency goals. Territorial authorities work with taxi services in medium and large cities to ensure that services complement other transport and land use initiatives.
Responsibility	Central Government and Territorial Authorities

Taxi services will remain important as the use of private vehicles for home to work journeys reduces. It will be therefore important for cities in New Zealand to provide for and manage taxi services, such as the location of taxi stands. On-street parking pricing may be a good way to manage this. New York City has pioneered an approach to greening the city’s taxi vehicle fleet through an incentive programme with taxi driver co-ops and unions, and expects all taxis to be hybrid vehicles by 2012. Working with taxi providers to ensure the greatest efficiency of the taxi fleet will have positive benefits for both taxi service providers, in terms of reduced pollution and lower costs and prices.

It may also be possible to better integrate taxi services with public transport services, through the installation of “free” taxi phones and taxi stalls at terminals.

5.6 Behaviour Change and Education

Rising oil prices will be a challenge to modern society because for many decades our economy and lives have been predicated on cheap oil. One advantage of the recent oil price spikes has been an increased awareness of vulnerability; it sends a clear signal to consumers and producers that changes will have to be made. However, rapid price increases will make the transition period more intense and difficult. Communication of the situation and education around how individuals, households, and communities may best respond will be essential to manage this transition effectively.

Strong coordinated relationships between infrastructure development and education and social marketing are crucial to achieving behaviour change, as government agencies cannot educate or market a transport 'product' (e.g. public transport) if that product does not exist in a usable form. It is essential that travel behaviour change and the other responses (land use, pricing and infrastructure) be considered together.

Conversely, education and advertising activities that solely focus on raising awareness are unlikely to be a useful or effective approach to behaviour change. To achieve behaviour change requires a 'multi-channel, multi-activity' approach. This refers to programmes that combine a range of different communication messages, channels, and initiatives to reach their audiences and address different emotional and practical barriers. These programmes need to be on-going; not one-off events.

Understanding communities is essential to identifying which barriers prevent the uptake of sustainable transport and land use choices and what motivators (e.g. fuel prices, health, and environmental sustainability) would deliver more informed choices. It is difficult to pitch schemes nationwide, as local differences are so pronounced. For example, rural communities have fewer travel mode options.

Any travel behaviour change initiative should have a target audience. Understanding businesses and individuals that are vulnerable to petrol prices is one form of market segmentation, however being vulnerable to fuel cost does not equate to willingness to change behaviour. Different audiences will be motivated by different things. Developing sound research and a good evidence base on understanding the needs of the community, segmenting the market, and identifying the target audience(s) is critical to the success of any travel behaviour change programme.

For example, increased car-pooling has the potential to reduce congestion and mitigate higher fuel costs, providing an effective short-term response to higher fuel prices. However, government agencies should not solely focus on the provision of infrastructure designed to increase rates of car-pooling, such as HOV lanes, but also softer measures, such as websites through which people may register for car-pooling. These latter types of measures are crucial for overcoming behavioural inertia and facilitating sustained change.

Behaviour change and education is a challenging area, but one where good case studies exist. Examples include "Eco-driving" campaigns that increase awareness of efficient driving practices and schemes that encourage people to scrap older vehicles in exchange for monthly bus passes (IEA, 2005, MOT, 2008e).

5.6.1 Travel Plans

Recommendation:	Travel Plan support programmes be developed and expanded to assist organisations to undertake travel plans. Develop regulatory or financial incentives for organisations to develop travel plans.
Responsibility	Regional Councils and Territorial Authorities

Travel plans are a management tool that assists organisations, businesses and schools to reduce travel demands associated with both home-to-work/school and work/school based travel.

Travel plans help to address organisational issues affecting how people choose to travel, such as company cars and free parking. Company policy changes have been shown catalyse large reductions in employee vehicle use, including:

- Parking cash-out – provides commuters who normally receive free parking to take cash instead;
- Company car cash-out – as per parking cash-out except for company cars;
- PT passes - involves providing employees with a subsidised PT pass in place of a free car-park;
- Flexible working/school hours, shorter week – reduces the number of school/work commute trips per week;
- End of trip facilities for cyclists, including showers and lockers; and
- Car pooling within the organization.

A primary motivation for businesses and schools to develop travel plans is often provided by the accurate realisation of the costs associated with vehicle travel. For this reason, the use of travel plans is expected to increase when the perceived value of driving reflects its underlying costs. Moreover, the removal of minimum parking requirements may encourage existing property owners to use travel plans to free up land to provide redevelopment opportunities. Regional councils may be able to provide tools and services that facilitate increased uptake of travel plans, particularly amongst large employers. Additional reasons to adopt travel plans include improved health and fitness of employees/students, increased motivation and reduced sick leave.

5.6.2 Car-share

Recommendation:	Territorial authorities provide support for car-share organisations, particularly co-operative or non-profits, in the form of information on how to start one, subsidised parking, and/or organisational promotion. This may be by through TMA (see below).
Responsibility	Territorial Authorities

The responses outlined in this report may reduce the practicality of vehicle ownership, but most households and businesses will still need occasional access to a private vehicle. Car-share organisations provide convenient access to a vehicle that is paid for directly commensurate to use. They manage a pool of vehicles parked at numerous locations around urban areas, which are available for short and long term use. Members of the organisation are able to book vehicles online and then access the vehicles via electronic swipe cards. One car-share vehicle is typically utilised by a large number of people, thereby distributing the costs of car-ownership, such as maintenance and parking, across a larger number of people.

Membership in a car-share organisation is often most attractive to households that do not rely on vehicles for home-to-work commuting, or small to medium sized companies that do not need to manage their own pool car fleet. By removing the need for commercial pool vehicles, the incentive for employer-funded vehicles is also removed. In this way, car-share vehicles are frequently used for commercial purposes during the day and residential needs during off-peak hours.

Numerous studies have indicated that members of car-sharing organisations have more sustainable travel patterns, with higher reliance on walking, cycling, and PT. As discussed above, residential use of vehicles is typically reduced to off-peak trips, such as grocery shopping and recreational visits. Members of car-share organisations have been found to reduce VKT by up to 40% compared to their previous travel patterns – which highlights the effects of direct pricing on demand for vehicle travel (Shaheen et al., 2005).

5.6.3 Transport Management Associations

Recommendation:	Territorial authorities establish TMA in town centres and key suburbs.
Responsibility	Territorial Authorities

Transport management associations (TMA) are usually formed to manage the provision of transport within a particular geographical area. They frequently involve both public and commercial stakeholders so as to connect strategic directions with on the ground community interests. The community and business roles in a TMA make it an ideal structure for disseminating information, educating stakeholders, and engaging the community to understand and help create the best solutions in a given locality.

Possible functions of TMA may include:

- Parking brokerage services – designed to connect demand for parking with surplus private off-street parking resources.
- Input into the allocation of parking revenues – TMA provide an interface through which small community projects are identified and funded using parking revenues.
- Over-seeing the management and implementation of travel plans and overflow plans, such as for special events and seasonal shopping patterns.

- Coordination of car sharing, home delivery, or other mobility market solutions that will work in the specific context of a given community.

The benefits of a TMA is that is provides an on the ground presence that manages smaller scale transport issues that fall below the radar of territorial authorities, or where constant community input in desired. TMA may also coordinate travel plans across multiple businesses and organisations within an area, increasing opportunities for car-pooling and resource sharing.

Lloyd District in Oregon, has had a TMA operating for approximately 10 years (www.lloydtma.com). This encompasses 650 business and 21,000 employees. From 1997 to 2006 the Lloyd TMA was able to reduce drive alone mode share from 60% to 42% and increase public transport mode share has almost doubled from 21% to 39%. The reductions in drive alone trips has significant implications for the amount of parking required to support land use in the Lloyd District. The increased efficiencies catalysed both by the reduced demand for parking and the increased transport accessibility has facilitated an additional 20,000 employees and 4,000 housing units being located in with the District.

5.6.4 Route Planning Information

Recommendation: Regional Councils work to improve and expand of route planning websites.

Responsibility Regional Councils

Route planning websites (such as MAXX in Auckland or Metlink in Wellington) are crucial to enable people to find the best means of getting from an origin to a destination, at a given time. They demystify public transport services for those who have never used them, and they increase the convenience for all users. Such websites should be expanded to other regions, even those that do not have extensive public transport services. Estimated bicycling times and route information would be a valuable addition to the current information provided on walking. Information on parking availability and prices, and road pricing can also be incorporated into these sites eventually, enabling people to quickly compare the cost and time of vehicle trips with alternative modes. These sites should be easy to find; a Google search of “Wellington public transportation” did not turn up the PT website in the top 10 hits, even though “Wellington public transport” ranked it first.

Information on public transport routes and timetables is often quite poor and extremely difficult for first time users. Route information should be clear and easy to read at terminals and on vehicles themselves. Stops should have names that are clearly visible from the vehicle. Route maps and timetables should be freely available at key locations. Real time information may be useful in areas where services are unable to keep to a regular timetable, although with the expansion of HOV lanes and the reduction in congestion that is expected from regulatory and pricing mechanisms, this should be less of a problem than is has been in the past. When a service is delayed or cancelled, there should be sufficient warning or replacement services provided for users. All these measures are designed to ensure that travel decisions are made in an environment characterised by complete and convenient access to information on alternative modes, thereby supporting more informed consumer choices and more relaxed public transport experiences.

5.7 Freight Management

Freight movements are by their nature trips that have an economic function – they serve to bring raw materials to producers, take goods to market, and deliver services. Freight thus differs from personal transport in so far as it is usually more essential and of higher value. For this reason freight travel deserves its own set of management responses.

Many freight movements by road will benefit from the management responses described above: internalising the costs of road use will discourage passenger trips that are low value or substitutable by other modes. This will reduce peak hour congestion allowing freight vehicles to travel more freely. Direct and efficient pricing may also catalyse effective market responses to reduce freight costs, such as the FreightHub (www.freighthub.co.nz) model, which connects existing spare truck capacity with customers to increase overall system utilization. An increased emphasis on surface quality rather than capacity expansions is also expected to deliver fuel efficiency benefits to freight operators. Finally, increased investment in road network maintenance may mean that larger and heavier trucks are more readily accommodated.

The following sections outline more targeted responses that may deliver localised improvements in the efficiency of freight movements.

5.7.1 Regional freight strategies

Recommendation:	Regional authorities develop freight strategies, including opportunities for integrated ports (rail and coastal shipping). Regional freight strategies should seek to facilitate mode shift by using the mechanisms described in the following section.
Responsibility	Regional Councils (Central Government Leadership)

The government has a Rail to 2015 strategy (MOT, 2005a) and has recently released a coastal shipping strategy, *Sea Change* (MOT, 2008). Improvements to rail and coastal shipping infrastructure may be expected to provide improved options for freight mode shift when faced with high transport costs. However, industries and access to coastal and inland ports vary greatly by region. For this reason, specific freight strategies may need to be advanced at the regional level to ensure modal integration. Such freight strategies should seek to identify key freight routes and potential multi-modal hubs. Routes with a high volume of heavy vehicles could be targeted for low friction surface improvements so as to improve fuel efficiency.

5.7.2 Home delivery Services

Recommendation:	Territorial authorities (TMA) investigate potential for advertising and coordinating home delivery services
Responsibility	Territorial Authorities (Central Government Leadership)

Home delivery of goods was once a common service in New Zealand, before car ownership reached high levels. As costs of parking and vehicle trips are internalised and oil prices rise, it is likely that home delivery will once again achieve economies of scale.

Home delivery services are expected to provide cost-effective access to goods and services for households and communities that cannot afford to travel long distances and those that cannot drive. Such services are expected to be particularly important in more isolated rural communities. While this is primarily a market-led response, territorial authorities may foster earlier development through information and coordination of services though a TMA. Home delivery would have benefits for management of traffic and parking demand, and would be facilitated by increasing levels of internet access.

5.7.3 Opportunities for Active Freight

Recommendation:	Regional and territorial authorities include active freight delivery in freight and transport strategies for town centres and areas that are suitable for vehicle-free development.
Responsibility	Regional Councils and Territorial Authorities (Central Government Leadership)

Solutions for freight delivery not reliant on motor vehicles should not be underestimated. In European countries where vehicle-free zones are fairly common, such as St. Mark’s Island in Venice, Italy, freight is delivered by active modes using a variety of small wheeled equipment. These areas often have active retail and commercial zones that require regular freight deliveries. Active freight delivery, if undertaken carefully, is a beneficial means of delivery in terms of reduced dependence on oil and decreased adverse effects within sensitive zones where land use intensification is desired. As part of a regional freight and sustainable transport strategy, regional and territorial authorities could work with delivery service providers and businesses to ensure that these solutions are available in town centres that are likely to restrict vehicle access. TMA may also be an appropriate institutional structure for coordinating such services where there is demand, for example, by consolidating loading bays around pedestrian streets so that access by active freight is possible.

5.8 Summary of Responses

This section summarises the recommended responses identified in the previous section.

An example from the East Cape was discussed at the beginning of Section 5. The following discussion identifies how the recommended measures are able to influence the travel and land use patterns of residents in isolated communities in ways that reduce their vulnerability to rising oil prices. This focuses on the potential benefits to Te Araroa, a small beach community located close to the East Cape. Travelling from Te Araroa to Gisborne requires a 200km round trip, which in the average car at today's fuel prices would cost approximately $45 (excluding other variable operating costs). The recommended measures are applied to both Gisborne and Te Araroa to highlight how benefits are delivered to both communities, although naturally the isolation of the latter means these benefits are more important in the context of high fuel prices.

The catalyst for change in Gisborne is the removal of minimum parking requirements, which allows for redevelopment in the Town Centre. As denser and more diverse development progresses in Gisborne, the available parking supply is reduced and prices are implemented to manage demand. Retailers in Gisborne benefit from the larger population of local residents and employees, which tend to provide more regular custom. Parking prices affect people travelling from Te Araroa – they travel to Gisborne less frequently and start to shop more at the local shop – a response identical to that associated with higher fuel prices, although more permanent given the fact that parking charges are less variable than fuel prices. When Te Araroa residents do need to travel to Gisborne, they seek to coordinate their travel times through and car-pool and thereby split fuel and parking costs. A local resident sees decides to formally respond to changing travel demands and starts a daily shuttle service between Te Araroa and Gisborne, which also stops at a number of other towns along the coast.

Despite enjoying increasing numbers of customers, businesses in Gisborne realise that a combination of high fuel prices and parking fees is dissuading visits from people living in more remote communities. These businesses subsequently establish a weekly home delivery service to provide access to outlying communities. The service charge for using this home delivery is approximately $20 per order – which is about half the combined cost of driving and parking on its own. As well as reducing the need to travel, home delivery provides suddenly provides access to goods and services for those households who do not have access to a vehicle. At the same time, however, the local shop in Te Araroa has used revenues from the upturn in business to provide home delivery services at a lower charge than retailers from Gisborne – competition begins to emerge and deliver benefits to isolated communities.

In the medium term the implementation of urban containment has focussed residential development around the Te Araroa store. The local shop subsequently expands and begins to stock a larger range of goods. The larger resident population also supports the development of a small two-storey building with a butcher shop, fresh produce store, café, restaurant, and automatic teller machine (ATM) on the ground floor along with residential accommodation on the second level overlooking the beach. Te Araroa residents now have access to a wider range of local goods and services, which once again reduces the need to travel to Gisborne. In terms of the latter, the local business soon realise that they are unable to compete for more remote customers and subsequently focus on redeveloping the downtown area to attract those customers are tourists who already reside or are travelling to Gisborne.

Thus even in the most isolated rural communities, the responses are able to reduce the reliance on vehicle travel and increase local access to goods and services in a way that is responsive to local needs.

There are a number of key messages that should be taken from this example, namely:

- Subsidised travel (i.e. parking) in urban centres directly undermines the viability of more isolated rural communities from developing the types of local businesses and services that they will need to manage sustained high oil prices.
- Subsidised travel is a net loss for both towns – it is beneficial for Gisborne to intensify and diversify in ways that cater for local residents and employees, while it is beneficial for Te Araroa residents to have access to local goods and services.
- Land use and pricing mechanisms are likely to be more relevant in rural situations than infrastructure based responses. These mechanisms reduce the distance travelled, allow for consolidated development, and support uptake of active modes.
- Direct and efficient pricing mechanisms are crucial for motivating the emergence of market based outcomes, such as home delivery. Alternatively they may encourage a van-pool services that connects isolated East Cape communities to Gisborne – which is also more likely to emerge in situations where parking is priced.
- Expenditure on vehicles and fuel may be expected to reduce and free up disposable income for reinvestment in local communities, some of which is likely to generate additional development and support increased local employment – thus establishing a feedback loop that may lead to further positive outcomes than those identified above.

In spite of the hypothetical nature of this example, the outcomes are realistic - indeed some of them are happening already simply as a result of higher fuel prices. Reliance on oil based transport fuels is reduced in both Te Araroa and Gisborne, which highlights the potential for the recommended measures to deliver win-win solutions. It is beneficial for business in Gisborne to have greater numbers of local residents and employees, thereby reducing the demand for car-parking and increasing opportunities for redevelopment, while it is also beneficial for Te Araroa residents to create demand for local shops, businesses, and services.

The table below summarises the responses, identifies the agencies responsible, and outlines the time-frames within which they may be implemented.

Table 5.3: Evaluation of Potential Responses to Rising Fuel Prices

Category	Response	Details	Time frame	Agency
Land use responses	Parking regulation and management	Central Government implement an NES or NPS that will direct TA's to remove minimum parking requirements and progressively manage and price public parking supply.	Short	Central and TAs
	Flexible zoning and urban containment	RCs and TAs adjust zoning regulations to encourage a mix of uses in developed areas, with appropriate provision for amenity and implement stricter zoning or MUL to discourage residential or commercial development in areas that require private vehicles for access.	Short	Regional and TAs
	Development incentives	Central Government research sophisticated development contributions that stimulate less oil intensive growth and support other planning objectives.	Medium	Central and TAs
	Urban renewal and TOD	Central government enable TAs to stimulate renewal of urban areas through increasing investment and / or reducing compliance costs.	Medium	Central and TAs
		Identify and invest in existing or potential TOD sites, incorporating parking and zoning recommendations made previously	Medium	TAs
Direct and efficient pricing	Commercial parking rate	Implement a targeted rate to fund local road maintenance and operations based on the number of car parks provided with non-residential premises	Medium	TAs
	Road pricing	Progress implementation of national road pricing scheme that fully internalises all costs.	Long	Central
	Tax treatments	Ensure tax treatments relating to commercial travel expenses provide appropriate incentives to travel and use fuel efficiently	Medium	Central
Infrastructure investment	Transforming roads into streets	Reallocation of road space including shared space and pedestrianisation, prioritising access over mobility.	Short	TAs
		Improve surface treatments		
	Active modes	Increase investment in active mode facilities and investigate plan changes for end of trip facilities	Short	TAs
	PT services and infrastructure	Provide HOV and / or bus lanes on arterial roads corridor by removing parking and / or reallocating existing vehicle lanes	Short/ Medium	TAs, RCs (Central)
		Invest in PT services and improve infrastructure as demand increases		
	Multi-modal integration	Facilitate modal transfers through the implementation of convenient systems and payment technologies	Medium	RCs
	Taxi services	Central Government update taxi service regulations to reflect energy efficiency goals	Medium	Central
Behaviour change and education	Travel Plans	Encourage the increased uptake of travel plans at key destinations, such as workplaces and schools	Short	RCs and TAs
	Car-sharing / Bicycle-sharing	Facilitate the emergence of car-sharing and bicycle sharing organisations	Short	TAs
	TMA	Facilitate the establishment of TMAs in town centres to coordinate non-strategic transport services, such as parking management services	Short/ Medium	TAs
	PT Information	Improve and expand transport websites and route information	Short	RCs
Freight management	Regional Freight Strategies	Develop Regional Freight Strategies that facilitate mode shift and offer opportunities for multi modal ports	Medium	RCs
	Home delivery	TAs (with TMA) investigate potential for advertising and coordinating home delivery services	Medium	TAs
	Active freight	Encourage the use of active freight in town centres	Short	TAs

5.9 General Legal Considerations

This section summarises general legal considerations that may affect the implementation of responses to rising oil prices. Specific legal analysis of individual measures is contained in Appendix K.

The existing transport and land use planning environment provide extensive opportunities for public participation. Public participation can provide a direct barrier to swift action where the public are afforded opportunities to appeal determinations and decisions. In those circumstances proposals can quickly become bogged down and in some instances never be implemented at all.

A relevant example is the policies proposed by the Local Government (Auckland) Amendment Act 2004 (LGAAA). The LGAAA seeks to improve the integration of Auckland's regional land transport system. This would require amendment to the Auckland Regional Policy Statement and the district level planning documents. The LGAAA came into force on 1 July 2004. Proposed changes to the RPS and district planning documents were notified on 31 March 2005 and decisions on the submissions received were released on 31 July 2007. The Environment Court received more than 160 appeals to those decisions raising issue with the changes. An optimistic assessment suggests that the appeals will take until the end of 2009 to resolve.

In summary, the proposed changes took three years to develop including consultation with communities and for decisions to be made following this consultation. Once the decisions were released a huge number of appeals were lodged which will take up to two years to resolve. Once the appeals are resolved and the RPS is finalised, the total time taken from the date the Act came into force would accrue to at least five years.

This environment can make responsive action in a timely manner impossible. In response to supply shortages of oil based fuels central government can introduce regulation by Order in Council to bypass these processes and implement emergency measures under the Petroleum Demand Restraint Act 1981. If the supply of petroleum dwindled to point that insufficient stock is available to maintain ordinary prudent stocking levels then the broad powers under section 4(2)(b) could be invoked to "Restrict, regulate, or prohibit the use of motor vehicles or any class of motor vehicles."

Invoking emergency powers is not an appropriate approach to sustained high prices - which may or may not reflect supply issues. This is more effectively addressed through sustained and progressive reform in advance of the prices, as well as rapid roll out of alternative infrastructure in the event of an unexpected price spike. For this reason there is a need to reconsider the way that public consultation is integrated into the development of the transport system, which balances the need for consultation against the flexibility to chance tack in response to unforeseen energy prices. Measures could seek, for example, to allow government agencies to accelerate certain projects that have already been identified in long term strategic planning documents with the need for further consultation. Exactly where the balance between consultation and flexibility is outside the scope of this report, but should be the subject of further research.

6. Impacts of the Recommended Responses

This section assesses the impacts of the responses identified in the previous section.

Firstly, the recommended responses are assessed in terms of their impacts on VKT. This analysis found that the recommended responses appear to cap demand for vehicle travel at or below current levels. Static demand for vehicle travel corresponds to substantial growth in demand for alternative modes.

Secondly, the energy efficiency benefits delivered by the recommended responses are quantified in terms of expected mode shift and its consequential impacts on oil intensity. This analysis does not include the effects of higher quality road surfaces on vehicle fuel economy, which are expected to deliver substantial benefits, particularly for heavy vehicles.

Thirdly, economic benefits were analysed on the basis of consumer costs savings (fuel and operating costs) and welfare benefits (congestion costs, air quality, greenhouse gas emissions, and physical activity). More pervasive but nonetheless tangible macro-economic impacts are also identified, although these are difficult to quantify.

Finally, risks associated with the recommended responses are discussed in terms of their potential to result in inadequate road capacity and localised economic shocks (defined in subsequent sections). This identifies the need for coordinated, signalled, and staged implementation so as to allow time for efficient and consistent behaviour change and adaptation.

Ultimately, the results of this section highlight that the recommended responses may be expected to deliver enduring economic, social, and environmental benefits. This transport paradigm is different in that it seeks to place a balanced focus on both sides of the travel equation and seeks to manage travel demand in addition to supply.

6.1 How the Responses Impact Travel Demands

The impacts of the recommended responses were assessed in terms of the following parameters:

- Expected coverage: The proportion of vehicle travel affected by the response, estimated as a combination of geographical and temporal (time based) factors;
- Implementation timelines: The time required to implement the responses in regard to their operational complexity, regulatory requirements, and legislative changes;
- Nature of implementation: The way in which the responses are implemented, in terms of incremental and/or step change; and
- Maximum impact: The maximum impact of the responses on VKT as estimated from international and local studies and experiences.

Values for these parameters are summarised in Table 6.1, with further details on the assumptions on which they are based contained in Appendix G. All responses were assumed to be fully implemented by 2028. Not all responses are shown below as their impacts on VKT were considered to be either negligible or too difficult to quantify.

Table 6.1: Parameters Controlling the Impacts of the Recommended Measures

Recommended response	Affected areas	Coverage	Maximum Impact	Start	Step change
Parking Management	Urban	26%	20%	2011	No
Road Pricing	Urban	14%	20%	2017	Yes
Zoning	Urban	78%	10%	2009	No
Public transport	Urban centres > 100,000	19%	15%	2009	No
Alternative modes	Urban	20%	10%	2009	No
Multi-modal	Mainly Urban	80%	5%	2009	No
Information	National	100%	2.5%	2009	Declining[12]
Travel Plans	Urban workplaces	20%	5%	2009	No
Car-pool / Car-share	Urban	50%	5%	2009	No

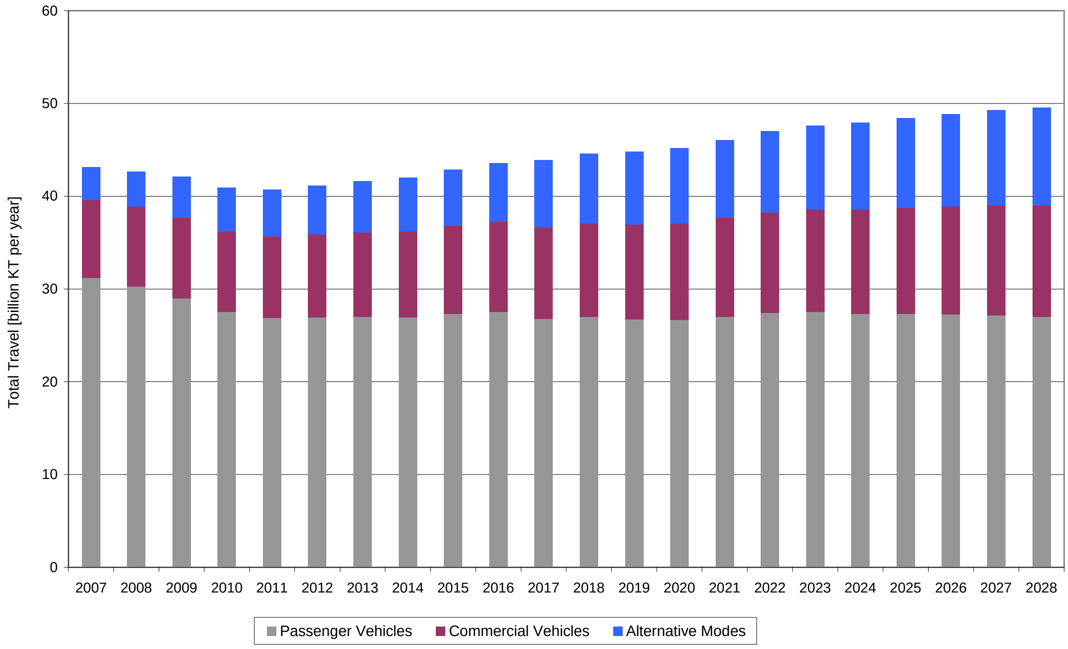
Determining the individual impacts of these responses is complicated by their inter-related effects. It is important that such effects are not 'double-counted' – hence the relatively low impact attributed to some responses, such as car-pool and car-share. Other responses such as parking management and road pricing may be expected to increase rates of car-pooling, but this effect is factored into the relative attributed to these responses. This is not to suggest that car-pooling is ineffective, but rather that it has relatively limited potential to affect travel demands *on its own*. These inter-related effects support the implementation of a broad package of responses, as opposed to selectively 'picking winners.'

It has been assumed that commercial travel demands are unaffected by these responses. Increased costs associated with road and parking pricing may cause some reductions in low value commercial travel, although reduced congestion on the road network may allow for additional commercial travel demand that was previously suppressed.

[12] Information and marketing campaigns are likely to bring forward or accelerate behaviour change that would otherwise occur more slowly. For this reason the impact of information declines over time, hence the declining impact attributed to this response.

The VKT reduction caused by recommended responses is expected to generate increased demand for alternative modes. This demand was modelled using mode substitution factors. Local data on these factors is not available, so it was assumed that 50% of the reduction in VKT is taken up by public transport, 10% by car-pooling, and 15% active modes respectively. The remaining 35% of VKT is averted through a combination of subtle adjustments such as trip-linking, trip-consolidation, telecommuting, and avoided travel. Figure 6.1 illustrates the resulting impact of the recommended responses on future travel demands under the Average fuel price scenario.

Figure 6.1: Impact of Recommended Responses on Travel Demands 2007-28

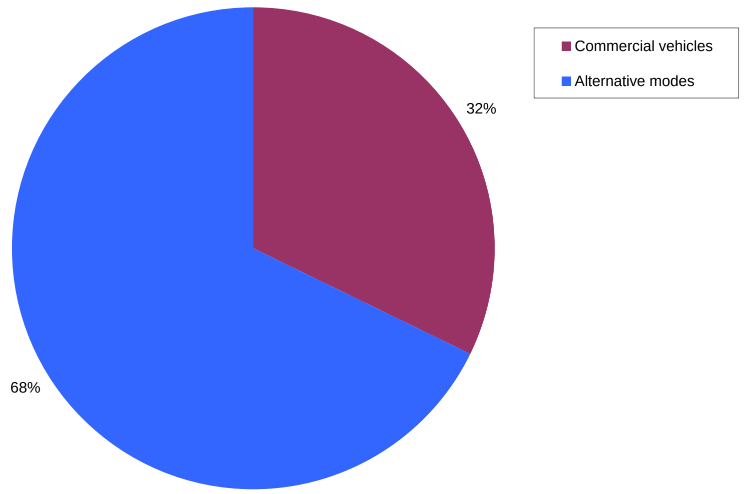


The recommended responses thus appear to cap total VKT slightly below current levels, while demand for alternative modes grows markedly.

Total travel by light passenger vehicle falls from 31 to 27 billion VKT per year and kilometres travelled by commercial vehicles and alternative modes grow substantially. From 2007 to 2028 travel by all modes increases from 44 to 48 billion VKT, at an annual average rate of 0.5%, although travel on the road network reduces slightly at an annual average rate of -0.2% with most the reduction in travel occurring in the period 2008-11. There is a marked shift from light vehicle travel to alternative modes, such that the latter increases from 8% to 19% by 2028 whereas the former declines from 72% to 56%. Heavy vehicle mode share grows from 20% to 23%.

From 2008 to 2028 total travel demands are expected to grow – this growth can be though of as the marginal increase in travel demands between now and then. During this time the balance of growth is split unevenly between the different travel categories. Figure 6.2 how the marginal travel demand growth (i.e. the travel demand growth from 2007 to 2028) is split between commercial vehicles and alternative modes. It is the marginal demand growth which shows which where pressure on the transport system may be expected.

Figure 6.2: Marginal Travel Demand Growth following implementation of Responses



Marginal travel demand growth under the three fuel price scenarios is summarised in Table 6.2.

Table 6.2: Marginal Travel Demand Growth by Mode and Fuel Price Scenario 2007-28

Mode	Fuel Price Scenario		
	High	**Average**	**Low**
Passenger vehicles	0%	0%	33%
Commercial vehicles	26%	32%	30%
Alternative modes	74%	68%	37%
Annual average VKT growth	-0.98%	-0.14%	0.88%
Annual average travel growth	0.13%	0.60%	1.25%

Marginal demand growth for the different modes is particularly stable across the various fuel price scenarios. Most notably, however, even in the low fuel price scenario alternative modes account for the largest proportion of the growth in travel demands. Total travel demands grow in all fuel price scenarios, while travel on the road network reduces in both the high and average fuel price scenarios and grows at just under 1% per annum in the low fuel price scenario.

Detailed discussion on the implications of this analysis for transport funding is outside the scope of this report, although some general comments are warranted. Firstly, it is emphasised that these results do not necessarily suggest 68% of all transport funding should be applied to alternative modes. A more appropriate interpretation is that the breakdown in marginal demand provides a basis for allocating investment in additional transport capacity. Maintaining and improving the existing transport network will be a priority, particularly in the short-term and until the full impacts of the recommended responses are worked through. Moreover, increased commercial vehicle travel may require substantial improvements to the road surface on major routes, which will also deliver improvements in energy efficiency. It does appear, however, that the application of the recommended responses would support substantially increased investment in alternative transport modes, particularly in the short term.

This modelling is intended to provide only a preliminary indication of the potential effects of the recommended responses on future travel demands. Results are dependent on the assumptions of the coverage (spatial and temporal), timing (start and rate of implementation), and impacts (short and long term). Further work could refine this modelling to provide a more detailed picture of the implementation timelines and the complex travel demand responses that may arise.

The possibility for further work should not however be construed as suggesting the results presented above are optimistic. Indeed it is possible that this approach has underestimated the potential for these responses to initiate auto-catalytic processes (also known as positive feedback loops) that motivate further reductions in vehicle ownership and use and/or increased uptake of alternative modes. An example of such a process is that reduced congestion on the road network will allow for more reliable bus journeys, which increase the relative attractiveness of bus travel. This may subsequently increase ridership and fare revenue and subsequently the viability improved services. These improvements would once again increase the attractiveness of the service, attract new riders, and thus begin the process anew (Levinson and Krizek, 2008).

Auto-catalytic processes may also cause more substantial reductions in light passenger vehicle travel. In particular, the cumulative impacts on vehicle ownership of direct and efficient pricing; denser and more diverse land use; and increased investment in alternative modes have not been modelled. These responses would perceivably reduce the economic utility associated with light passenger vehicles, which may cause long term reductions in travel. Previous analysis indicated that changes in vehicle ownership may account for historical growth in VKT, growth which the recommended responses are likely to undo.

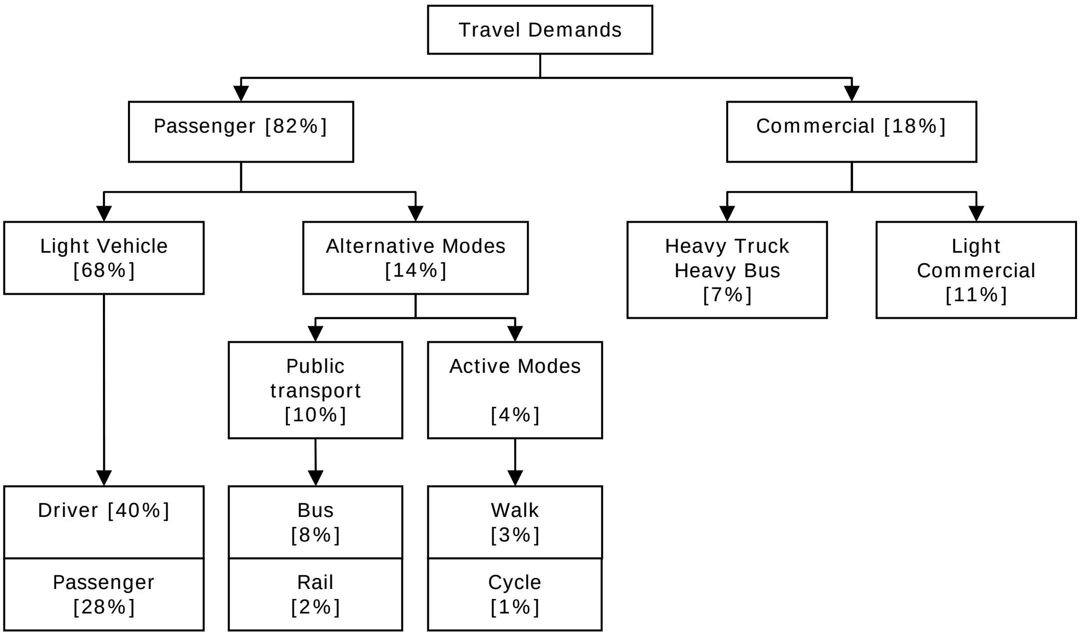
Less obvious are the impacts of innovative market responses that a more directly and efficiently priced transport network may be able to generate. This may make use of improving information technology to connect people and deliver information and services without the need for travel. For example, higher transport costs may see greater use of video-conferencing as a substitute for business travel.

6.2 How the Responses Deliver Energy Efficiency

This section identifies how the recommended responses result in more energy efficient travel patterns.

Figure 6.3 illustrates the estimated mode share changes that are expected to result from the recommended responses. This illustrates that PKT by alternative modes more than doubles from 6% to 14%, whereas mode share for light vehicles drops from 51% to 40%. Car-passenger mode share remains the same, suggesting that there is an increase in average vehicle occupancy from approximately 1.6 to 1.7 people per vehicle. The mode share for commercial vehicles increases from 14% to 18%.

Figure 6.3: Affect of recommended responses on VKT mode share by 2028



The recommended responses are anticipated to cause a 21% reduction in oil intensity over the next 20 years. This would see, for example, average transport fuel consumption declining from the 1,000 litres per capita discussed previously in Section 2.4 to approximately 790 litres per capita by 2028 – all other things being equal.[13]

The reduction in oil intensity provided by the recommended responses is approximately three times that provided by the improvements in fuel economy considered in the Base case. Only under the Upper fuel price scenario is travel expenditure on oil based transport fuels expected to increase. This analysis is expected to be conservative because it does not account for the effect of denser and more diverse land use patterns on average travel distances.

6.3 What are the Economic Benefits?

The responses outlined in this report are likely to have major impacts on the way that New Zealanders travel. Demand for vehicle travel is expected to reduce, both in total and per capita terms, while demand for alternative modes is expected to increase.

[13] Note that the mode shares illustrated in Figure 6.3 have been assumed on the basis of all other factors being equal. This is particularly problematic in the case of public transport, and especially rail. Rail accounted for the largest relative increase in mode share for home to work journeys in the 2006 census, while bus, walking, and cycling mode share fell. This is likely to reflect substantial investment in Auckland and Wellington's rail networks as well as a tendency for rail to pick up longer distance trips that would otherwise be undertaken by light passenger vehicle – the same trips that are likely to be most affected by higher fuel prices. For these reasons the increase in rail mode share is likely to be under-estimated in relation to the other alternative modes. Further research should seek to expand on the analysis in this report so as to provide a more accurate indication of the relative breakdowns in mode share between alternative modes. Note also that this does not account for additional investment in public transport, which may be expected to cause more mode shift than that illustrated in Figure 6.3 – particularly in Auckland. For these reasons the mode share for alternative transport modes is likely to be relatively conservative.

By virtue of their relative economic neutrality, the measures recommended in this report are expected to manage travel demands at relatively low cost. This section provides a preliminary examination of benefits to individuals, wider society, and the broader domestic economy. The analysis that follows is based on the Average fuel price scenario.

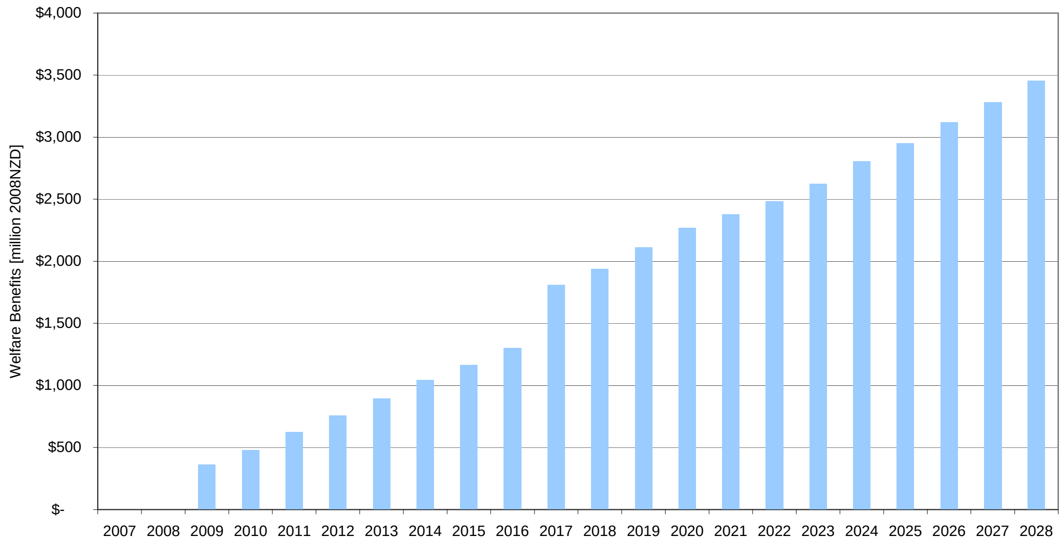
6.3.1 Consumer Savings

This section quantifies the consumer savings resulting from reduced vehicle travel.

Consumer savings are a function of VKT. Fuel expenditure savings are estimated for each year by multiplying the total annual VKT by the average fleet fuel economy (allowing for expected improvements), and the price of fuel. Vehicle operating cost savings accrue from reduced expenditure on maintenance, which were estimated at a flat rate of $0.15/km. Figure 6.4 illustrates the consumer savings based on fuel and operating cost savings for the total population.

It is recognised that consumer expenditure on other forms of transport modes may increase as a result of the recommended measures. Increased uptake of alternative transport will require expenditure on other items, such as bicycles and public transport fares. These increased consumer costs are expected to be typically less than the averted vehicle expenditure – particularly for those who elect to take up car-pooling or active modes. Those who switch to public transport may effectively break even – although should their mode shift allow a household to reduce the number of vehicles it supports then consumer savings above and beyond those indicated above may be expected.

Figure 6.4: Consumer cost savings delivered by the Recommended Responses



For those who continue to drive there will still be the benefit of a number of indirect welfare benefits, particularly improved in travel times as a result of reduced congestion. The primary difference is that when confronted with the certainty associated with these responses, consumers may change and adapt so as to mitigate the additional costs – something that is more difficult to do in reaction to the variable nature of fuel prices. Such benefits are discussed in more detail in the following section.

6.3.2 Welfare Benefits

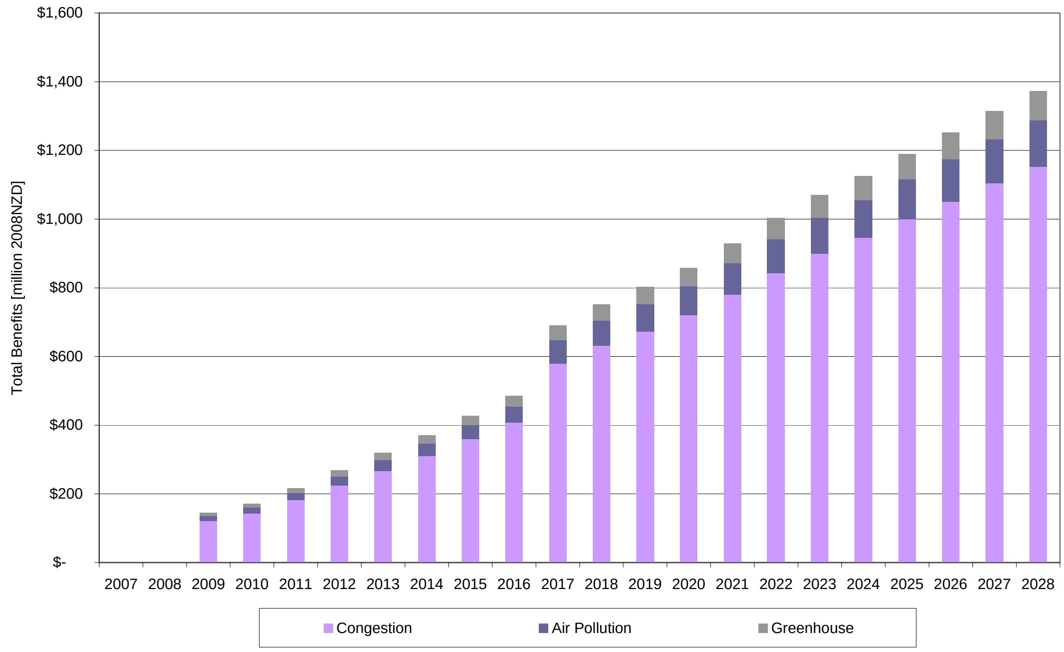
The recommended responses are also expected to deliver a number of benefits to society. These are defined as welfare benefits and include reduced congestion (Land Transport NZ, 2007b), improved air quality (Fisher et al., 2007), reduced greenhouse gas emissions (Treasury, 2008b), and increased physical activity (Land Transport NZ, 2007b). Marginal costs were able to be used for congestion, greenhouse gas emissions, and physical activity.

In the case of air pollution only average costs were able to be derived, which may underestimate the actual value of improved air quality – particularly if the alleviation of congestion allows for primarily free flow travel on the road network. On the other hand, air quality benefits were solely calculated as a function of total VKT and not broken down between light and commercial vehicles. The reduction in VKT is primarily associated with the use of light passenger vehicles and thus may overstate the air quality benefits. Further research should seek to more accurately quantify the marginal costs of air pollution caused by light and commercial vehicles.

Savings attributed to averted costs of road construction were not included in the analysis as these are assumed to be re-invested into increased maintenance of the existing road network and alternative modes.

Figure 6.5 summarises the value of the benefits attributed to congestion, air pollution, greenhouse gas emissions, and physical activity.

Figure 6.5: Welfare Benefits delivered by the Recommended Responses



Congestion reduction benefits are calculated to be approximately $1.2 billion in 2028. This is slightly less than the total costs of congestion costs (inflation adjusted) found in other studies (Booz Allen Hamilton, 2005). This finding corroborates with the application of a pure road pricing system that is able to manage travel demands below the level where substantial queues builds. Further details on the assumptions underlying these calculations are contained in Appendix I.

It is noted that the congestion reduction and physical activity benefits realised by these responses are not delivered by either improved fuel economy or alternative fuels. Technological developments may provide some benefit to society in terms of reduced air pollution and greenhouse gas emissions, but these benefits are small in comparison to that realised by averted vehicle travel.

6.3.3 Macro-economic Benefits

In addition to the consumer savings and welfare benefits discussed in the previous section are a number of general macro-economic benefits.

In terms of commercial freight, the reduction in vehicle traffic resulting from the implementation of these measures is expected to provide more reliable travel times. Road pricing on its own is expected to eliminate significant amounts of low value travel and free up road space for commercial vehicles, which is expected to deliver substantial benefits. Fewer vehicles and fewer drivers travelling further distances at less cost, which may reduce overall transport costs and thereby have flow on effects for prices for other goods and services.

Other macro-economic benefits are less obvious but nonetheless tangible. Parking management and car-sharing, for example, may be expected to concentrate vehicle ownership in fewer vehicles. Investment in fuel efficient vehicles is more rapidly recouped when vehicles travel longer distances. Thus reducing individual vehicle ownership and consolidating vehicle travel into fewer more efficient vehicles is expected to shift the relative investment balance and result in more rapid improvement in the fuel economy of the national fleet.

International research has indicated that excessive vehicle travel tends to reduce economic development, particularly in urban areas (Kenworthy and Laube, 1999). This research finds that the total economic costs of increased vehicle travel outweigh the benefits beyond approximately 7,500 VKT per capita per annum, although this does vary depending on geographic and demographic factors (Kenworthy et al., 1997). Recent research into the costs of travel associated with different modes found that the use of private vehicles in Auckland generates larger total costs than the use of public transport, even accounting for operating subsidies (Jakob et al., 2006).

The measures in this report are expected to reduce total (i.e. both light passenger and commercial travel) per capita VKT from 9,500 VKT in 2007 to 7,800 VKT by 2028, which is more in line with what is considered to be the optimum amount of travel, from an economic perspective. Quantifying these more pervasive macro-economic benefits is outside the scope of this report but should be the subject of further analysis.

Finally, it is noted that the economic neutrality of the recommended responses means that there are no additional costs imposed on business in New Zealand – at worst they represent what economists term a "zero sum game" which is where costs that are borne in one sector of the economy are simply transferred to another. In this case of this report, however, the transference of costs results in improved outcomes because these costs are charged more directly and efficiently to consumers, thereby allowing for consumers to reduce manage their use of transport system in a way that reduces costs.

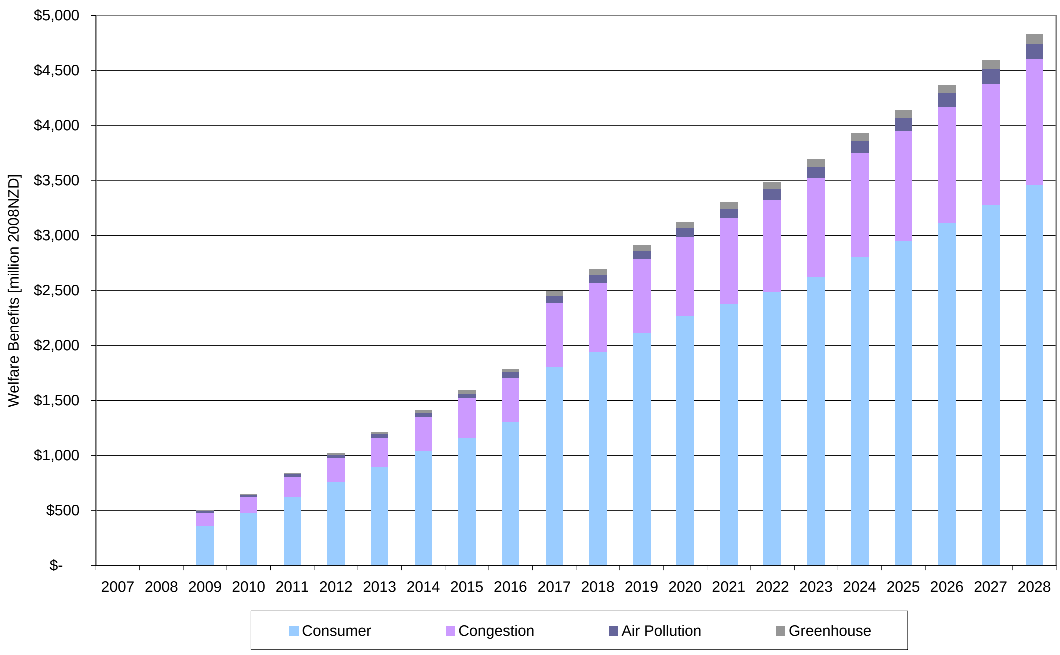
For example, the costs of providing parking are currently subsidised through higher development costs and general property rates – such that there is no way to avoid paying for them *even if people wanted to*. Charging parking directly to users provides them with the opportunity to decide how much parking they want to pay for and manage their use accordingly. Similar arguments apply to road pricing.

For these reasons, the recommended responses serve to increase the competitiveness of New Zealand's businesses, firstly by improving the efficiency with which transport and land use resources are used and secondly through relieving congestion on the road network. The type of congestion relief delivered by the recommended responses far exceeds those able to be achieved by expanding the capacity of the road network.

6.3.4 Total Benefits

This section has discussed the consumer savings, welfare benefits, and macro-economic benefits delivered by the recommended responses. Figure 6.6 summarises the values for these benefits.

Figure 6.6: Total Benefits delivered by the Recommended Responses



These responses are thus estimated to deliver $15 billion in net present value benefits over the next 20 years, assuming a standard discount rate of 10%. Most of the responses are based on travel demand management, rather than infrastructure investment, and are therefore relatively cost-effective. By 2028 total annual benefits are expected to be approaching $5 billion annually.

6.4 What are the Risks?

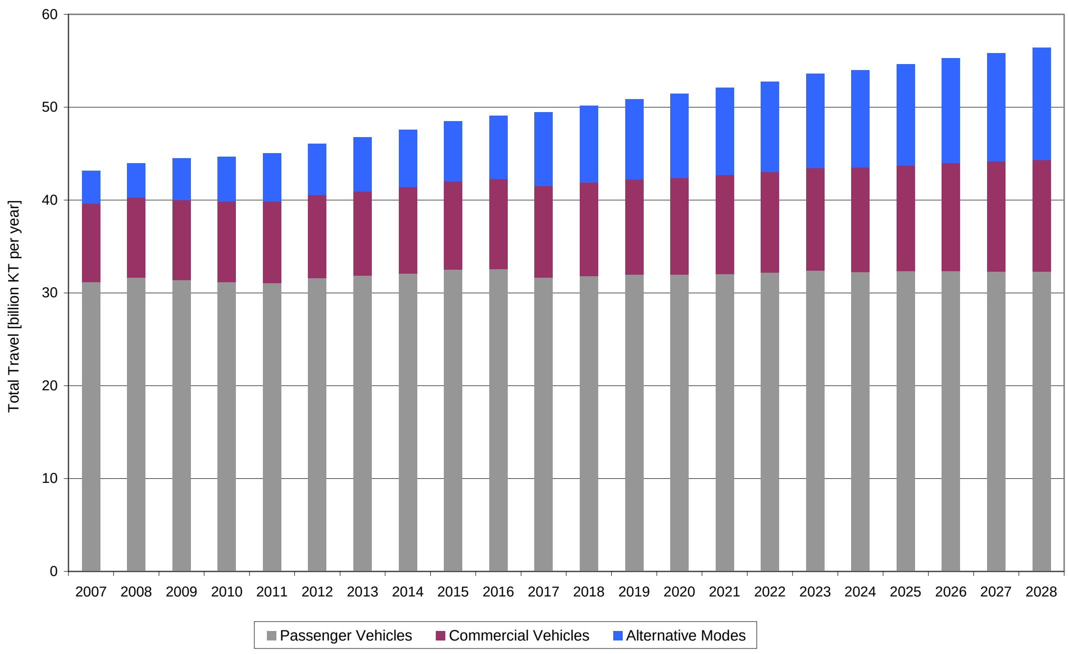
This section examines some of the key risks associated with the recommended responses, namely inadequate road capacity and localised shocks.

6.4.1 Inadequate Road Capacity

Modelling suggests that the comprehensive, coordinated, and staged implementation of the recommended responses will enable a shift in focus away from supply side capacity expansions of the road network and into increased investment in network maintenance and alternative modes. One of the primary risks this raises is that shifting focus away from capacity expansion may mean that unexpected growth in traffic volumes results in a shortfall of road capacity.

Circumstances that may contribute to this situation emerging include lower than expected fuel prices, higher than expected population growth, higher economic growth, and more rapid growth in disposable incomes. The sensitivity of travel demands to these factors was assessed by considering the Lower fuel price scenario with high economic growth (+10%), high growth in disposable income (+10%), and high population growth (+2.5%), as illustrated in Figure 6.7.

Figure 6.7: Total Travel Demands under High Vehicle Travel Scenario



Even in this high travel demand the recommended responses restrict growth in VKT growth to annual average growth of approximately 0.5% - which is well below historical growth rates. This low overall growth reflects that the recommended responses direct additional travel demands across a range of modes, rather than being automatically funnelled onto the road network.

This discussion obscures a more fundamental reason why inadequate road capacity is not considered a risk. Many of the measures, such as road pricing and parking pricing, provide government agencies with a number of tools through which demand for transport infrastructure may be managed. For example, unexpected demand may be met through temporarily increased prices for the use of parking and road resources, with additional revenue then able to be reinvested into the transport system to provide additional capacity in the most efficient way to provide for higher demands. In this way investment in capacity becomes more responsive to demand than the current system which depends on the ability of government agencies to predict and provide for demand well in advance.

There is therefore a reduced risk of higher than expected demand growth with the recommended approach than exists in the status quo. Instead of merely adding capacity, government agencies may adjust prices in the short term to ensure the transport system operates at near optimal efficiency, before the additional revenue is reinvested in the requisite capacity. This situation appears to result in vastly reduced risks to government agencies, both in terms of under-estimating or over-estimating future travel demands.

6.4.2 Localised Shocks

One of the primary risks associated with implementing major pricing based reforms is that adverse effects may disadvantage certain communities and individuals. These effects are defined in this report as localised shocks.

Localised shocks generally arise from step-changes in the price of travelling to a particular area, where the step-change may occur in both time and space. For example, localised shocks are likely to occur if road pricing mechanisms are implemented quickly and without warning, so as that many travellers are unable to adjust their travel patterns. Alternatively, localised shocks may eventuate if priced parking is implemented in one town centre at $3/hour while parking at an adjacent town centre remains subsidised.

Minimising the impacts of localised shocks requires signalled, staged, and coordinated implementation across a range of government agencies. Signalling changes in advance allows affected parties to take steps to avoid or minimise potential prices. Staging changes in a graduated manner allows affected parties to accommodate additional costs through minor adjustments to expenditure priorities. Coordinating changes across government agencies will provide to maximise benefits from a package of responses. For example, investment in alternative transport modes will be most effective if it is backed up by the coordinated application of pricing measures that directly and efficiently price the use of vehicles.

The need for coordination does need not imply homogeneity. Pricing should, as much as possible, reflect the value of the relevant resource being used. Value will differ significantly from place to place in accordance with supply and demand, such that road and parking prices in major urban areas are likely to be higher than in rural centres. Indeed, a number of the responses identified in this report are designed to support more diverse travel and land use patterns. For example, sophisticated road pricing is likely to result in a reduced travel cost burden for low income households in rural areas than is able to be realised through the homogenous application of a consumption based fuel excise tax.

In some situations providing direct financial assistance, such as discounts for public transport passes, may be required to minimise localised shocks as the transport system is reshaped.

7. Further Research

This research report highlighted the need for further research in the following areas:

- Feedback loops between higher global energy costs and domestic growth. It is likely that sustained high oil prices would impact on the economic growth assumptions considered in this research report. Further research could seek to identify the effects of such prices for the global and domestic economy.

- The longitudinal effects of an ageing population on per capita travel demands. This research could investigate how age affects the quantity of travel undertaken by various modes and/or travel patterns across the day (O'Fallon and Sullivan, 2003). This should aim to identify how overall VKT is split between peak and off-peak travel.

- The impacts of higher fuel prices on other commercial modes such as air, rail, and coastal shipping. Research may need to occur on a relatively fine level to identify regional and commercial parameters that affect uptake of alternative modes for commercial travel (Clark et al., 2005). Elasticities of air passenger numbers to fuel prices may also shed light on specific effects on travel patterns around major airports.

- Models of short term price variability using statistical methods such as Levy processes (Krichene, 2008). Temporal granularity will be important; weekly oil price appear to have the strongest relationship to fuel prices. More detailed research into the relationship between oil and retail price of transport fuels may also be of interest.

- Methods to incorporate short term price oil price models within a long term modelling framework, such as the Meta Model, to better understand future price variability. This could inform, for example, the size of price swings government agencies may need to incorporate into contingency estimates and risk management.

- Factors influencing travel demands, including but not limited to vehicle ownership, economic growth, workforce participation, and disposable income. Local studies are also required into the cross-elasticities of fuel prices with respect to demand for public transport and active modes.

- More detailed modelling of the effects of both fuel prices and the recommended responses on total travel demands, including quantification of the long term autocatalytic processes the responses may initiate, such as reduced vehicle ownership, reduced travel distances, and increased demand for alternative modes.

- Ways in which regulatory requirements for public consultation on transport projects may be streamlined so that government agencies are able to move more swiftly in the event that unexpected increases in fuel prices demands the acceleration of strategic infrastructure responses.

- Ramifications of oil prices on regional and local travel demands, and how these impacts may be incorporated into planning documents, such as Roading Management Plans and Long Term Council Community Plans.

- Further research could seek to identify how the recommended responses lend support to the targets outlined in the updated NZTS and associated Government Policy Statement (MOT, 2008b, New Zealand Government, 2008).

8. Summary

This research report has considered how government agencies may manage the transport challenges associated with rising oil prices. The key results of this research are summarised in the following sections.

Modelling Prices for Transport Fuels

Recent high oil prices reflect a combination of increased production costs, growing demand in developing countries, increased reliance on unconventional and synthetic sources, and limited spare production capacity. Future oil prices were modelled using a Monte Carlo simulation that combined a number of price forecasts to generate a statistically representative distribution of future oil prices. The Average price, along with associated Upper and Lower confidence intervals, were extracted from this distribution. The Average price projection indicated a drop in oil prices may be expected in the second half of 2008 after which prices are expected to escalate to reach approximately $155 2008USD/barrel by 2011. Looking ahead prices appear to plateau and gradually drop to approximately $125 2008USD/barrel in 2028. Upper and lower price scenarios varied from $210 to $50 2008USD/barrel respectively. Care should be taken in interpreting the long term results of the model, with a greater emphasis placed on near-term results. Future prices for transport fuels were calculated on the basis of expected movements in the New Zealand Dollar along with expected carbon and bio-fuel charges. This showed that prices for petrol and diesel may be expected to peak in 2011 at approximately $2.80 and $2.50 2008NZD/litre. Risks to these price projections are expected to lie on the upside, particularly in the short term.

Modelling Future Travel Demands

Travel demand elasticities were calculated with respect to fuel prices, economic growth, vehicle ownership, workforce participation, and disposable income. Elasticities for light passenger and commercial travel demands were evaluated separately. Light passenger travel demands were found to be sensitive to a variety of factors, especially fuel prices and vehicle ownership. Commercial travel demands were found to be substantially less sensitive to fuel prices and more sensitive to economic growth – the other factors considered in the analysis (that is vehicle ownership, workforce participation, and disposable income) were not found to have a significant impact on travel patterns. Cross-elasticities for public transport and active modes were estimated using a combination of local and international studies. Under the Average fuel price scenario total VKT is expected to remain below 2007 levels until circa 2016 after which the effects of economic growth begin to dominate. There is also a shift in travel demand growth away from light passenger vehicles towards commercial vehicles and alternative modes. This is likely to require increased investment in road network maintenance and alternative transport modes.

Responses to Rising Oil Prices

A toolbox of potential solutions is discussed to facilitate the development of a more efficient transport system. Central to these responses is the understanding that travel and land use have not historically been effectively managed or priced. This has led to structural imbalances that have subsidised private vehicle trips. Rectifying these structural imbalances so that road users are faced with the true costs (both internal and external) of their choices is expected to deliver travel and land use patterns that are significantly more energy efficient. Recommended responses include:

- *Land Use* – parking regulation and management; flexible zoning and urban containment; development incentives; and urban renewal and TOD.
- *Direct and Efficient Pricing* – commercial parking rate, pay parking, road pricing, and tax treatments.
- *Infrastructure Investment* – the transformation of roads into streets, investment in active modes, investment in public transport services and infrastructure, multi-modal integration, and taxi services.
- *Behaviour Change and Education* – travel plans, car-sharing/bike-sharing, Transport Management Associations, and public transport information.
- *Freight Management* – regional freight strategies, home delivery, and active freight.

General legal considerations highlight how regulatory requirements for public consultation may reduce the ability of government agencies to respond swiftly and effectively in the event that fuel prices rose unexpectedly. In this event new measures should seek to provide transport agencies will the ability to accelerate infrastructure investment.

Impacts of the Recommended Responses

The effect of the recommended responses on future travel demands was analysed by estimating their expected coverage, maximum impacts, and implementation timelines. The results of this analysis indicate that the recommended responses can be expected to reduce total VKT below current levels. This suggests that land use management and direct and efficient pricing, along with targeted infrastructure, is able to preserve road network levels of service and allow for substantially increased investment in alternative transport modes. Initial modelling indicates that alternative transport modes may account for approximately two thirds of future growth in travel demands, with the balance attributed to increasing commercial travel. Consumer savings associated with the recommended responses were evaluated in terms of averted expenditure on fuel and vehicle operating costs. Welfare benefits were evaluated for reduced congestion, improved air quality, increased physical activity, and reduced greenhouse gases were also estimated. By 2028 the recommended responses were found to deliver total savings in the order of $5 billion per annum or approximately $16 billion in net present terms. The recommended responses are conservatively estimated to reduce reliance on oil based transport fuels by three times greater than that realised solely through improvements in fuel economy.

9. Conclusions

This research concludes that:

9.1. There is a serious and urgent risk that high oil prices will eventuate within the next five years. These prices appear likely to be sustained for the next two decades.

9.2. Prices for petrol and diesel are expected to rise to approximately $2.80 and $2.44 per litre by 2014 - suppressing total vehicle travel below current levels until 2016.

9.3. High fuel prices shift demand away from light passenger vehicles to commercial vehicles and alternative transport modes.

9.4. The resilience of the transport system to high oil prices is currently being undermined by market distortions that cause an over-reliance on private vehicles.

9.5. A paradigm shift is required away from “predict and provide” transport planning to “manage and price” type measures.

9.6. Responses should focus initially on delivering reforms that allow for denser and more diverse land use while also directly and efficiently pricing vehicle travel.

9.7. Efficient land use and pricing may be expected to generate additional demand for infrastructure solutions that provide safely for a diverse range of modes.

9.8. Modelling indicates that these responses are able to contain total vehicle travel at or below current levels and increase demand for alternative transport modes.

9.9. Containing growth in vehicle travel allows for increased investment in road network maintenance (particularly low friction road surfaces) and alternative transport modes.

9.10. The recommended responses are “no regrets” measures which, once implemented, deliver a range of economic, social, environmental benefits.

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Appendix A Density and Amenity

Increases in density alone do not control the quality of a development. The same density can be manifested in a number of different ways, including:

- Low rise – High coverage
- Medium rise – Medium coverage
- High rise – Low coverage

Various typologies of the same density is illustrated in Figure 9.1.

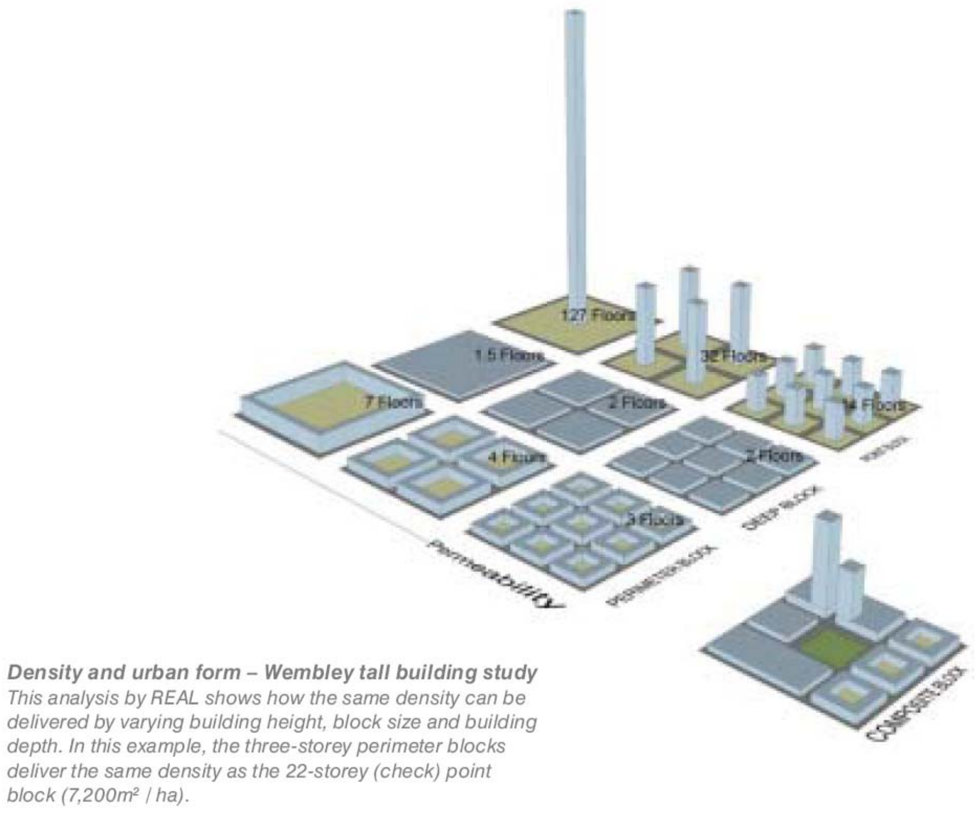

Figure 9.1 Density and urban form *(source Urban Design Compendium)*

This report has noted that higher densities are expected to be more resilient to sustained high oil prices. However, it is emphasised for urban intensification to create dynamic and sustainable urban communities, a number of factors need to be considered in addition to density. It is considered that medium rise and medium coverage development with variations in building height will produce a preferable built form and good ratio of open space to buildings in most areas of New Zealand. The *Urban Design Compendium* has examples of good functional design parameters and case studies of where they have been implemented. It is also noted that density alone does not deliver reduced reliance on oil based transport fuels – allowing for a mixture of uses is also important, such as residential, commercial, and retail.

Appendix B Economic Evaluation Processes

This appendix highlights some potential issues with current economic evaluation processes that may be exacerbated in a situation of high fuel prices. It is acknowledged that economic evaluation processes, and the BCR they produce, are only one of three factors considered when allocating transport funding; their primary purpose is to rank similar classes of projects rather than discriminate between different types of transport investment. Despite these caveats, BCR do play a role in shaping the type of funding applications local authorities are prepared to investigate and develop, while also influencing public and political perceptions of the economic benefits delivered by various transport modes. The issues raised in this appendix include the treatment of induced traffic and land value impacts.

Firstly, it is uncertain whether the EEM treats projects consistently in terms of generated, or induced, traffic. The EEM Vol. 1 (EEM1), which applies to road transport projects, discusses induced traffic in the following way:

> *In general it shall be assumed that [road] projects do not induce any new trips or cause a re-distribution to new destinations. If there are cases where the effect of excluding induced or redistributed trips seriously affects the evaluation, then a variable matrix approach should be adopted (Land Transport NZ (2007b), p. A2-12).*

It is noted that this is somewhat circular – how may one assess whether induced traffic affects the results until an assessment is undertaken? More important, however, is the contrast to the EEM2, which applies to sustainable transport projects. The EEM2 discusses induced traffic in the following way:

> *It is important to consider generated traffic when evaluating congestion reduction strategies … reduction of congestion is likely to make private vehicle travel more appealing for other potential road users, which will partially offset the congestion reduction benefits. This generated traffic effect should be valued as a disbenefit equivalent to 50 percent of the congestion reduction benefit (Land Transport NZ (2007a) pp. 3-19 to 3-20).*

These two extracts suggest that the EEM1 allows for, but does not mandate, consideration of induced traffic for road projects, whereas the EEM2 incorporates it automatically as a 50% disbenefit. Notwithstanding this apparent inconsistency, experience suggests that induced traffic is often not accounted for in evaluating the economic benefits of major road projects. For example, the SH18 Hobsonville Deviation and SH16 Brigham Creek Extension on Auckland's urban fringe, did not account for induced traffic – when it would appear to be an exemplary situation where additional road infrastructure would induce travel and development to a level that compromised travel time savings.[14]

[14] In the context of oil prices and vehicle dependency it is noted that travel time savings may not fully capture the potential benefits delivered by active modes, such as walking and cycling, or public transport. The attractiveness of travel by active modes is generally a function of environmental

Secondly, the EEM is not considered to adequately deal with the impacts of transport investment on land values. The EEM Vol. 1 currently excludes considerations of land value impacts because it is considered to be "double-counting" of the positive effects of improved level of service and increased "accessibility" (mobility is probably more appropriately used in this context). There are several issues with this interpretation. Firstly, it does not give consideration to the negative effects of vehicle volumes on land values. For example, many of the studies surveyed in Ryan (1999) found negative impacts in the area immediately surrounding transport infrastructure followed by positive impacts further away. This suggests that transport infrastructure provides benefits for land values that are not directly adjacent to the infrastructure in question. Such effects have been quantified in other studies; Levinson and Krizek (2008) surveyed 35,000 house sales and found that residential properties fronting onto a busy street sold for 1% less than comparable properties on quiet streets. Similarly, the number of meters to the nearest major highway was found to detrimentally impact on residential property values. All variables in their analysis were statistically significant at $p<0.01$ (Levinson and Krizek, 2008). Negative land value effects may be important not only in determining the benefits of investment in road infrastructure, but also for determining between different types of sustainable transport investment. For example, it is apparent that electrified buses and light rail will have less negative impacts on land values than standard diesel buses. Land value impacts are likely to become more important as the density of New Zealand's urban centres continues to increase.

Finally, this research suggests that the use of roads has historically been underpriced, as car parking, carbon emissions, accidents, air pollution, noise, and other external costs are not directly borne by the road user. Growth in car ownership and other travel demand factors used to project growth in traffic are based on the historical level of demand for vehicle trips. Yet this historical level of demand is predicated on under-priced roads, and is therefore not a reflection of the economically efficient level of demand. This report suggests that full internalisation of costs, such as parking and congestion, may go a long way towards suppressing growth in vehicle volumes and reducing the need for peak hour capacity expansions. Notwithstanding these issues, this research has highlighted that fuel price rises may cause a reduction in travel demands over the next 5 years. It may be necessary to re-evaluating the BCR for major road projects in light of these traffic volumes, and potentially delay expenditure where alternative transport investment delivers greater transport benefits.

This appendix has noted some areas where the processes in the EEM may detract from the ability of government agencies to respond to rising fuel prices. It is noted that the EEM is part of both a wider and evolving process and, as such, should be considered a living document. The authors suggest central government agencies may wish to accelerate this process as part of the internal housekeeping required to prepare for the challenges of rising oil prices.

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amenity, as opposed to speed. Travel time savings also tend to place a focus on mobility over accessibility; the former is easier to quantify.

Appendix C The Meta Model

This Appendix provides further details on the inputs and methodology underlying the model used to generate the oil price forecasts discussed in this report.

Forecasts

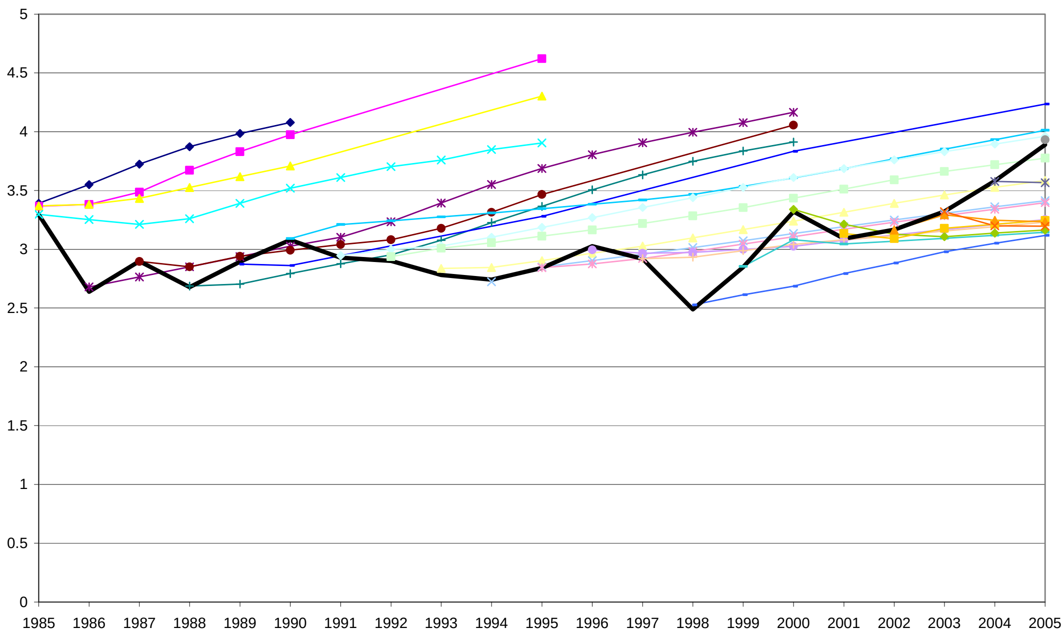
Forecast Name	CSIRO	MED	Goldman Sachs	NYMEX	IEA	LOPEX
Denominated USD	2008	2005	2008	2008	2008	1998
Global CPI	1.00	1.08	1.00	1.00	1.00	1.50
Future Discount	0	0	0	-2%[15]	0	0
2008	$100	$90	$108	$126	$84	$33
2009	$95	$105	$110	$127	$77	$34
2010	$200	$120	$120	$125	$74	$35
2011	$210	$120	$120	$124	$71	$38
2012	$220	$120	$75	$123	$68	$41
2013	$215	$120	$75	$123	$66	$44
2014	$210	$120	$75	$123	$63	$47
2015	$175	$120	$75	$123	$60	$50
2016	$165	$114	$75	$123	$60	$53
2017	$155	$108	$75	$123	$60	$56
2018	$145	$102	$75	$123	$60	$59
2019	$175	$96	$75	$123	$60	$62
2020	$180	$90	$75	$123	$60	$65
2021	$140	$90	$75	$123	$61	$77
2022	$100	$90	$75	$123	$62	$88
2023	$95	$90	$75	$123	$63	$100
2024	$96	$90	$75	$123	$64	$111
2025	$97	$90	$75	$123	$64	$123
2026	$98	$90	$75	$123	$66	$134
2027	$99	$90	$75	$123	$67	$146
2028	$100	$90	$75	$123	$68	$157
2029	$101	$90	$75	$123	$69	$169
2030	$102	$90	$75	$123	$70	$180

Error Bounds

None of the mainstream forecasters offer a confidence interval on their results, and few make their past predictions or model details freely available. However, EIA forecasts are available from the early 1980s. These are shown, along with the actual price of oil, in Figure 9.2.

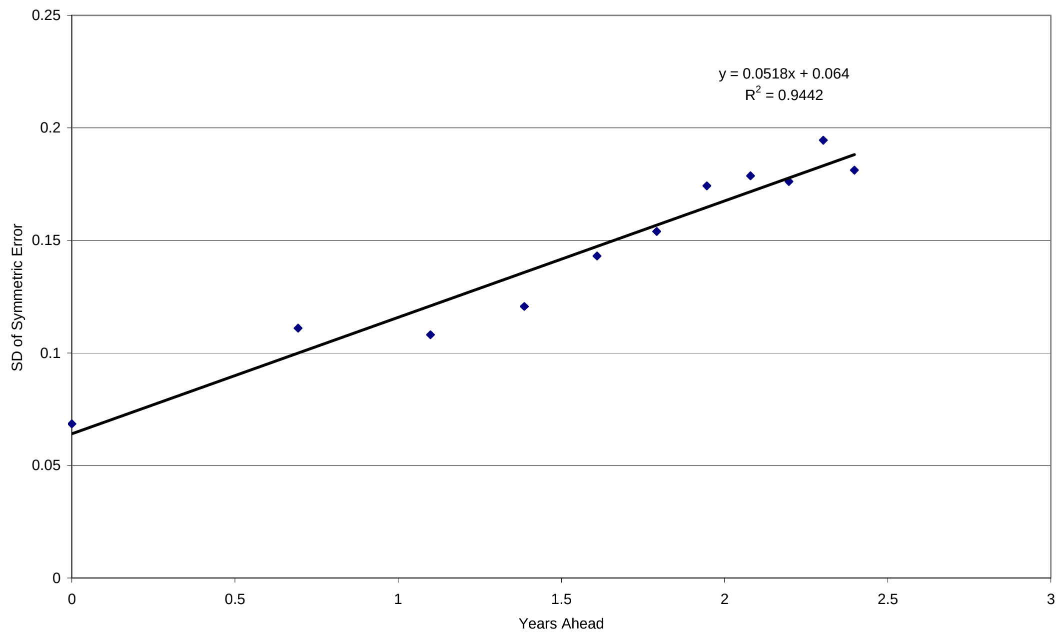
[15] Note that the future discount is applied only to NYMEX prices until 2016 (the last date for which prices are available) after which persistence forecasting is used to extend their price to the end of the time horizon.

Figure 9.2: EIA forecasts 1985-2005



Given the shortage of data, the EIA history was used to generate synthetic error bounds for all forecasts by assuming that the true oil price lay within the 95% error bounds of past EIA forecasts. For scale invariance and to avoid negative prices, the logarithm of years after the prediction and the error in the prediction of the logarithm of price was compared, as shown in Figure 9.3.

Figure 9.3: SD of symmetric error versus log time for EIA forecasts



Applying historical error bounds to predict future prices resulted in a large degree of variability – with a few rare extreme price forecasts in excess of $2,000 USD/barrel. It is also considered likely that future forecasters will be more accurate than historical forecasts – at least so long as oil a globally traded commodity. For this reason, both the intercept and slope of the logarithmic error bounds illustrated above were reduced when projecting future prices. This effectively reduced the "upside" risk to the price projections beyond that which has been experienced in the past.

The forecasters seem to predict on a "business as usual" basis – various non-economic risk factors are not taken into account, even though they clearly have a significant effect on the price of oil. The LOPEX, CSIRO, and MED High forecasts do not appear to account for these risk factors, while other forecasts remain silent on their methodology. For this reason, it assumed that there is a 5% risk premium to the base forecasts generated by the model. The price generation process is discussed in the following section.

Generating Price Forecasts

In order to generate an "expected forecast" and error bounds on that forecast, a large number of candidate forecasts were generated by sampling for each year from the set of forecasts, the error distribution for that year (discussed in the previous section), and "non-economic" risk factors, which were assumed to add approximately 5% to the underlying price forecast. That is, for a single trajectory t, the prediction in year y, the price $P_t(y)$ is:

$$P_t(y) = e^{\ln\left[f_{U_t}(y)\right] N\left[1, a+b\ln(y-y_0)\right]} \prod_{Risks} Z_r$$

Where f_U is the U th forecast, U_t is a randomly chosen forecast used for the whole trajectory, N is a normal random variable sampled every year, a and b are parameters of the error correlation, and Z_r is a random variable for each risk element that is fractional change in cost with the probability that the modelled event occurs, and 1 otherwise.

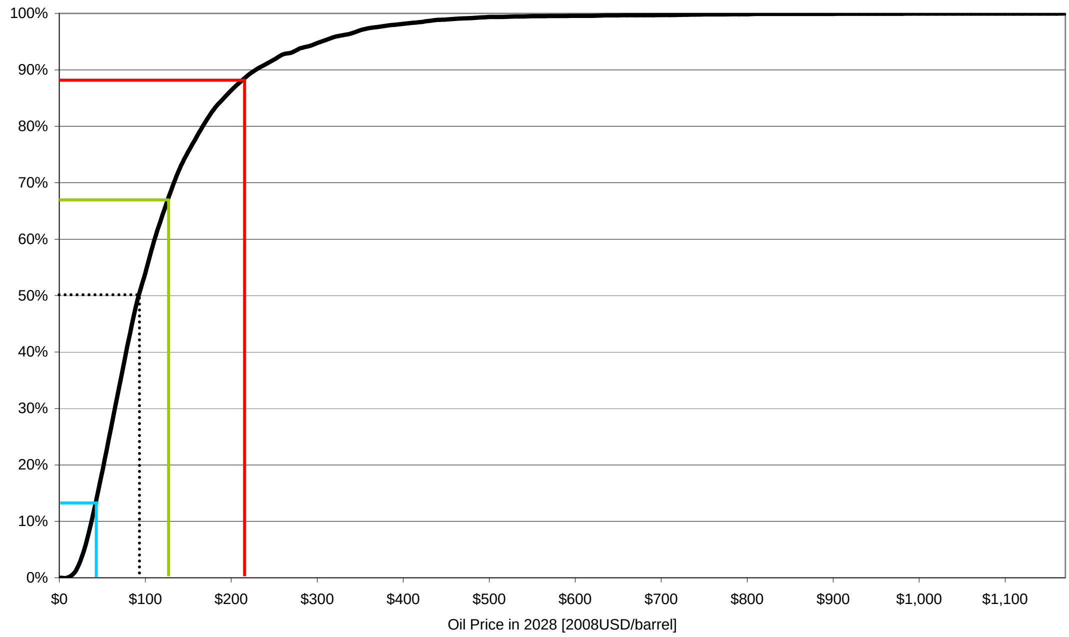
The merits of this modelling approach rest broadly on the robustness of the various forecasts used and to a lesser degree the magnitude of the risk premium added by non-economic risk factors. Most forecasts are made on an annual basis and will therefore not incorporate the most recent price trends. It is emphasised that the ability of such a model to generate representative price projections may be expected to improve in the future, as more forecasts become available and there is larger amount of historical data on which to base error estimates.

Results

The cumulative distribution function (CDF) associated with forecasts prices in 2028 is illustrated below. This analysis illustrates large degree of uncertainty associated with oil price forecasts; prices range from a low of $8 in 2028 to a high of $1,170.

The general shape of the CDF suggests the distribution is skewed to the right – which is consistent with upside price risks. The CDF also demonstrates the relative positions of the Lower, Median, Average, and Upper price scenarios generated by the Meta Model. CDF are useful for placing the upper, mid-range, and lower price forecasts within the context of the complete distribution of price forecasts generated by the model.

Figure 9.4: CDF for Oil Price Distribution generated by the Meta Model



The sensitivity of the price projections to changes in forecasting assumptions are discussed in the following section.

Sensitivity Analysis

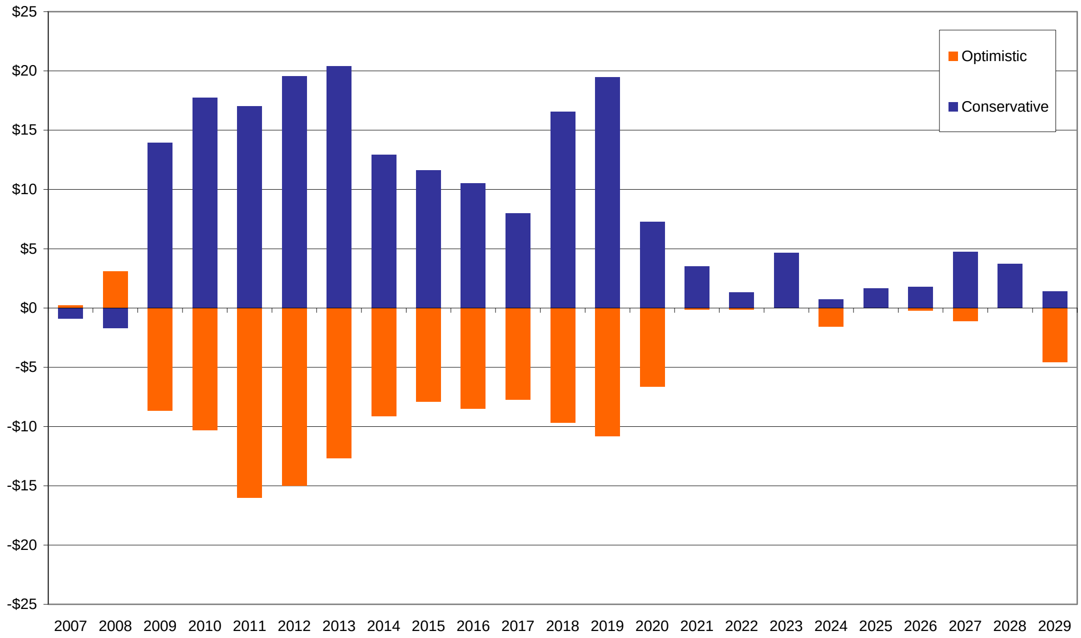
The sensitivity of the price projections shown above was examined by introducing weights to adjust the relative importance attributed to individual forecasts. For example, the results of the default scenario described used equal weighting for each of the forecasts.

The following two sensitivity tests were undertaken:

- "Optimistic scenario" – doubled the relative weighting of the optimistic price forecasts, namely the NYMEX, Goldman Sachs, IMF, and EIA forecasts; and
- "Conservative scenario" – doubled the relative weighting of the conservative price forecasts, namely the CSIRO and LOPEX forecasts.

The figure below illustrates the price projected under these scenarios measured in terms of their relative deviation from the base price projection, which applied equal weightings to each forecast.

Figure 9.5: Variation from the Base Price for Conservative and Optimistic Weighting



This figure shows how the Optimistic scenario produces oil prices up to $15 USD/barrel lower in 2012, whereas the peak price scenario produces prices $20 USD/barrel higher. Towards the end of the forecast horizon the relative differences reduce to within ± $5 USD/barrel of the un-weighted scenario. The average variation for the mainstream and peak scenarios is -4% and +6% respectively.

This relatively high degree of convergence suggests that the price projections generated by the Meta Model are relatively insensitive to changes in the weighting assigned to individual forecasts.

Merits of the Meta Model and Possible Extensions

The Meta Model essentially combines a number of individual price forecasts into a single representative forecast with associated error bounds. This section discusses the merits of this approach and possible extensions to the model.

Given the high degree of natural variability in oil prices, and the associated error involved in making forecasts, it is important that the Average price projection is viewed within the context of its associated confidence intervals. There is a tendency for averages to hide more than they reveal. The Meta Model generates annual averages, which in themselves can mask the price variability that may arise in a market characterised by inelastic short term supply and demand. Krichene (2008) has developed models of short term variability using Levy processes. It may be possible to integrate these short term price models within the annual framework used by the Meta Model to provide insight into likely price variations.

The Meta Model does not attempt to explicitly model the supply and demand factors affecting oil prices. However, the underlying forecasts (on which the Meta model is based) do explicitly model these market factors. The CSIRO forecast, for example, models the effect of declining resource availability, increasing production costs, and technological substitution, whereas the LOPEX forecast considers the cartel behaviour of OPEC member countries as well as technological improvements in oil extraction.

All these factors are likely to play a role in determining the price of oil, but it is difficult to say in advance which factor will be the most relevant. By basing price projections on a number of forecasts the Meta Model is able to account for a wider range of supply and demand factors than may be considered by any individual forecast. The multiple factors affecting oil prices are therefore modelled implicitly, as opposed to explicitly.

One area where the model could be extended is by incorporating information on upper and lower price bounds. The CDF illustrated previously has a small number of extremely low or high forecasts that may be dealt with such price bounds. Alternatively, the model could seek to incorporate a supply and demand stack so as to model price behaviour outside of the normal range of prices.

Such measures may help to reduce the range of the confidence intervals and provide increased certainty about the future price path. Given that the measures would control extreme forecasts at both the lower and upper end of the price scale, they would be expected to have only a minimal effect on the mid-range, or average price.

In the event that a particular forecaster become preferred in relation to other forecasters, then this preference may be incorporated into the weightings attributed to individual forecasts. This would proceed in similar way to the sensitivity testing undertaken in the previous section. In this way the model is able to place a higher value on information from certain forecasters without completely disregarding information from other sources.

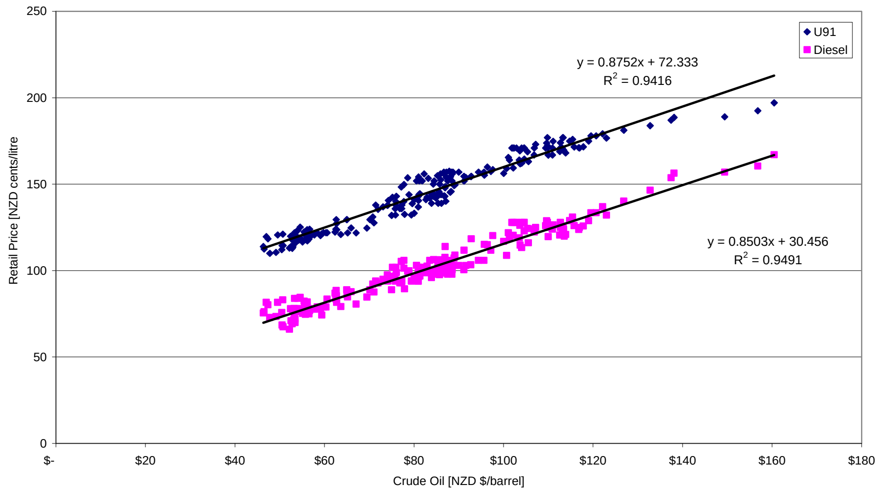
One of the primary limitations of the Meta Model is the limited availability of long term forecasts. Many forecasts only provide prices for 1-5 years ahead - with prices in the longer term assumed to revert to a baseline price. For example the “MED High” and “Goldman Sachs” forecasts revert to $90 USD/barrel and $75 USD/barrel after 2020 and 2012 respectively.

For this reason the Meta Model provides a higher degree of granularity in the short term, with more limited insight in the medium to long term. It is important that the medium to long term trends are thus interpreted with a certain degree of caution – particularly given that many of the models do not appear to explicitly model depletion of oil reserves, which may be expected to play an increasing role in determining future prices.

Appendix D Modelling the Retail Price of Fuel

This Appendix discusses the relationship between the international price of fuel and the retail price of petrol paid at the pump. The figure below illustrates the correlations between prices for crude oil and retail transport fuels.

Figure 9.6: Crude oil versus Retail Fuel Price for Diesel 2004-2008



The linear regression for diesel and petrol are summarised in Table 9.1.

Table 9.1: Summary of Linear Regression relating Crude Oil to Retail Fuel Price

Fuel	R^2	Linear Regression	
		Gradient	Intercept
Regular Petrol	94%	0.8752	72.3
Diesel	95%	0.8503	30.5

This analysis indicates that a simple linear regression model of the price of crude oil explains 94% and 95% of the variation in retail fuel price. This relationship was stronger than the relationship between crude oil and the landed price, and thus provided a reasonable basis for predicting the future retail price. Premium petrol accounts for approximately 25% of New Zealand's petrol consumption and retails for approximately 6c/litre more than Regular Petrol. For this reason 0.25*6 = 1.5c/litre was incorporated into the modelled Petrol price to account for a proportion of Premium Petrol. Thus the petrol prices discussed section represents a simple weighted average of both grades.

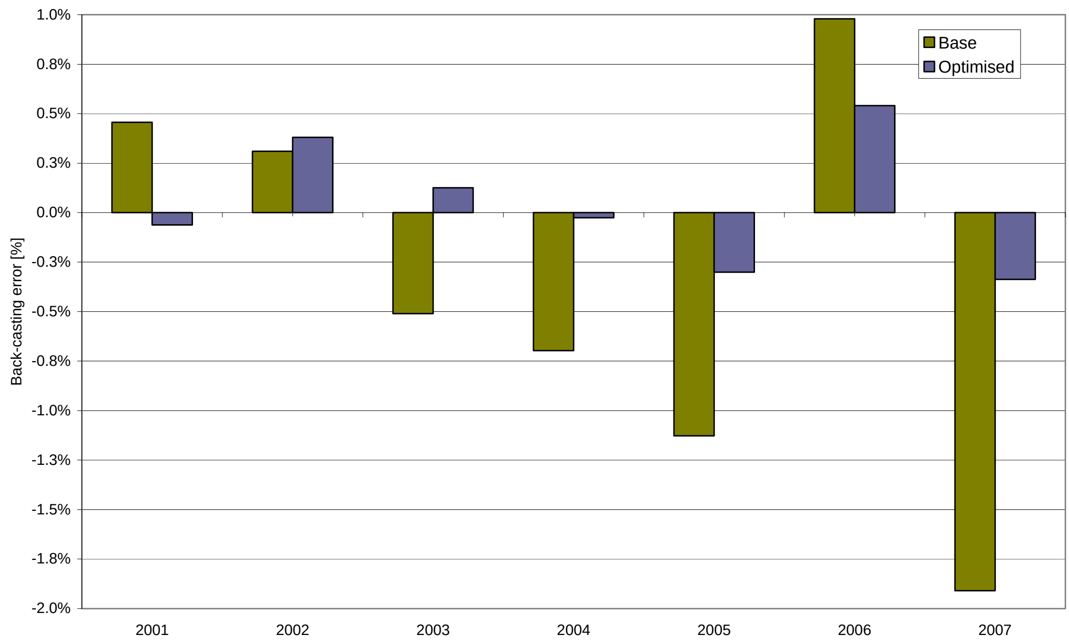
The following additional cost components were added to the expected price projection:

- Greenhouse gas emission charges increasing from 3.5c to 11.5c/litre in 2011-28; and
- Biofuels sales obligation causes increase in fuel margins of 0.5c/litre in 2012 increasing to 3c/litre by 2028.

Appendix E Back-casting Models

This Appendix discusses results of the Back-casting model in more detail. The structure of the back-casting spreadsheet is outlined in the table below.

Figure 9.7: Light Passenger Travel back-casting error 2001-07



The Optimised model is thus able to model historical VKT within approximately ±0.5% of actual values. Table 9.2 illustrates the time spread accompanying the elasticities generated by the Optimised model. This reveals that the impacts of the different factors varies significantly over time – with the impacts of fuel prices limited to the first 2 years and the impacts of economic growth and vehicle ownership spread equally over the five year period. The impacts of fuel prices on commercial travel appear to be more concentrated in the first year in comparison to light passenger travel.

Table 9.2: Time spread of elasticities for Optimised Light Vehicle travel demands

Travel	Factor	Year				
		1	2	3	4	5
Light passenger	Fuel Price	57%	43%	0%	0%	0%
	Economic Growth	20%	20%	20%	20%	20%
	Vehicle Ownership	20%	20%	20%	20%	20%
	Workforce Participation	25%	25%	25%	25%	0%
	Disposable Income	29%	29%	29%	14%	0%
Commercial	Fuel Price	91%	9%	0%	0%	0%
	Economic Growth	20%	20%	20%	20%	20%

Appendix F Base Travel Demand Factors

Light Vehicles

Year	Fuel Price			Economic	Workforce	Income	Per Capita Travel			Total Travel			Per capita Travel		
	Upper	Average	Lower				Upper	Average	Lower	Upper	Average	Lower	Upper	Average	Lower
2007	0	0	0	0	0	0	100%	100%	100%	31.5	31.5	31.5	7455	7455	7455
2008	-8.55%	-4.84%	-0.71%	0.11%	0.02%	0.05%	92%	95%	99%	29.2	30.3	31.7	6831	7107	7415
2009	-5.13%	-2.44%	0.95%	0.21%	-0.02%	0.09%	87%	93%	101%	28.1	30.0	32.4	6500	6955	7508
2010	-8.39%	-5.53%	-1.18%	0.32%	-0.07%	0.14%	80%	88%	100%	26.1	28.8	32.5	5981	6597	7449
2011	-3.11%	-2.50%	-0.75%	0.43%	-0.07%	0.18%	78%	87%	100%	25.7	28.5	32.8	5827	6468	7433
2012	-1.20%	-0.07%	1.29%	0.54%	-0.10%	0.20%	78%	87%	102%	25.8	29.0	33.8	5794	6504	7576
2013	-0.58%	-0.26%	0.31%	0.54%	-0.07%	0.20%	78%	88%	103%	26.1	29.4	34.4	5800	6531	7651
2014	-0.76%	-0.48%	0.40%	0.54%	-0.03%	0.20%	78%	88%	104%	26.4	29.8	35.2	5797	6546	7736
2015	1.34%	1.05%	0.75%	0.54%	-0.03%	0.20%	79%	89%	105%	27.2	30.6	36.1	5916	6661	7849
2016	0.46%	0.43%	-0.29%	0.54%	-0.03%	0.20%	80%	90%	106%	27.8	31.3	36.6	5986	6737	7883
2017	1.32%	0.65%	0.40%	0.54%	-0.04%	0.20%	82%	92%	107%	28.6	32.0	37.3	6107	6828	7969
2018	0.40%	0.51%	0.26%	0.54%	-0.06%	0.20%	83%	93%	108%	29.2	32.6	38.0	6173	6910	8044
2019	-1.42%	-1.05%	0.17%	0.54%	-0.08%	0.20%	82%	92%	109%	29.2	32.8	38.6	6126	6882	8111
2020	-0.59%	-0.43%	-0.20%	0.54%	-0.10%	0.20%	82%	93%	109%	29.5	33.2	39.2	6128	6897	8146
2021	1.62%	1.24%	0.04%	0.54%	-0.12%	0.20%	84%	94%	110%	30.4	34.1	39.8	6266	7025	8200
2022	2.14%	1.46%	0.22%	0.54%	-0.13%	0.20%	86%	96%	111%	31.5	35.1	40.4	6438	7170	8268
2023	0.53%	0.39%	0.65%	0.54%	-0.14%	0.20%	87%	97%	112%	32.1	35.7	41.3	6511	7241	8371
2024	-0.97%	-0.70%	-0.69%	0.54%	-0.15%	0.20%	87%	97%	112%	32.2	36.0	41.6	6486	7233	8362
2025	0.28%	0.03%	0.18%	0.54%	-0.16%	0.20%	88%	98%	113%	32.8	36.5	42.2	6542	7277	8425
2026	-0.54%	-0.27%	-0.02%	0.54%	-0.17%	0.20%	88%	98%	114%	33.1	36.9	42.8	6544	7299	8472
2027	0.07%	-0.13%	-0.05%	0.54%	-0.16%	0.20%	88%	98%	114%	33.5	37.3	43.3	6586	7331	8516
2028	-0.99%	-0.49%	-0.06%	0.54%	-0.16%	0.20%	88%	98%	115%	33.6	37.6	43.9	6559	7338	8560

Commercial Vehicles

Year	Fuel Price			Economic	Combined			Mode shift	Total Travel			Per capita Travel		
	Upper	Average	Lower		Upper	Average	Lower		Upper	Average	Lower	Upper	Average	Lower
2007	0	0	0	0	100%	100%	100%	0%	8.7	8.7	8.7	2052	2052	2052
2008	-2.67%	-1.65%	-0.45%	0.26%	98%	99%	100%	0.0%	8.5	8.6	8.7	2003	2024	2048
2009	-1.43%	-0.72%	0.27%	0.52%	96%	98%	100%	-0.3%	8.5	8.7	8.9	1980	2015	2059
2010	-2.19%	-1.52%	-0.36%	0.79%	95%	97%	101%	-0.3%	8.5	8.7	9.0	1947	1995	2063
2011	-0.79%	-0.67%	-0.22%	1.05%	95%	97%	101%	-0.3%	8.5	8.8	9.1	1947	1997	2075
2012	-0.30%	-0.02%	0.40%	1.31%	96%	98%	103%	-0.3%	8.7	8.9	9.3	1962	2018	2105
2013	-0.15%	-0.07%	0.10%	1.31%	96%	99%	104%	-0.3%	8.8	9.1	9.5	1980	2038	2129
2014	-0.19%	-0.13%	0.13%	1.31%	97%	100%	105%	-0.3%	9.0	9.3	9.7	1997	2057	2155
2015	0.34%	0.28%	0.24%	1.31%	99%	102%	106%	-0.3%	9.2	9.5	9.9	2025	2084	2182
2016	0.12%	0.12%	-0.09%	1.31%	100%	103%	107%	-0.3%	9.4	9.7	10.1	2048	2109	2204
2017	0.34%	0.18%	0.13%	1.31%	101%	104%	109%	-0.3%	9.6	9.9	10.3	2077	2135	2230
2018	0.10%	0.14%	0.08%	1.31%	102%	105%	110%	-0.3%	9.8	10.1	10.5	2101	2161	2255
2019	-0.36%	-0.29%	0.06%	1.31%	103%	106%	111%	-0.3%	9.9	10.2	10.7	2116	2177	2280
2020	-0.15%	-0.12%	-0.06%	1.31%	104%	107%	112%	-0.3%	10.1	10.4	10.9	2135	2198	2303
2021	0.41%	0.34%	0.01%	1.31%	106%	109%	113%	-0.3%	10.3	10.6	11.1	2166	2228	2328
2022	0.55%	0.40%	0.07%	1.31%	107%	110%	115%	-0.3%	10.6	10.9	11.3	2201	2261	2354
2023	0.14%	0.11%	0.21%	1.31%	109%	111%	116%	-0.3%	10.8	11.1	11.5	2228	2287	2384
2024	-0.25%	-0.19%	-0.22%	1.31%	109%	112%	117%	-0.3%	10.9	11.2	11.7	2246	2307	2404
2025	0.07%	0.01%	0.06%	1.31%	111%	114%	118%	-0.3%	11.1	11.4	11.9	2271	2332	2431
2026	-0.14%	-0.07%	-0.01%	1.31%	112%	115%	120%	-0.3%	11.3	11.6	12.1	2292	2355	2456
2027	0.02%	-0.04%	-0.01%	1.31%	113%	116%	121%	-0.3%	11.5	11.8	12.3	2317	2379	2482
2028	-0.25%	-0.13%	-0.02%	1.31%	114%	117%	122%	-0.3%	11.7	12.0	12.5	2335	2401	2508

Alternative Transport Modes

Year	Active modes									Public transport								
	Cross-elastic demand			Combined			Total [million km]			Cross-elastic demand			Combined			Total [million km]		
	Upper	Average	Lower	Upper	Average	Lower	Upper	Average	Low	Upper	Average	Low	Upper	Average	Low	Upper	Average	Low
2007	0	0	0	100%	100%	100%	1.33	1.33	1.33	0.00%	0.00%	0.00%	100%	100%	100%	2.24	2.24	2.24
2008	4.57%	2.59%	0.38%	105%	103%	100%	1.40	1.37	1.34	6.33%	3.58%	0.52%	106%	104%	101%	2.41	2.35	2.28
2009	2.29%	1.05%	-0.55%	107%	104%	100%	1.45	1.40	1.35	3.18%	1.46%	-0.76%	110%	105%	100%	2.51	2.41	2.29
2010	4.26%	2.85%	0.69%	112%	107%	101%	1.53	1.46	1.38	5.90%	3.95%	0.95%	116%	109%	101%	2.69	2.53	2.33
2011	1.24%	1.06%	0.33%	113%	108%	101%	1.56	1.49	1.40	1.72%	1.47%	0.46%	118%	111%	101%	2.77	2.60	2.37
2012	0.52%	-0.06%	-0.72%	114%	108%	100%	1.59	1.51	1.40	0.72%	-0.09%	-1.00%	119%	111%	100%	2.82	2.62	2.37
2013	0.26%	0.15%	-0.09%	114%	108%	100%	1.61	1.52	1.41	0.36%	0.20%	-0.13%	119%	111%	100%	2.85	2.65	2.39
2014	0.38%	0.24%	-0.21%	114%	108%	100%	1.63	1.54	1.42	0.53%	0.33%	-0.29%	120%	111%	100%	2.90	2.69	2.41
2015	-0.75%	-0.58%	-0.38%	113%	107%	99%	1.63	1.55	1.43	-1.04%	-0.81%	-0.53%	119%	110%	99%	2.90	2.69	2.42
2016	-0.17%	-0.17%	0.19%	113%	107%	100%	1.65	1.56	1.45	-0.24%	-0.24%	0.26%	119%	110%	99%	2.92	2.71	2.45
2017	-0.69%	-0.33%	-0.23%	112%	107%	99%	1.65	1.57	1.46	-0.96%	-0.46%	-0.32%	117%	110%	99%	2.92	2.73	2.46
2018	-0.15%	-0.24%	-0.12%	112%	107%	99%	1.66	1.58	1.47	-0.20%	-0.34%	-0.16%	117%	109%	99%	2.94	2.74	2.48
2019	0.77%	0.59%	-0.08%	113%	107%	99%	1.69	1.60	1.48	1.07%	0.81%	-0.11%	118%	110%	99%	3.00	2.79	2.50
2020	0.24%	0.17%	0.12%	113%	107%	99%	1.71	1.62	1.50	0.34%	0.24%	0.16%	119%	110%	99%	3.03	2.82	2.53
2021	-0.89%	-0.68%	-0.03%	112%	107%	99%	1.71	1.62	1.51	-1.23%	-0.94%	-0.04%	117%	109%	99%	3.02	2.82	2.55
2022	-1.06%	-0.71%	-0.11%	111%	106%	99%	1.71	1.63	1.52	-1.47%	-0.99%	-0.16%	116%	108%	99%	3.00	2.81	2.57
2023	-0.18%	-0.14%	-0.34%	111%	106%	99%	1.72	1.64	1.53	-0.25%	-0.19%	-0.46%	115%	108%	98%	3.02	2.83	2.57
2024	0.54%	0.39%	0.40%	112%	106%	99%	1.74	1.66	1.55	0.74%	0.54%	0.56%	116%	109%	99%	3.07	2.87	2.61
2025	-0.20%	-0.05%	-0.13%	111%	106%	99%	1.75	1.67	1.56	-0.28%	-0.07%	-0.19%	116%	109%	99%	3.08	2.89	2.63
2026	0.31%	0.15%	0.03%	112%	106%	99%	1.77	1.69	1.57	0.43%	0.21%	0.04%	116%	109%	99%	3.12	2.92	2.65
2027	-0.07%	0.06%	0.02%	112%	106%	99%	1.78	1.70	1.58	-0.10%	0.08%	0.03%	116%	109%	99%	3.14	2.94	2.67
2028	0.54%	0.25%	0.03%	112%	107%	99%	1.80	1.72	1.60	0.75%	0.35%	0.04%	117%	109%	99%	3.19	2.97	2.69

Appendix G Impacts of Responses on Travel

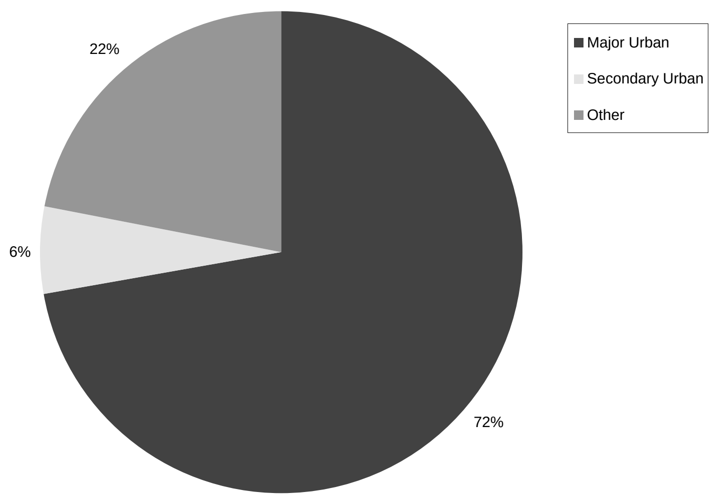
The following table summarises the assumptions used to estimate the impacts of the recommended responses on travel demands.

The coverage of the measure is defined by the areas and times during which it is likely to affect travel patterns. In terms of area, Statistics NZ sub-national population estimates were used to breakdown the population into three categories:

- Major Urban;
- Secondary Urban; and
- Other.

The breakdown of the population in these three categories is highlighted in Figure 9.8.

Figure 9.8: Relative sub-national population by population density



From 2001-07 there was an overall increase in the percentage of population living in major urban areas and reductions in the other two categories. This continues a long historical trend that is expected to accelerate as oil prices rise.

The recommended responses were assessed in terms of their relationship to the above areas. This assumed values for their spatial and temporal coverage. Some responses, such as PNR, may be expected to reach across categories and provide more energy efficient access to urban areas for those living in rural areas.

An explanation of the information used to guide these assumptions is provided below.

Table 9.3: Determining the coverage of the recommended responses

Response	Coverage				Overall
	Spatial	Notes	Temporal	Notes	
Parking Management	78%	Urban	33%	Daytime trips	26%
Road Pricing	72%	Major Urban	20%	Peak trips	14%
Zoning	78%	Urban	100%	All urban trips	78%
Public transport	59%	Urban > 100,000	33%	High quality service 8 hours per day	19%
Active Modes	78%	Assumes no rural uptake	20%	Daylight and good weather	16%
Multi-modal	89%	All urban plus half rural	90%	Alternative modes suitable most times of day	80%
Information	100%	National	100%	Information available all times of day	100%
Travel Plans	78%	Urban workplaces	25%	Most peak trips + some day trips	20%
Car-pool / Car-share	75%	Large urban + some small urban	67%	Car-pool and car-share available 18 hours/day	50%

The impact of the recommended responses was then estimated from the sources summarised in Table 9.4.

Table 9.4: Determining the impacts of the recommended responses

Response	Impacts	Notes	Sources
Parking Management	20%	Pricing parking typically reduces VKT by -0.15 to -0.30. Removing minimum parking requirements will increase demand for existing parking and thereby drive the price up to more efficient level. It is noted that these measures are more comprehensive than those tested in ARPES study and therefore the effects are commensurately larger.	Bianco (2000), Booz Allen Hamilton (2001a), Litman (2006a), Shoup (2005)
Road Pricing	20%	Road pricing typically reduces trips by 15-30% although this is highly dependent on the nature of the scheme and associated pricing schedule. In general the effects of road pricing is often greater than modeling suggest, possibly due to higher motorist resistance to out of pocket expenses (as with parking).	MOT (2006), Hugosson and Sjöberg (2006)
Zoning	10%	Flexible zoning is expected to result in increased density and diversity of uses with travel demands approximately 10% lower than average. TOD and urban renewal projects will allow for increased development around transport stations and in existing urban areas with more multi-modal access	Litman (2008), Dunphy (2004)
Public transport	15%	PT home-to-work mode share is approximately 4%, although VKT is higher at 7% as it tends to replace longer journeys. Continued investment in high quality PT, such as rail and/or BRT, suggests 15% VKT offset is achievable. PT in Finland (population 5.2 million people) currently has VKT mode share of approximately 18%.	Statistics (2006), MOT (2008a), CFIT (2001)
Active Modes	5%	Active modes may be expected to primarily replace trips less than 5km. While these trips account for approximately 33% of total trips, many of these short trips are actually individual car trips are part of longer "trip chains" or "journeys." Local research suggests that only 20% of trip chains are less than 5km and therefore suitable for uptake by alternative modes. Moreover, as active modes are replacing primarily short trips, their overall impact on VKT is likely to be even lower.	O'Fallon and Sullivan (2005)
Multi-modal	5%	Multi-modal integration is expected to occur on a number of fronts - such as integrated ticketing for PT, PNR to connect road and PT systems, improved walking and cycling connections reduce need to drive and increase accessibility to PT.	TRPG (2004)
Information	2.5%	Effects are difficult to estimate. Information tends to increase the effectiveness of other measures. In general should seek to correct "imperfect information" in regard to: future price of oil and investment in alternative modes; awareness of parking/congestion costs; and promote use of alternative modes and travel demand management. Dynamic information systems may help convey information congestion charges, parking prices, delays etc.	Thompson et al (2001), Ker (1999)
Travel Plans	5%	Effectiveness of travel plans appears to vary between 5-15% depending on the comprehensiveness of the measures implemented, and in particular whether they introduce incentives to reduce parking demands.	Rye (2002)
Car-pool / Car-share	5%	Car-share may reduce per-capita VKT by anywhere between 5-80% with 40% a general average. Information systems to assist with car-pooling (ride-share websites etc) may be important for establishing initial connections esp. for small workplaces in rural areas.	Shaheen (2005)

Table 9.5: Travel Demand Reduction Factors 2007-2028

Year	Parking	Road Pricing	Zoning	PT	Active	Multi-modal	Information	Travel Plans	Car-Sharing / Car-pooling	Total
2007	100%	100%	100%	100%	100%	100%	100%	100%	100%	100.0%
2008	100%	100%	100%	100%	100%	100%	100%	100%	100%	100.0%
2009	100%	100%	100%	100%	100%	100%	98%	100%	100%	96.8%
2010	100%	100%	99%	100%	100%	100%	98%	100%	100%	96.0%
2011	100%	100%	99%	100%	100%	99%	98%	100%	100%	94.9%
2012	99%	100%	99%	100%	100%	99%	98%	100%	100%	93.8%
2013	99%	100%	98%	99%	100%	99%	98%	100%	99%	92.7%
2014	99%	100%	98%	99%	100%	99%	98%	100%	99%	91.6%
2015	98%	100%	97%	99%	100%	99%	98%	100%	99%	90.5%
2016	98%	100%	97%	99%	100%	98%	98%	100%	99%	89.4%
2017	97%	97%	97%	99%	100%	98%	99%	100%	99%	85.3%
2018	97%	97%	96%	99%	100%	98%	99%	100%	99%	84.2%
2019	97%	97%	96%	98%	100%	98%	99%	99%	99%	83.2%
2020	96%	97%	96%	98%	100%	98%	99%	99%	99%	82.2%
2021	96%	97%	95%	98%	100%	97%	99%	99%	98%	81.3%
2022	96%	97%	95%	98%	100%	97%	99%	99%	98%	80.3%
2023	95%	97%	94%	98%	99%	97%	99%	99%	98%	79.3%
2024	95%	97%	94%	98%	99%	97%	99%	99%	98%	78.3%
2025	95%	97%	94%	98%	99%	97%	100%	99%	98%	77.4%
2026	94%	97%	93%	97%	99%	96%	100%	99%	98%	76.4%
2027	94%	97%	93%	97%	99%	96%	100%	99%	98%	75.5%
2028	94%	97%	93%	97%	99%	96%	100%	99%	98%	74.6%

Appendix H General Data

Year	Population	NZD/USD	Economic Growth	Disposable Income	Workforce Participation
2008	4264000	0.780468	2.37%	1.35%	0.66751
2009	4306000	0.744647	2.37%	1.35%	0.66475
2010	4348000	0.684945	2.37%	1.35%	0.66157
2011	4390000	0.641525	2.37%	1.35%	0.66102
2012	4430000	0.615474	2.37%	1.35%	0.66060
2013	4470000	0.600000	2.37%	1.35%	0.66014
2014	4510000	0.600000	2.37%	1.35%	0.65959
2015	4550000	0.600000	2.37%	1.35%	0.65918
2016	4590000	0.600000	2.37%	1.35%	0.65869
2017	4626000	0.600000	2.37%	1.35%	0.65727
2018	4662000	0.600000	2.37%	1.35%	0.65554
2019	4698000	0.600000	2.37%	1.35%	0.65383
2020	4734000	0.600000	2.37%	1.35%	0.65176
2021	4770000	0.600000	2.37%	1.35%	0.64941
2022	4804000	0.600000	2.37%	1.35%	0.64685
2023	4838000	0.600000	2.37%	1.35%	0.64409
2024	4872000	0.600000	2.37%	1.35%	0.64143
2025	4906000	0.600000	2.37%	1.35%	0.63863
2026	4940000	0.600000	2.37%	1.35%	0.63581
2027	4970000	0.600000	2.37%	1.35%	0.63315
2028	5000000	0.600000	2.37%	1.35%	0.63081
Derived from	Statistics NZ (2006)	Treasury (2008c)	Average 2000-08	Average 2001-07	Treasury (2008a)

Appendix I Calculating Economic Benefits

Benefit Summary

Year	VKT			Cost Savings				
	Base	Option	Reduction	Congestion	Air Pollution	Greenhouse	Consumer	Total
2007	31.19	31.19	0.00	$0	$0	$0	$0	$0
2008	30.30	30.30	0.00	$0	$0	$0	$0	$0
2009	29.93	28.97	0.97	$120,968,292	$14,121,932	$9,642,132	$362,260,498	$506,992,855
2010	28.66	27.51	1.15	$143,763,720	$16,783,088	$11,365,200	$478,337,167	$650,249,175
2011	28.35	26.90	1.45	$181,914,964	$21,236,894	$14,263,946	$624,799,076	$842,214,879
2012	28.75	26.96	1.79	$224,409,859	$26,197,781	$17,459,824	$756,603,975	$1,024,671,438
2013	29.11	26.98	2.14	$267,286,113	$31,203,188	$20,633,099	$896,965,565	$1,216,087,965
2014	29.42	26.94	2.48	$310,273,422	$36,221,559	$23,773,600	$1,041,968,717	$1,412,237,298
2015	30.19	27.32	2.87	$359,169,822	$41,929,763	$27,339,156	$1,163,886,854	$1,592,325,595
2016	30.78	27.52	3.26	$407,494,545	$47,571,228	$30,821,787	$1,301,935,958	$1,787,823,519
2017	31.42	26.79	4.63	$579,295,788	$67,627,439	$43,585,941	$1,808,220,767	$2,498,729,935
2018	32.02	26.97	5.04	$631,102,137	$73,675,352	$47,268,579	$1,939,086,833	$2,691,132,900
2019	32.12	26.73	5.38	$673,543,659	$78,630,008	$50,248,793	$2,112,334,230	$2,914,756,690
2020	32.41	26.65	5.75	$720,149,133	$84,070,767	$53,542,775	$2,267,331,858	$3,125,094,533
2021	33.24	27.01	6.23	$779,860,143	$91,041,477	$57,836,655	$2,376,282,381	$3,305,020,655
2022	34.15	27.41	6.74	$843,069,044	$98,420,533	$62,413,005	$2,485,566,049	$3,489,468,631
2023	34.70	27.52	7.18	$899,103,996	$104,962,096	$66,470,886	$2,625,400,833	$3,695,937,811
2024	34.88	27.33	7.56	$945,833,375	$110,417,320	$69,874,312	$2,805,484,001	$3,931,609,008
2025	35.32	27.33	7.99	$999,799,978	$116,717,423	$73,843,025	$2,952,346,690	$4,142,707,115
2026	35.65	27.24	8.40	$1,051,362,725	$122,736,898	$77,653,672	$3,119,341,094	$4,371,094,389
2027	36.00	27.17	8.82	$1,104,015,968	$128,883,678	$81,569,804	$3,279,095,152	$4,593,564,602
2028	36.22	27.01	9.21	$1,153,133,370	$134,617,682	$85,228,037	$3,457,149,684	$4,830,128,773

Congestion Reduction

Congestion Benefits	Congestion Rates	Population	Notes
Auckland	$1.27	33%	The congestion reduction benefits per kilometre removed from the road network were calculated as the weighted sum of the percentage of the population living in one of the three major urban centres (adjusted for CPI) inflation. This assumes that the recommended responses reduce VKT in proportion to the percentage of population living in urban areas. Such an assumption is likely to underestimate the actual VKT reductions in urban areas and therefore expected to be a conservative estimate of the congestion reduction benefits associated with the recommended responses.
Wellington	$0.98	11%	
Christchurch	$0.09	13%	
2002NZD/km	$0.54		
CPI	116%		
2008NZD/km	$0.63		

Air Pollution

	2008 Total	Average per km	Source
Air Pollution	$578682000	$0.015	Fisher et al., (2007)

Greenhouse gases

Year	Fuel saved			Petrol			Diesel			Total CO2	Benefits
	VKT saved	[litres/km]	Litres	Split	Saved	kt CO2	Split	Saved	kt CO2	tonnes	
2007	0.00	0.1080	0	90%	0	-	10%	0	0	-	$0
2008	0.00	0.1073	0	89%	0	-	11%	0	0	-	$0
2009	0.97	0.1064	102827005	89%	91748607	212	11%	11078398	29	241,053	$9,642,132
2010	1.15	0.1055	121159658	89%	107791118	249	11%	13368540	35	284,130	$11,365,200
2011	1.45	0.1046	152008381	89%	134840826	311	11%	17167555	45	356,599	$14,263,946
2012	1.79	0.1037	186000742	88%	164510549	380	12%	21490194	56	436,496	$17,459,824
2013	2.14	0.1029	219728452	88%	193770125	448	12%	25958327	68	515,827	$20,633,099
2014	2.48	0.1021	253083512	88%	222526660	514	12%	30556851	80	594,340	$23,773,600
2015	2.87	0.1014	290938462	88%	255054632	589	12%	35883831	94	683,479	$27,339,156
2016	3.26	0.1007	327884609	87%	286591407	662	13%	41293202	109	770,545	$30,821,787
2017	4.63	0.1001	463507614	87%	403929172	933	13%	59578441	157	1,089,649	$43,585,941
2018	5.04	0.0996	502493299	87%	436597225	1,009	13%	65896074	173	1,181,714	$47,268,579
2019	5.38	0.0992	533987019	87%	462572548	1,069	13%	71414471	188	1,256,220	$50,248,793
2020	5.75	0.0988	568791818	86%	491243756	1,135	14%	77548061	204	1,338,569	$53,542,775
2021	6.23	0.0986	614190470	86%	528855943	1,222	14%	85334528	224	1,445,916	$57,836,655
2022	6.74	0.0983	662555865	86%	568778891	1,314	14%	93776974	246	1,560,325	$62,413,005
2023	7.18	0.0982	705385342	86%	603712358	1,395	14%	101672984	267	1,661,772	$66,470,886
2024	7.56	0.0981	741242169	85%	632473617	1,461	15%	108768553	286	1,746,858	$69,874,312
2025	7.99	0.0980	783068417	85%	666126378	1,539	15%	116942040	307	1,846,076	$73,843,025
2026	8.40	0.0980	823189725	85%	698115748	1,613	15%	125073977	329	1,941,342	$77,653,672
2027	8.82	0.0980	864400742	85%	730817794	1,688	15%	133582948	351	2,039,245	$81,569,804
2028	9.21	0.0980	902850869	84%	760978495	1,758	16%	141872374	373	2,130,701	$85,228,037

Fuel	kt C02/PJ	kt CO2/J	MJ/litre	J/litre	kt CO2/litre
Petrol	70	7.0E-14	33	33000000	2.3E-06
Diesel	73	7.3E-14	36	36000000	2.6E-06

Appendix J Review of Travel Demand Elasticities

Light vehicle travel

This section reports on the evidence of the quantitative magnitudes of consumer (household) responses to fuel prices. For transportation planning, there are two types of response that are of particular interest: the direct response of consumers in their purchases of fuels, and the embodied response in terms of VKT. Even in the short term and especially over the long term we expect fuel demand elasticities to be larger than VKT price elasticities. This is because, faced with higher petrol or diesel prices, consumers can economise not just by driving less, but also by driving more slowly and/or by switching to more economical vehicles with higher fuel mileages, so that a, say, ten percent reduction in petrol consumption will be associated with a smaller reduction in kilometres driven.

There is one recent econometric study of fuel demand and VKT in New Zealand, by Kennedy and Wallis (2007). These researchers find relatively small elasticities: the long-run fuel consumption elasticity estimate is about -0.2, and the long run VKT elasticity is -0.3. Apart from the finding that the VKT elasticity is larger than the consumption elasticity, which seems anomalous, we do not consider that the Kennedy/Wallis study, thorough and competently executed though it certainly is, is a good guide to the likely responses of NZ households to a future regime of sustained very high fuel prices, well beyond prices ever experienced here, though not so far beyond prices in high-tax economies, as illustrated in Table 4.1. The Kennedy/Wallis data series cover the years from 1974-2006. This period began with what were at the time unprecedentedly high petrol prices, as a result of the 1970s OPEC oil price spikes, followed by a long period during which real (inflation adjusted) fuel prices actually trended downwards, and with just the beginnings of the current upturn at the end of the data series (cf. their figure 2.2). Thus, the fuel demand responses tracked over this period include factors operating in opposing directions. First, there will be the long-term responses to the ‘high’ late 1970s prices, which, in NZ as elsewhere, stimulated various economising measures on the part of consumers and producers, such as more fuel-efficient vehicles. But then there will also be the short-term responses to the gently downward trending prices in the 1980s and 1990s, which will have encouraged a more easy-going attitude to fuel consumption.

To complement this local study we have consulted several comprehensive and detailed surveys of the literature of empirical studies of energy elasticities around the world (Goodwin et al., 2004, Graham and Glaister, 2004, Graham and Glaister, 2002, Litman, 2007d). Graham and Glaister (2004) survey 213 long run fuel demand price elasticities from 113 studies, and report that the mean estimate is -0.77. Goodwin *et al* (2004) surveyed 46 estimates of long run fuel consumption elasticities and average these to be -0.64. Their surveyed value for the income elasticity of fuel demand, from 20 studies, is quite low, at 0.49. Graham and Glaister (2002) conclude that the ‘overwhelming evidence from our survey suggests that long run [gasoline consumption] elasticities will typically tend to fall in the -0.6 to -0.8 range (2002, p22), whereas the long run traffic (VKT) elasticity is likely to be about -0.3. The long run income elasticity of fuel demand is in the range 1.1 to 1.13.

Litman (2008) is the most up to date survey, and includes an illustration of how sustained differences in fuel prices play out in consumer demand and technology choices:

> 'Fuel taxes are about 8 times higher in the UK than in the US, resulting in fuel prices that are about three times higher. UK vehicles are about twice as fuel efficient, automobiles are driven about 20% less per year, so annual fuel costs are only 1.25 times higher than in the U.S. since per capita vehicle ownership is lower, average per capita fuel expenditures are similar in both countries… Similar patterns can be found when comparing other countries with different fuel prices. This indicates that automobile use is sensitive to price.' (2008, p7)

Note that the quality of travel and location options affects the elasticity of vehicle travel with respect to price. Consumers who live in automobile dependent communities, or who lack suitable housing options in accessible, multi-modal locations (for example, if urban neighbourhoods are considered unsafe or stigmatized compared with automobile-dependent suburban locations) are less able to reduce their vehicle travel in response to rising fuel prices. There is some research on this, with a recent study finding that higher fuel prices caused a reduction in traffic on highways with parallel rail transit services, but not on highways that lack such service (Congressional Budget Office, 2008). Public transport demand elasticities are discussed in more detail in the following section.

Public transport

The evidence presented above suggests that rising fuel prices indeed cause a reduction in demand for vehicle travel. But what happens to the kilometres not driven in private vehicles when fuel prices increase; to what extent are private automobile trips replaced by trips on alternative modes? More specifically, to what extent is the choice of alternative modes a reflection of social preferences or a reflection of availability? Naturally, we expect private transport demands to be more elastic in situations where attractive and accessible alternatives exist. We have found a number of good studies of the determinants of public transport (PT) usage, though somewhat fewer than there are studies of private vehicle and fuel elasticities.

The quality (not just the price) of options is likely to be an important factor in VKT responses to higher fuel prices in New Zealand, because there is more room for improvement in the public transit systems here. In particular in Europe higher population densities and comprehensive public bus and rail systems have been in place, often for a century or more. In Section 4.5 below we note the evidence that service quality is directly related to PT usage; there is less direct evidence on what must be the other side of this coin - that improved PT service reduces VKT, but it must be so. Litman's survey of elasticities, which is the most up to date of all the surveys, cites several very recent studies that approach this issue (Bento et al., 2005, Giuliano and Dargay, 2006, Whelan, 2007).

Bresson et al (2003) focus on a comparison of the demand for PT in England and France, and determine that long-run price (fare) elasticities are in the range -0.5 to -0.8. They find interesting differences in the two nations' income elasticities: in England this is -0.9, reflecting the conventional view that public transport is what economists call (without pejorative intent) an “inferior good”, meaning simply that people use less of it as they get wealthier (and thus able to afford to buy and use their own private vehicle). In France, in contrast, there is no significant evidence for a non-zero income elasticity. The income elasticity of PT services is therefore more complicated than often assumed - in a high-car ownership society like New Zealand, we might expect income elasticities of demand for PT to be quite small, reflecting the fact that other factors are more important determinants of the choice of transport mode.

Bresson *et al* also note Goodwin’s 1992 survey of 50 demand elasticity estimates for bus use, implying a summary figure of -0.4. And they note a 1998 survey paper by Preston, which finds ‘service elasticities’ of the use of bus transport at 0.49 for large cities (population > 0.5 million) and 0.33 for smaller cities. Service elasticities refer to the responsiveness of consumers to changes in the service quality of PT. Dargay and Hanly (2002) find a service elasticity of +1.0 for local bus services in England, as well as a cross elasticity with respect to motoring costs of +0.66, a fare elasticity of -0.9, and an income elasticity of -0.8 (Dargay and Hanly, 2002).

A problem with estimating service elasticities is identifying causation as opposed to correlation. The most common measure used for service quality is simply the number of bus kilometres travelled, as a proxy for the frequency and breadth of the service. But of course the supply of bus kilometres could and indeed should be responsive to the demand, so it is difficult to infer that the first causes the second, even though nearly all studies apparently do make this assumption.

One article which used econometric methods to control for endogeneity (as it is called) is Holmgren’s ‘Meta-analysis of Public Transit Demand’ (Holmgren, 2007). A meta-analysis is a “model of the models” which doesn’t just report or survey previous studies, but attempts to explain why the results of these studies differ in terms of differences in model specifications. Holmgren finds that the “famous rule of thumb” that the service elasticity of bus transport demand is +0.3 does emerge from the meta-analysis, but only if the quality of service is assumed to be exogenous. If, instead, service quality is endogenous, so that service levels, at least in part, are themselves responsive to demand, then the true service elasticity (ie, the response to a truly exogenous service quality shift, such as one initiated as a deliberate government initiative to *induce* people to change their transportation mode, rather than responding to demand changes) is apparently much larger than the rule of thumb, being around 1.05. His meta analysis reveals numbers for the price (fare) elasticity (-0.59), the income elasticity (-0.62), the petrol price cross-elasticity (+0.4) and the elasticity of public transport use to car ownership rates, which is -1.48.

Commercial Vehicles

A survey of international studies into commercial travel demand elasticities are summarised in Table 9.6 (Clark et al., 2005).

Table 9.6: Commercial Travel Demand Elasticities

Study	Product						
	Produce	**Wood**	**Chemical**	**Metal**	**Plastic**	**Stone**	**Electrical**
Oum et al (1992)	-0.52	-0.56	-0.98	-0.41	-	-	-
Friedlander and Spady (1980)	-1.01	-1.72	-	-1.58	-1.08	-1.06	-1.31
Winston (1983)	-0.99	-0.14	-1.87	-0.18	-2.01	-2.04	-0.78
Abdelwahab and Sargious (1992)	-1.2	-1.06	-0.93	-0.8	-1.14	-0.75	-1.19
Luk and Hepburn (1993)	-0.8						
Björner (1999)	-0.81						

The contribution of various sectors to commercial travel demands in New Zealand was sourced from Bolland et al (2005) and categorised according to the product types listed in Table 9.6.

The weighted average of the elasticities for these sectors provided an estimated commercial elasticity of -0.95 for New Zealand's overall commercial travel demands in response to general price increases. Assuming that fuel accounts for 11% of total operating costs, then the elasticity in response to rising fuel costs may be estimated at 11% of -0.95 = -0.104 (Bass and Latto, 2005).

Appendix K Legal Implications

Minimum Parking Requirements

Minimum parking requirements are typically set out in local authority District Plans. The general process for changing District Plans to amend minimum parking requirements is slow and dependent upon the priority given to the change by each individual local authority. Plan changes are also subject to appeal to the Environment Court. Plan changes effected this way will almost inevitably produce divergent outcomes.

The most efficient way to implement the recommendation may be for central government to enact a National Environmental Standard (“NES”) or a National Policy Statement ("NPS") under sections 43 and 45 of the Resource Management Act 1991 (RMA).

A NES under section 43 RMA sets minimum standards that must be met as a matter of law and do not require amendment to bylaws, district or regional plans to take effect. Where an NES states that an activity is permitted or does not require resource consent section 43A(5) acts to relegate the role of planning instruments to addressing those effects of the activity not addressed by the NES. Sections 43B(3) and 43E(3) prohibit bylaws, district or regional plan rules, and resource consent conditions from being more lenient than a NES. These regulatory documents can provide for more stringent measures but not more lenient measures. Section 43D RMA limits the application of an NES to existing designations. Where car parks have been created by RMA designation an NES would not apply until the designation lapses or the conditions of the designation are altered.

Section 43(1) RMA permits regulations that prescribe any or all of the technical standards, methods, or requirements for district plans restricting use of land and subdivisions as well as regional plans for water use and discharge of contaminants into the environment. The proposal of minimum parking requirements is a use of land and relevant to subdivision consents also.

A NPS under section 45(1) RMA provides a broad power to "state objectives and polices for matters of national significance that are relevant to achieving the purpose of the Act", namely to promote the sustainable management of natural and physical resources. The proposal to remove minimum parking requirements is arguably a nationally significant issue, in the context of rising oil prices and the effects on long term land use patterns. A different approach to the provision of parking would promote sustainable management of natural and physical resources.

Section 55 RMA requires local authorities to amend a district plan to give effect to and take any action required by a NPS, within the timeframe specified in the NPS.

Both NES and NPS mechanisms provide opportunity for public input in the development of the NES and NPS, and can relieve local authorities of the obligation to publicly notify and hold hearings to consider submissions prior to incorporation of changes to the district plan.

Pay Parking

Pay parking on roads and public property can be implemented through local authority bylaws. local authorities have powers to make bylaws under sections 145 and 146 of the Local Government Act 2002 ("LGA'02") and section 72 of the Land Transport Act 1962. Section 146(b)(vi) LGA'02 provides express power to create bylaws for the management of land under the control of the local authority, including roads.

Bylaws created by local authorities must be promulgated under the special consultative procedure prescribed by sections 83, 86 and 156(1) LGA'02.

Local authorities are also free to set user charges as they choose in relation to commercial parking facilities under their control.

It is not clear how parking pricing could be regulated in relation to the use of privately operated parking facilities. Legislative intervention would be required to empower local authorities to regulate privately operated parking facilities.

The rededication by local authorities of land currently used for parking to other uses will require consideration of land status issues. For example: in some cases land vested in a local authority may be constrained by a designation, underlying district zone rue, the vesting document such as a trust, Public Works Act 1981 action or the provisions of the Reserves Act 1977. In such cases change of the use of the land may be prohibited or restricted and if the land use cannot be changed, legislative intervention by central government may be required.

In the case of private land, changes to land use rules in district plans would be required, and subject to rights of objection and appeal.

Flexible Zoning and Urban Containment

A number of local authorities are seeking to provide for flexible zoning and urban containment through the development and implementation of growth strategies. While the Auckland Regional Council is required under sections 37SE to 37SH of the Local Government Act 1974 to adopt a growth strategy for its region, all other growth strategies have been adopted at the discretion of the particular local authority. Nonetheless, a number of growth strategies have been adopted, such as the BOP Smart Growth Strategy.

In addition, but again specific only to Auckland, the Local Government (Auckland) Amendment Act 2004 (LGAAA) mandates that all councils in the Region integrate their land transport and land use provisions and ensure these are consistent with the Auckland Regional Growth Strategy (“RGS”), give effect to its Growth Concept and contribute to the land transport and land use matters specified in Schedule 5 (sections 39 and 40, LGAAA). Again, although a number of local authorities have sought to integrate their land transport and land use planning at a regional level, this is at the discretion of the local authorities concerned.

Any proposal to make this mandatory for all councils would require legislative amendment.

Development Contributions

Sub-part 5 of Part 8 of the Local Government Act 2002 provides for territorial authorities to set development contributions. Regional councils may not set development contributions. This is a separate and additional power to that given to local authorities (both regional and territorial councils) to impose financial contribution conditions in resource consents in section 108(2)(a) of the RMA 1991 (and, on a transitional basis, in sections 407 and 409 of that Act).

Development contributions may need to be made if a development has the effect (including any cumulative effects from a grouping of developments) of requiring new or additional assets, or assets of increased capacity, that result in the territorial authority incurring capital expenditure for reserves or network or community infrastructure. To avoid the danger of overpayment by developers or "double dipping" by territorial authorities (ie obtaining funding from more than one source for the same purpose) a territorial authority cannot require a development contribution where it has taken a financial contribution for the same development or for the same purpose. The territorial authority must ensure that it accurately identifies the purpose for the development contribution so that these requirements are met, as there may be many instances where a development will be subject to financial as well as development contributions.

Before a territorial authority can require development contributions, it must adopt a development contributions policy that includes: (a) an explanation of, and justification for, the way in which development contributions are calculated; (b) the significant assumptions underlying those calculations; (c) any conditions and criteria for remission, postponement or refund of contributions or return of land; and (d) the basis of valuing land for the purposes of assessing money contributions for reserves.

While it is possible for territorial authorities to differentiate between developments that contribute more to the need for new or additional transport assets, or transport assets of increased capacity, in our experience few territorial authorities have calculated development contributions in this way or provided for remissions on this basis. While it may be technically difficult to make these calculations or justify them, there appears to be no legal impediment to doing so. In addition, any choice to do so will be at the discretion of the territorial authorities concerned, although central government could seek legislative change to the Local Government Act 2002 to mandate this consideration or provide guidelines/technical assistance to achieve this. Development contributions policies may be amended or a new policy adopted, subject to the special consultative procedure, at any time.

Urban Renewal Projects and Transit Oriented Development

We understand Cabinet has recently considered proposals on how to manage urban renewal projects in New Zealand. While there are general statutory powers, such as the RMA 1991 and the Public Works Act 1981, there are no specific legal powers that local authorities have regarding urban renewal. Cabinet has considered proposals for new institutional arrangements and legislative change to assist moving beyond one-off projects, to a more comprehensive, integrated and transformational approach to urban development. (See Gray, R.N. 2006. Towards an Urban Transformation Framework for New Zealand: A discussion paper prepared for the Ministry for the Environment).

Public sector agencies in Australia, the United Kingdom and the United States all play significant roles in leading urban renewal and all use a form of Urban Development Authority (UDA) with a variety of legal tools and powers. Urban Development Authorities (UDAs) are considered to be the most appropriate response in areas that experience: land fragmentation; uncoordinated central government responses and conflicting objectives as well as funding inconsistencies associated with this; and property market disinterest and deprivation.

In addition UDAs are often used, because of their specialised legal tools and powers, where there are under-utilised land-holdings of a significant scale, such as decommissioned government sites and assets such as railway yards, hospitals and teaching institutions.

We note that the legal tools discussed in the previous sections concerning land use responses will also be applicable to TOD. In addition, in overseas jurisdictions (such as California), specific legislation has been passed to support TOD. For example, in Californian the Transit Village Act (Assembly Bill 3152) was passed in 1993 to encourage California cities and counties to build higher density housing and compact communities around the state’s rail stops. The Act stipulated that no public works projects, tentative subdivision maps, or parcel maps could be approved, nor zoning ordinances adopted or amended, within an area covered by a transit village plan unless the map, project, or ordinance was consistent with the transit village plan.

Commercial Parking Rate

It should be noted that local roads are not solely funded through rates. The construction of local roads is sometimes funded by developers by way of financial contributions or development contributions levied on a subdivision consent. Maintenance and operation of roads is generally funded through rates.

Targeted rates under sections 16 to 18 of the Local Government (Rating) Act 2002 can be set for the purpose of funding local roads, subject to the procedural requirement that the activities or groups of activities are identified in the local authority's funding impact statement, created pursuant to the LGA'02.

Road Pricing

Road pricing is not provided for under the current regulatory environment. Legislative intervention would be required to introduce this proposal.

Section 361 of the Local Government Act 1974 provides a mechanism for councils to establish toll gates on any bridges, tunnels or ferries within the district or under the control of the Council.

Section 46 of the Land Transport Management Act 2003 provides limited ability to levy tolls, and is restricted to new roads only. Tolls can be levied in relation to "the planning, design, supervision, construction, maintenance, or operation of a new road" only.

We referred earlier to the emergency powers in the Petroleum Demand Restraint Act 1981. If the supply of petroleum dwindled to such a point that these powers were invoked, section 4(2)(b) allows for regulations created by Order in Council to "Restrict, regulate, or prohibit the use of motor vehicles or any class of motor vehicles". A road pricing mechanism could be introduced swiftly in the event of supply shortages although its operational complexity may mean this is a difficult task.

Tax Treatment

We note that the government through Land Transport NZ introduced a fuel efficiency scale for the sale of vehicles. Amendment to the IT'07 to provide for differential deductions could be applied on the basis of a minimum point on that scale, with periodic adjustments over time to account for alteration in the efficiency of vehicles. We also note the Emissions Trading (Climate Change and Renewable Preference) Bill proposes a mechanism to account for the pollutants produced by combustion engines within vehicles. The Bill essentially addresses externalities from the operation of motor vehicles but fails to address fuel consumption choices.

Transforming Roads into Streets

Reduction in speed and volume of motor vehicle traffic can be achieved through a combination of amendment to regulations promulgated under the Land Transport Act 1998 (“LTA’98”) relating to the setting of speed limits, and bylaws under the LGA02 or section 72 LTA’98.

Shared spaces can be incorporated through Bylaws, the provisions of the Local Government Act 1974 relating to malls under section 336, and stopping roads under section 342 and the tenth schedule of the Act. Shared spaces could also be created through zoning or other planning mechanisms under RMA District Plans.

Pedestrianisation of roads and road stopping are not easy processes and in our experience can be time consuming and expensive. The processes under sections 336, 342 and the tenth schedule of the Local Government Act 1974 involve public notification, consideration of public submissions, determination, and rights of appeal to the Environment Court. The outcome cannot be guaranteed. Legislative amendment could be sought to simplify the process, reduce costs and increase the speed by which these events can occur.

Park and Ride

PNR services / facilities can be developed and implemented voluntarily by local authorities through annual works programmes or by inclusion in the Regional Transport Strategy ("RTS"), subject to the appropriate resource consents being obtained.

Under section 175 LTA'98 Regional Councils are required to prepare a RTS. A RTS must, among other things, "contribute to the overall aim of achieving an integrated, safe, responsive, and sustainable land transport system" and "take into account how the strategy ensures environmental sustainability."

Development of PNR services / facilities is a responsive measure to assist in meeting the objective of a sustainable land transport system.

In creating a RTS, Regional Councils are required by section 179 LTA'98 to use the special consultative process prescribed by sections 83 and 156(1) LGA'02. Section 175(4) LTA'98 states that a RTS must not be inconsistent with any National Land Transport Strategy ("NLTS").

We consider a RTS is the appropriate mechanism to deliver PNR services/ facilities to the communities within a region. Where a RTS fails to make adequate provision for polices to develop and implement PNR services and facilities, central government can prescribe, within a NLTS, objectives which a RTS must adopt so as to not be inconsistent with the NLTS.

These RTS and NLTS processes provide opportunities for public input at the development stage. The processes do not, however, provide submitters with rights of appeal.

Public transport Investment

Regional Council's are able to plan to expand PT services and facilities. The current process requires coordination of priorities through a RTS made under section 175 LTA'98. This process includes input from local authorities, affected communities, land transport network providers and the general public.

Sections 174 and 181 of the LTA'98 require Transit New Zealand and Land Transport New Zealand ("LTNZ") in performing their functions (including LTNZ's function of allocating funding), duties and powers to ensure they take account of any current national or regional transport strategies.

In order for PT investment to receive priority over road funding the NLTS would need to be amended to prescribe that position.

Central government funding is allocated under Part 2 of the Land Transport Management Act 2003. Funding is allocated pursuant to a national land transport programme produced annually from land transport programmes submitted by local authorities. Under the Land Transport Management Amendment Bill, government funding would change. Central government would still provide funding through NLTPs, and the Bill provides for a restructuring of the current LTNZ, the office of the Director General of Land Transport and

Transit New Zealand into one entity. The Bill will push annual programme development to a three year cycle and local authorities would need to combine and submit one regional programme instead of individual programmes. This may have a side effect of restricting the ability to obtain a place on the programme, and may cause innovative or urgent proposals to stagnate while waiting for a place.

Funding from local authorities is coordinated through local authority annual plan processes under the LGA'02. These processes require use of the special consultative procedure prescribed in sections 85 and 156(1) LGA'02. Under the Land Transport Management Bill regional councils will be able to collect revenue from a regional fuel tax. This tax will enable regional councils to provide their own priorities for projects with regional priority, and may overcome timing lags created by a three year cycle.

Funding is also available from the private sector though working partnerships.

Multi-modal Integration

The discussion under proposal is directly applicable to the proposal for multi-modal integration. Integrated ticketing is an issue complicated by the subsidisation of public transport services. Services are subsidised in different ways and for different reasons. This issue is yet to be resolved and may need to be addressed beyond a regional level to a national level and be considered by central Government in terms of a resolution. If change is to occur quickly legislative change is required.

Taxi Services

Regulation of taxi services is currently a central government function under LTA'98. The current transport regulatory environment does not provide for specific integration of taxi services with other modes.

To enable local authorities to integrate taxis services into regional transport planning would require legislative intervention.

We note that in spite of the lack of coercive powers it is open to local authorities to consult with taxi service providers and, where appropriate, for the RTS to provide for a commercial arrangement to be entered into via a public private sector partnership, to secure the desired transport outcome.

Travel Plans

We expect that there will be individual and collective employment contract obligations negotiated under the Employment Relations Act 2000 that will impact upon the ability of employers to provide for the changes envisaged (such as parking cash-out, company car cash-out and PT passes). Coercive measures may be required for employers to participate. If so amendment to the Employment Relations Act 2000 would be required.

There are also likely to be FBT issues associated with the provision of these benefits. For administrative efficiency FBT is taxed on an employer to encourage remuneration payment in cash, rather than payments in kind. Measures such as parking cash-outs would reduce compliance costs associated with FBT. If an employer is paying in cash, FBT is not levied. This would result in a reduction in the FBT tax take, which would be replaced by an increased income tax take.

Car-sharing

From a legal perspective, car-sharing is mainly governed by the contractual relationship (or terms and conditions of membership) between the car-share company and the account holder and driver. These activities would be covered by the general law of contract and tort. They would also be afforded the protection of the Commerce Act 1986, the Fair Trading Act 1986 and the Consumer Guarantees Act 1993. Until these activities are well established and specific concerns arise, we expect further regulation would not be required.

In addition, it has been noted that application procedures to apply for parking spaces can be cumbersome in some countries. In Italy, for example, the lack of legal definitions and restrictions for car-sharing has created challenges for legal shared-vehicle parking. Experts from a number of countries have indicated that supportive parking policies are a key opportunity for car-sharing in their countries. Vehicle insurance is a major operational cost of car-sharing, with some few countries (such as Australia) indicating that finding insurance is an ongoing problem, especially for younger drivers, international, older, and lower-income drivers.

Transport Management Associations

From a legal perspective, as well as the issues discussed regarding travel plans (e.g. employment and taxation issues) and car-sharing, the appropriate legal structure for these associations (such as incorporated societies) should be considered.

In addition, with carpooling, there may be legal issues if the driver begins to offer these services on a commercial basis. However, if there is no financial transaction between the driver and passenger or there is a donation, the activity should not be classified as commercial. Again, as long as the activity is not commercial, no tax issues should arise. With regard to insurance and accident compensation, non-commercial rules should apply.

Facilitating Mode Shift, Multi-modal Ports, Home Delivery, Active Freight

There appear to be no legal impediments to government agencies planning for facilitating mode shift, multi-modal ports, Home Delivery, or Active Freight.