

Final Report

Oil Demand Restraint Options for New Zealand

Prepared for

Ministry of Economic Development

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Hale & Twomey Limited

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Executive Summary

This report provides material to assist the Ministry of Economic Development to develop an Oil Emergency Response Manual. The report has been developed on the basis of:

- a recent IEA report on saving oil in a hurry that provides analysis of instruments that could be used in New Zealand;
- experience with demand restraint measures for other issues and products; and
- an analysis of New Zealand demand data and of likely reductions associated with individual measures.

A review of the 2000 UK fuel crisis provided evidence of the types of voluntary reductions in vehicle use that could be encouraged if there was a supply crisis in New Zealand. The UK experience also highlights the risks of hoarding and how this response can turn a potential crisis into an actual crisis.

A review of the recent IEA report—Saving Oil in a Hurry—provides a long list of suitable measures, some of which build off the UK experience. And the UK's Emergency Response Manual provides information on institutional arrangements, communications strategy, requirements for a system of rationing (including a list of priority users) and a number of compulsory and persuasive measures.

Planning for electricity supply failures and droughts reveals a common pattern of emergency plans. They shift from calls for voluntary restraint through to more mandatory reductions. And, throughout, there is a requirement for effective monitoring and good communication.

Theoretical work on behavioural change reveals the kinds of messages that would be required in order for voluntary change to be most effective. It also highlights the need for preparatory work and raised issues of trust that will need to be considered in deciding who best to manage the crisis.

Rationing is a last resort. A review of alternative approaches highlighted the potential efficiency impacts, particularly the risks of allocating supplies to those that do not value them highly. There are ways to make rationing more efficient, including through identifying priority users and through allowing trading of allocation rights.

An assessment of the likely effectiveness of initial voluntary restraint measures, plus mandatory speed limit changes, suggests the potential for reductions in aggregate oil demand as shown in the Table below. In addition, it is estimated that compulsory restrictions on car use, eg a return to car-less days, could provide additional reductions of 4-5%.

Potential Reductions in Aggregate Oil Demand

Measure	Anticipated Savings (individual measures taken)	Anticipated Savings (all measures taken)
Drop 10% of discretionary Trips	2.16%	2.16%
Switch to More Efficient Vehicle	0.43%	0.43%
Carpooling	1.23%	1.23%
Telecommuting	0.40%	0.39%
Compressed Work Week	0.17%	0.17%
Mandatory Speed Limit Reduction	1.42%	1.41%
Tyre Pressure	1.40%	1.32%
Total Saved	7.20%	7.11%

Steps to Be Taken Now

To achieve these via an Emergency Plan, the following steps should be taken now:

- MED should work with industry to
 - discuss and agree roles and responsibilities;
 - agree the measures to be adopted;
 - identify barriers to implementation;
 - compile an Emergency Response Manual;
- Consider the need for and/or introduce new legislation relating to speed limits and car-pooling;
- Design a rationing scheme in some detail and draft regulations under the Petroleum Demand Restraint Act 1981 that will allow rapid introduction of rationing;
- Develop a set of guidance documents for voluntary measures including guidance on institutional arrangements, communications, implementation issues and timeframes/trigger points.

Institutional Arrangements

A set of institutional arrangements need to be designed to be put in place if an emergency is triggered. Some of the arrangements already exist, but building on these, it will require:

- A **Senior Officials Coordination Team** that would handle the day-to-day management of the event for the government. It might have the following roles:
 - coordinating the collection of information on the emerging crisis;
 - providing advice to Ministers on measures to be implemented in consultation with the Industry/Government Management Team;
 - liaising with industry, local government and emergency services on implementation issues

It would be made up of senior officials and could include representatives of industry and the emergency services.

- An **Industry/Government Management Team**, probably in the form of the current **National Emergency Sharing Organisation (NESO)** a committee of oil industry representatives that is chaired by the MED.¹ It would make decisions on industry responses and provide advice to Ministers either directly or via the Coordination Team.
- A **Communications Team** that would design and implement a communications strategy. It would include officials, communications experts (contracted in) and industry representatives.
- A **Supply Network/Stock Coordination Team** that would coordinate inter- and intra-regional allocation of supplies. This would be a grouping of the oil companies and might include government representation.

In addition, the emergency management teams of individual oil companies would be drawn on for advice on logistical issues.

Local government would have a significant role in relation to several measures and regional/local teams would need to be established also with the role of identifying local opportunities and communication avenues.

Communications Strategy

Communications will be vital to ensure that the public and industry is informed on the state of the problem and what to do. It would aim both to help achieve desired public responses and to avoid undesirable outcomes through providing public reassurance that the crisis is under control.

There are a number of required components of the strategy:

- Approach to media interaction—professional management of the media, providing accurate and regular information and through being available. Building trust with the media will be a key component of crisis management.
- Publicity Material—some publicity material might be prepared in advance, but more importantly, up to date information will need to be kept on the measures that will be suggested to the public: car-pooling; telecommuting; tyre pressure change; compressed work-week; using the more fuel-efficient car; dropping some unnecessary (eg recreational/business) trips; optimal speed. The information will need to be turned into a series of easy-to-remember messages for the public.
- Mechanisms—the media programme will be delivered through a mixture of TV, radio, print media and the internet. In addition, direct contact with drivers might

¹ Under the International Energy Agreement, every IEA member is required to have a NESO. It exists to make arrangements for sharing oil supplies between member countries in the event of a severe emergency. New Zealand also uses the NESO committee to assist with invoking lower level or non IEA emergency measures.

be achieved, eg via email. The actual mechanisms and style of approach that will be most effective will change over time. The government should either develop a plan that is regularly reviewed, in consultation with the communications/ advertising industry, or to plan simply to immediately obtain advice in a hurry when a crisis emerges.

- Working Directly with Schools and Business

Components of a Response Plan

A response plan should include a transition from voluntary to more mandatory measures. The suggested approach is as set out below. The different components are explained in turn below.

Suggested Components of a Response Plan

Size of Supply Shortfall	All durations	Short (<3 months)	Long (>3 months)
Large (>25%)	Voluntary measures Speed limits Minimum sales requirement	Rationing: full priority use allocation, no trading	Rationing: full priority use allocation, plus trading
Medium (7-25%)	Voluntary measures Speed limits Minimum sales requirement	Rationing: limited priority use allocation, no trading	Rationing: limited priority use allocation, plus trading
Small (7% or less)	Voluntary measures Speed limits Minimum sales requirement if hoarding likely		

Voluntary Measures

Voluntary measures should be sought immediately and would include encouragement through publicity at national and local levels of:

- Dropping discretionary trips;
- Car-pooling;
- Tele-commuting;
- Compressed work weeks;
- Tyre pressure reduction;
- Modified driver behaviour

Speed Limits

The speed limit on the open road to be reduced, eg to 80km/hour. This could be introduced immediately as a mandatory measure or started initially as part of the voluntary package—encouragement of reduced speed on the open road.

Minimum Sales

A minimum purchase requirement is a useful component of a scheme if there is a perceived risk of a crisis emerging through hoarding. It ensures against frequent topping up if sales of fuel is otherwise available but discouraged via the

communications strategy. It will also be a vital component if there is an announcement that another form of rationing scheme is to be introduced in the future.

There would need to be a very rapid decision made on whether this was necessary so that it could be introduced quickly.

Rationing

Rationing will be required if significant reductions in fuel consumption are required. The choice of rationing approach will differ with the expected degree of severity and expected duration of any emergency.

For a very significant supply constraint, a rationing device will be required to limit total consumption. There are two main approaches:

- Allocation to defined priority users—this can ensure that those that most need or value fuel can obtain access. The risk with the priority use scheme is that it does not allocate to those with a high economic dependence, eg companies or individuals that rely on using a vehicle for their work. And it will never be possible to be comprehensive in developing lists that covers all of these individuals.
- Allocation plus trading—tradability enables those that value fuel highly to obtain it. However, if tradability is introduced without greater allocation to priority users, emergency services that have high value uses from the public perspective, but not necessarily high ability to pay, may not be able obtain supplies. Where there is very reduced availability of supplies, the value of fuel under traded coupons may rise to very high levels.

The recommended approach is to use some combination of priority use categories and tradability. The Table above sets out the recommended series of measures to be adopted, depending on the expected duration and severity of the supply shortfall. Where there is a large shortfall in supplies expected (or a very significant reduction in demand required), the rationing approach should include allocation to a long list of priority users. Where the rationing requirement is reduced, we suggest that the list of priority users is limited to emergency services.

Groundwork for Individual Measures

A number of individual measures require provisional work to ensure that they can be implemented effectively. This includes

- Car-Pooling—the means for individuals to find others to share with and designations for some roads. There are some legislative issues that might need to be investigated also.
- Reduced Speed Limits—may require new legislation.

- Rationing—legislation to introduce a rationing scheme, including tradability, is provided by the Petroleum Demand Restraint Act 1981. Design of Regulations under this Act would be a useful step in advance of an emergency. A rationing scheme will be complex and will require additional design beyond the scope of this project. This includes:
 - the compilation of a list of priority users;
 - a mechanism for registration;
 - the design of the coupon for trading.

Information and Monitoring Systems

Monitoring systems will be required to check the status of the emerging supply problem and to provide information for communication to the public. Supply and demand data should be used to develop a risk monitor that provides information on the balance of supply and demand and how it is changing over time. Usefully this could be developed beforehand by MED working with industry.

Timeframes and Trigger Points

The recommended programme will depend on the scale of the problem and is set out in generic terms below.

Components of an Oil Demand Restraint Plan

Time	Institutional	Communication/ Information	Measures
Immediate	Establish Coordination Team, Strategic Management Committee, Communications Team and Supply Network/Stock Coordination Team	Identify a figurehead(s) to front the interaction with the public and media	Decide whether there is a risk of hoarding. If so, introduce an immediate requirement for minimum sales
Next step	Work with local government and industry to provide necessary guidance documents and information packs surrounding the different voluntary measures	<p>Develop a monitoring system including measures of consumption, business-as-usual levels of consumption and supply levels</p> <p>Design a risk meter as the basis for public communication</p> <p>Establish targets for demand reductions against which progress is monitored</p> <p>Identify and work with an advertising/PR company to manage the communication with the public throughout the crisis</p>	Assess risk (severity and duration of supply shortage/reduction requirement). Introduce measures as suggested in Table 13 above

It suggests that the decision will be made at the beginning of an emerging supply shortage and will lead to the introduction of measures as outlined above. In practice, the type of measure to be employed might need to shift over time, eg if voluntary measures are insufficient, additional measures might need to be taken to achieve greater

reductions, eg stepping up from voluntary measures to mandatory speed limits or to rationing. This process will be one that occurs over time as an event unfolds, and in response to monitoring of the event, both on the supply and demand side.

Review

A regular review of any Emergency Management Plan will need to be undertaken to ensure that it is up to date and that it takes account of new information as required.

1. Introduction

1.1. Background

The Ministry of Economic Development is currently developing an Oil Emergency Response Manual which aims to ensure that the effects of an oil supply disruption are minimised and that New Zealand fulfils its obligations as a member of the IEA. This report is an overview of demand restraint measures available to New Zealand and a recommended programme of demand restraint. We consider a range of measures for both international emergency situations where the IEA implements emergency measures and domestic situations where New Zealand responds independently.

One of the three elements of the International Energy Programme (the agreement put in place by OECD member countries which created the IEA) requires each member country to have a programme of oil demand restraint measures that will enable it to reduce its consumption as required in an oil supply emergency. The IEP provides for two levels of demand restraint: a 7% reduction in demand if supply is reduced by 7% and a 10% reduction in demand if supply is reduced by 12%.

The analysis in this report provides guidance on how these levels might be achieved. It also provides guidance on measures that might be introduced if there was a domestic event that led to a supply shortage that did not trigger an IEA response.

1.2. Approach and Structure of the Report

The report has been developed on the basis of:

- A recent IEA report on saving oil in a hurry that provides analysis of instruments that could be used in New Zealand;
- Experience with demand restraint measures for other issues and products;
- An analysis of New Zealand demand data and of likely reductions associated with individual measures.

The report starts (Section 2) with a review of lessons to be learned from a recent oil supply failure in the UK—the 2000 fuel crisis. Section 3 summarises the IEA report, and provides lessons from experience with other products—electricity and water. It also reviews work on behavioural change and draws out lessons for campaigns to encourage voluntary shifts in behaviour. A review is provided of rationing, using both price and non-price methods. Section 4 analyses New Zealand specific data to estimate the likely reductions that are achievable from a range of actions. Section 5 sets out a suggested plan of action.

2. The UK Fuel Tax Protests of 2000

In September of 2000, the UK experienced a fuel 'crisis' as a result of protests against fuel taxes that resulted in blockades of oil refineries and other disruption to the distribution of fuel to filling stations for approximately seven days. In this section we summarise some of the relevant experiences and lessons learned from that episode and discuss the implications for management of future events.² The UK crisis was relatively short-lived, and specific demand restraints were not imposed. Nevertheless, it provides useful information about the responses of consumers to a fuel shortage.

After the 2000 crisis was over, several surveys and some analysis of traffic flow data were carried out to assess how people responded to the crisis. As well as stockpiling fuel, many motorists and transport companies adapted their behaviour in order to conserve fuel. While some of these responses are likely to be influenced by factors specific to the UK, such as public transport prices and efficiency, commuting distances, population density, and so on, we believe that the evidence on how people responded in the UK will provide some guidance as to likely possible response patterns in New Zealand.

In this section we first present summaries of the responses of motorists to the UK 2000 crisis. We then discuss the evidence relating to people's perceived impacts of the crisis, and how they might respond to future crises. We conclude this section with an analysis of the lessons from the UK crisis that may be applicable to fuel shortage management in New Zealand.

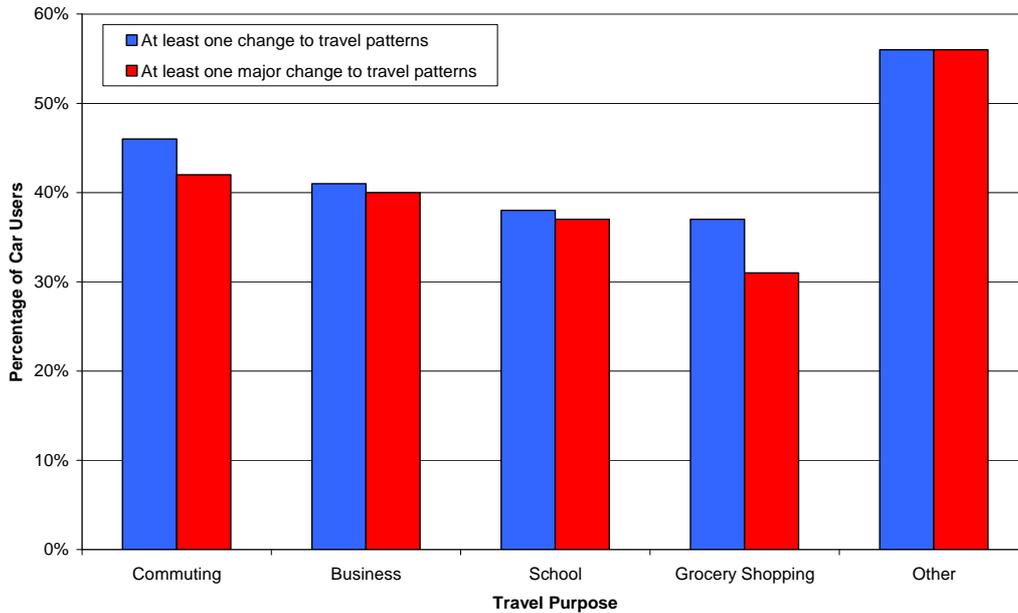
2.1. Changes in Travel Patterns

First, Figure 1 shows the results of a survey of motorists on the impacts on their travel patterns for different types of travel during the week of the crisis. 'Minor changes' were defined to be changes in driving style or route, or trip rescheduling. 'Major changes' were changing the mode of transport, changing the origin or destination, or cancelling trips. The largest impact was on the 'Other' category, which includes leisure travel. The crisis had a significant impact on the travel behaviour of a large number of people.

Figure 2 shows the types of changes to travel patterns made by car users, as identified by the same survey. Leisure trips (in the 'Other' category) seem the most amenable to trip reduction, and over 50% of car users reduced this type of trip. The adjustments made to other types of trips vary considerably. For example, trip restructuring (changing the origin or destination, or chaining multiple trips into a single trip) was most common for grocery shopping trips, and switching to walking or cycling was most common for school-related trips. In general, trips for the purpose of commuting or for business were changed by smaller proportions of car users, reflecting the lack of flexibility for these types of trip.

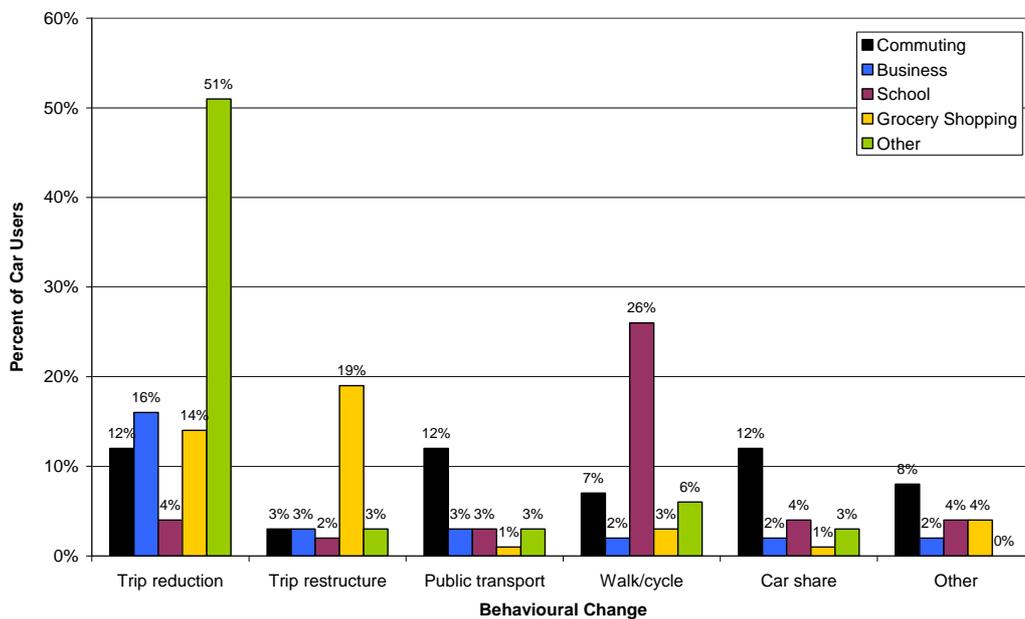
² Most of the information in this section was obtained from Lyons and Chatterjee (2002), *Transport Lessons from the Fuel Tax Protests of 2000*, Ashgate Publishing Limited, Hampshire.

Figure 1 Impacts on travel patterns of car users



Source: Chatterjee K and Lyons G (2002) Travel behaviour of car users during the UK fuel crisis and insights into car dependence. pp123-159 In: Lyons G and Chatterjee K Transport Lessons from the Fuel Tax Protests of 2000. Table 7.4.

Figure 2 Types of trip changes



Source: Chatterjee K and Lyons G (2002) Travel behaviour of car users during the UK fuel crisis and insights into car dependence. pp123-159 In: Lyons G and Chatterjee K Transport Lessons from the Fuel Tax Protests of 2000. Table 7.5.

Of the alternatives to using a car, it appears that during the UK crisis, trip reduction was generally favoured over all other alternatives. This indicates that for a number of trips, the value of the trip was less than the cost (perceived or actual) of making other arrangements, so people chose to cancel rather than to find an alternative means of

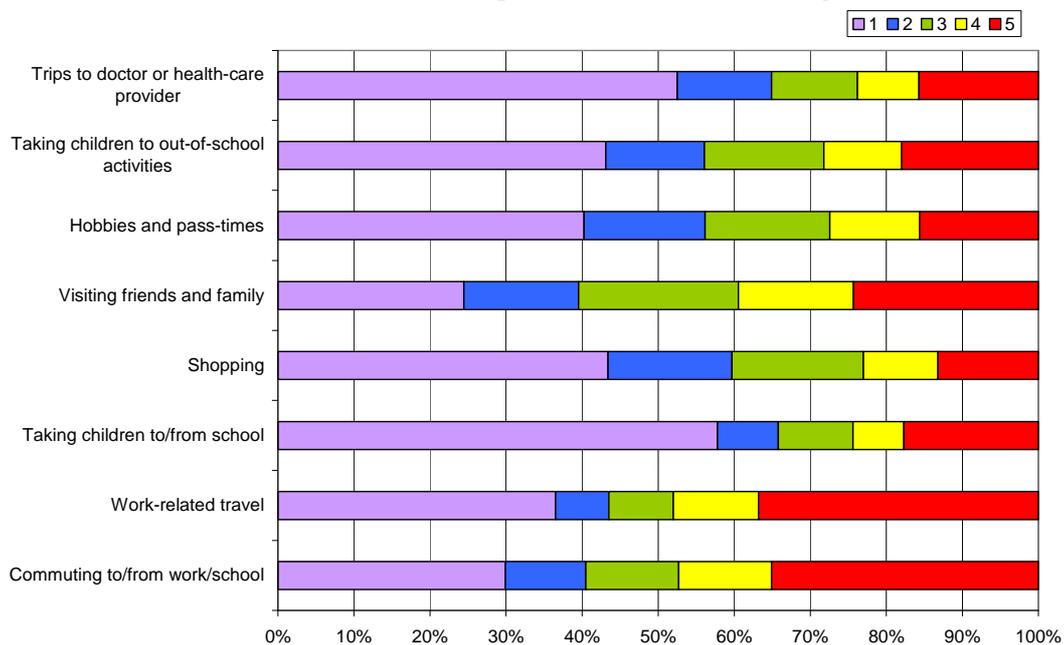
travel. This is perhaps partially a reflection of the short duration of the UK crisis. If people had expected the crisis to end soon, the trips that were labelled as 'reduced' may simply have been postponed until people expected the crisis to have ended. The possibility for postponement probably diminishes with duration of a fuel shortage, and if the crisis was longer the observed pattern of behavioural changes may have been different.

2.2. Perceived Impacts of Fuel Shortages

Following the UK crisis, people were also surveyed to assess their perceptions of the extent to which different types of trip would be affected by a *future* fuel shortage. **Figure 3** shows the responses that people gave regarding how eight different types of trip would be affected by a future shortage, with 1 representing no effect and 5 representing severe disruption.

Around 60% of people said that each of type of trip would be affected in some way by a fuel shortage. In general, the perceived level of disruption is much greater for work-related and commuting trips compared to more flexible activities such as shopping and recreational activities. In terms of economic effects, the fact that many people perceived disruptions to their commuting and work schedules could be an issue in a prolonged shortage.

Figure 3 Perceived impacts of future fuel shortages



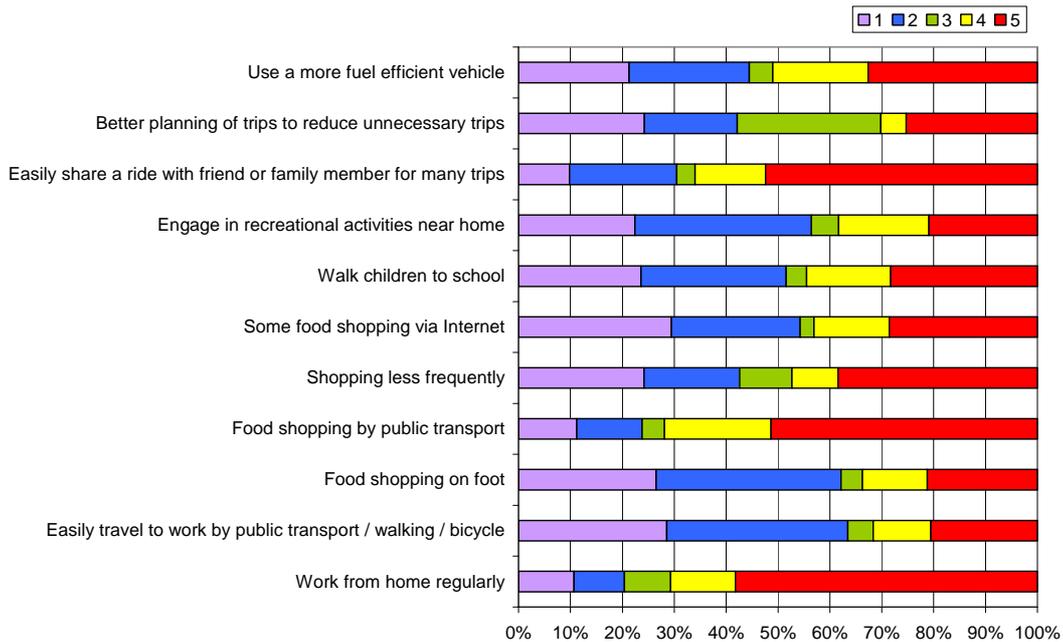
1 = Not affected, 5 = Severe disruption.

Source: Thorpe N, Bell M, Polak J and Noland RB (2002) A telephone survey of stated travel responses to fuel shortages. pp161-181 In: Lyons G and Chatterjee K Transport Lessons from the Fuel Tax Protests of 2000. Table 8.4.

2.3. Responses to Future Shortages

Figure 4 shows how people in the UK responded when asked what steps they would take to cope with a future fuel shortage, with 1 representing strong agreement and 5 representing strong disagreement. In general, respondents appeared relatively pessimistic about the ease with which they could adapt their travel behaviour to a future shortage. The perceived or actual difficulty of making such adjustments means that people are less likely to make them unless it is really necessary, and indicate that people's willingness to adjust to a shortage is low.

Figure 4 Possible adaptations to future fuel shortages



1 = Strongly agree, 5 = Strongly disagree.

Source: Thorpe N, Bell M, Polak J and Noland RB (2002) A telephone survey of stated travel responses to fuel shortages. pp161-181 In: Lyons G and Chatterjee K Transport Lessons from the Fuel Tax Protests of 2000. Table 8.6.

2.4. Lessons from the Crisis

There are several lessons from the 2000 UK crisis that are relevant to fuel shortage management in New Zealand. First, the data presented above indicate that even a relatively brief shortage is likely to affect the travel behaviour of a large number of people. Although over a short period of time many leisure-related trips may be expendable, people still seemed to face considerable difficulties in commuting and work-related travel, which may have negative economic effects.

Another major lesson from the UK crisis, that is not reflected in the figures above was that as petrol is a necessity for many people, and as it is relatively easily stored by consumers, panic buying is likely to result in a shortage if measures are not taken to prevent it. Uncertainty about the duration of the crisis and availability of petrol on a day-to-day basis during the 2000 crisis led many motorists to keep their tanks filled at

high levels. Lyons and Chatterjee's book³ includes much anecdotal evidence that motorists were filling their tanks on a daily basis in case fuel was not available in the coming few days. Such behaviour resulted in stocks at filling stations being quickly depleted, and made the crisis much more serious than it otherwise might have been.

Furthermore, as people noticed the filling stations starting to run dry from motorists filling their tanks, the public's perception of the seriousness of the situation was exacerbated. This led to a vicious circle of even more panic buying and more widespread shortages.

The results might be partly because consumers in the UK were highly averse, even to small risks of running out of petrol, and that accurate and credible information was not made available as to the probabilities and likely extent of any shortage. As a result, consumers overestimated the seriousness and likelihood of a shortage, and overstocked on fuel. However, an alternative or additional explanation is that overstocking is not very costly—it is simply shifting a purchase (slightly) in time; vehicles will need to be refilled at some stage.

Once panic buying and stockpiling sets in, it is likely to be difficult to reverse people's perceptions of the seriousness of the situation, particularly if the panic buying is causing localised shortages. The UK experience indicates that attempting to limit the extent of panic buying through advertising campaigns may also prove very difficult.

Panic buying of fuel is a potential risk in New Zealand and one that can exacerbate a risk of crisis into an actual crisis. Management of people's expectations via various media will be one of the most important challenges during a fuel shortage.

³ Lyons G and Chatterjee K (2002) *Transport Lessons from the Fuel Tax Protests of 2000*. Ashgate Publishing Limited, Hampshire.

3. Experience with Restraint Measures

3.1. Overview

In this section we examine the experience of restraint programmes for oil in New Zealand and other countries, including emerging plans in response to the IEA requirements. We also examine restraint programmes for other commodities—electricity and water.

Additional discussion is provided on two types of measure:

- behavioural change, including the factors that contribute to voluntary changes; and
- efficient rationing using price and non-price approaches.

This discussion is used to provide an understanding of the types of measure that could be used in New Zealand.

3.2. Oil Demand Restraint

This section reviews our own and international experience with oil demand restraint in an emergency. Understanding around the effectiveness of alternative demand restraint options in an emergency has been limited by the lack of specific research opportunities during actual events. Research has been focussed on measures aimed at more normal circumstances where, for instance, there is a desire to manage transport fuel demand (or demand for transport itself) or reduce environmental impacts associated with transport. There is now a body of research emerging that considers behavioural responses to some disruptions. In addition the IEA has very recently completed a study of possible options to save oil, with a key objective being to provide a framework for member countries to consider the merits of various options. In this section we consider our own experience with demand restraint, and also relevant international experience.

3.2.1. Local History

The first oil crisis occurred in 1973 around the time of the Arab/Israeli conflict when OPEC was negotiating new crude oil prices with the oil majors and sought to double prices from \$3 to \$6 per barrel. A number of embargoes saw crude prices soar leading to fundamental changes in the price negotiation arrangements with producer states.

However it wasn't until the late 1970s that the impact of oil prices combined with political instability in the Middle East resulted in restrictions on supply. Towards the end of 1978, OPEC had announced a 14.5 percent rise in the term contract price of oil. Then a political revolution occurred in Iran, its oil industry was paralysed and 5.7 million barrels per day of production were withdrawn from the market. The multinational oil companies declared *force-majeure*, and it appeared likely that New Zealand would suffer a shortfall of 18 percent in its crude oil needs. OPEC raised its prices again in July and New Zealand was paying \$19 a barrel, compared with \$12 at the beginning of the year.

New Zealand's response was to introduce a series of measures to constrain oil demand⁴. Weekend sales of gasoline were banned and on 30 July 1979, carless days were introduced. In this scheme, all private motor vehicle owners were required to refrain from using their car on one day of the week, that day being designated by the owner. Each car displayed a sticker on its windscreen which noted the day on which it could not be used, and infringements were punishable by a hefty fine. Exemptions were allowed. Other restrictions were also brought in, including reducing the speed limit and restricting the hours that petrol could be sold at service stations and garages. The restrictions ended in December 1980.

There is little in the way of quantitative analysis of the impact and effectiveness of these policies at the time, particularly a quantification of the impact of the various measures on transport fuels demand. However we have the benefit of one study which surveyed and analysed the behavioural and attitudinal responses to carless days in the Christchurch area⁵. The study noted the following:

- the most common reaction was to either postpone a trip, use a second car or complete the trip by sharing a car with another person (the report noted that car sharing was perhaps the most significant change to arise out of the programme and that some respondents commented favourably on the greater social interaction arising from car sharing, contributing to a "stronger community feeling");
- exemptions (which were allowed) were almost exclusively sought for work trips, but were proportionately less important overall in the way that people coped (there was some anecdotal information to suggest that people avoided electing weekend days as it was easier to secure exemptions for work trips);
- many of the adaptation strategies focussed on side-stepping the restrictions rather than saving fuel;
- the greatest level of dissatisfaction indicated was the effect on irregular trips (such as a funeral, taking children to school on a very wet day, or special social occasions);
- most adversely affected tended to be families with children needing to attend various activities, particularly where there was only one car, although it was acknowledged that car sharing tended to reduce the impact;
- one car families were more impacted by the scheme than two car families but it was illusory to consider multi car households as "always having a spare car in the garage", as these households activity patterns could be based on a two car level of transportation (some of the dissatisfaction expressed was based on this aspect)
- attitudes towards the scheme indicated that the majority disliked the scheme because of the injustices but many saw it as beneficial in awaking people to the economic necessity of reducing oil consumption. The majority also felt that they

⁴ Economic Stabilisation (Conservation of Petroleum) Regulations (No 3) 1979

⁵ The impact of the carless days scheme on the behavioural and attitudinal aspects of car-usage in Christchurch (Elliot et al ,1980)

coped better than anticipated prior to introduction of the scheme. And also there was much more widespread acceptance of car-sharing.

The report concludes with the following:⁶

“..if there are to be any long term benefits of the Carless Days Scheme, it seems likely they will come from two directions – firstly, from an increased awareness of the range of transport modes available to individuals in order to carry out trips, and secondly, from alerting the driving public to indicate the need for them, as individuals, to take action to reduce energy use”.

No specific research has been identified relating to the other two measures—restricting weekend sales and reducing the speed limit. Anecdotal evidence suggests that restrictions on weekend sales encouraged more hoarding.

3.2.2. Relevant international history/experience

The IEA has recently completed a study called “Saving Oil in a Hurry: Measures for Rapid Demand Restraint in Transport”. The report provides a quantitative assessment of potential oil savings to be made and costs of oil demand restraint measures, under the conditions of a supply disruption or other oil-related emergency. The study is intended to provide methodologies for member countries to use for their own situations.

The study focuses on options to rapidly reduce oil demand in the passenger transport sector because of the opportunity to save oil quickly and because good data is available from consideration of longer term transport policy issues such as managing transport fuel demand growth and reducing environmental impacts from transport. The report noted that response rates in an emergency are likely to be different (and possibly larger), given consumer concerns about the particular situation and possible altruistic attitudes that could influence travel behaviour.

The study considers the options across four IEA regions (Japan/Republic of Korea(RK), IEA Europe, USA/Canada and Australia/New Zealand) using data from these countries. The study evaluated a variety of measures if applied individually during a crisis, under the following general headings:

- Increases in public transit usage
- Increases in carpooling
- Telecommuting and working from home
- Changes in work schedules
- Driving bans and restrictions
- Speed limit reductions
- Information on tyre pressure effects

⁶ p65

Within each of these approaches several specific measures were evaluated and a representative measure then selected with a “consensus” estimate of the likely effect. In some cases specific measures were considered over a range of approaches ranging from public information campaigns to mandating of specific requirements. Policies aimed at changing the price were not explicitly scored, noting the difficulty of implementing when fuel prices themselves may be rising rapidly. While the impact of increasing price was likely to suppress demand the report has looked at a wider range of measures that would increase responsiveness to an oil emergency.

In Section 4 we evaluate a number of the options for New Zealand using the methodologies in the report, wherever possible using the most recent New Zealand data. From that we estimate the potential savings in transport fuel demand. We then comment on New Zealand specific factors that might affect these estimates and develop an indication of how effective these options could be if applied in the New Zealand context.

3.2.3. Summary of “Saving Oil in a Hurry”

In general two types of policy approaches were assessed – one focusing on providing people with more travel options to allow them to save fuel, the other on measures more prohibitive in nature such as driving bans, mandatory carpooling and speed limit reductions. The results are summarised in Table 1.

Table 1 Summary of Total Effects (all IEA Countries) of Oil-Saving Policies

Potential Oil Savings	Measure
VERY LARGE More than one million barrels per day	Carpooling: large programme to designate emergency carpool lanes along all motorways, designate park-and-ride lots, inform public and match riders Driving ban: odd/even licence plate scheme. Provide police enforcement, appropriate information and signage Speed limits: reduce highway speed limits to 90km/hr. Provide police enforcement or speed cameras, appropriate information and signage
LARGE More than 500 thousand barrels per day	Transit: free public transit (set fares to zero) Telecommuting: large programme, including active participation of businesses, public information on benefits of telecommuting, minor investments in needed infrastructure to facilitate Compressed work week: programme with employer participation and public information campaign Driving ban: 1 in 10 days based on licence plate, with police enforcement and signage
MODERATE More than 100 thousand barrels per day	Transit: 50% reduction in current public transit fares Transit: increase weekend and off-peak transit service and increase peak service frequency by 10% Carpooling: small programme to inform public, match riders Tyre pressure: large public information programme
SMALL Less than 100 thousand barrels per day	Bus priority: convert all existing carpool and bus lanes to 24-hour bus priority usage and convert some other lanes to bus-only lanes

Source: IEA (2005) Saving Oil in a Hurry: Measures for Rapid Demand Restraint in Transport.

The results indicate that the more prohibitive the approach the greater the estimated reduction in fuel savings. These may not however be a good indication for New

Zealand, given the make up of New Zealand's roading and transport infrastructure (relatively little motorway infrastructure and limited public transport except on some major urban areas). However some generic conclusions relevant to New Zealand's circumstances are worth noting:

- Restrictions on driving can provide significant savings but multiple vehicle households tend to be less affected which may raise concerns about equitable sharing of the burden
- Measures to increase carpooling could provide large reductions but success might be dependent on the level of incentive offered. Information programmes (including web based) would increase effectiveness.
- The ability of speed limit reductions to constrain demand depends on effective enforcement.
- The effectiveness of policies making it easier for people to use alternative transport modes depends on the measure and level of investment made, with much of the investment needing to be done before any crisis occurs. Providing free public transport appears moderately effective but would be likely to be costly per barrel of oil saved.
- Construction of carpooling lanes would be likely to be costly, but extending the operating hours of bus and carpool lanes could be an inexpensive way to achieve small reductions.

The report recognised that good public information campaigns can be effective and relatively cheap to implement, including advice on telecommuting and flexible work schedules, advice on the effects of excessive speed, poor tyre inflation and appeals to use alternative modes. The effectiveness of measures encouraging people to change their behaviour depended on some planning and pre-investment.

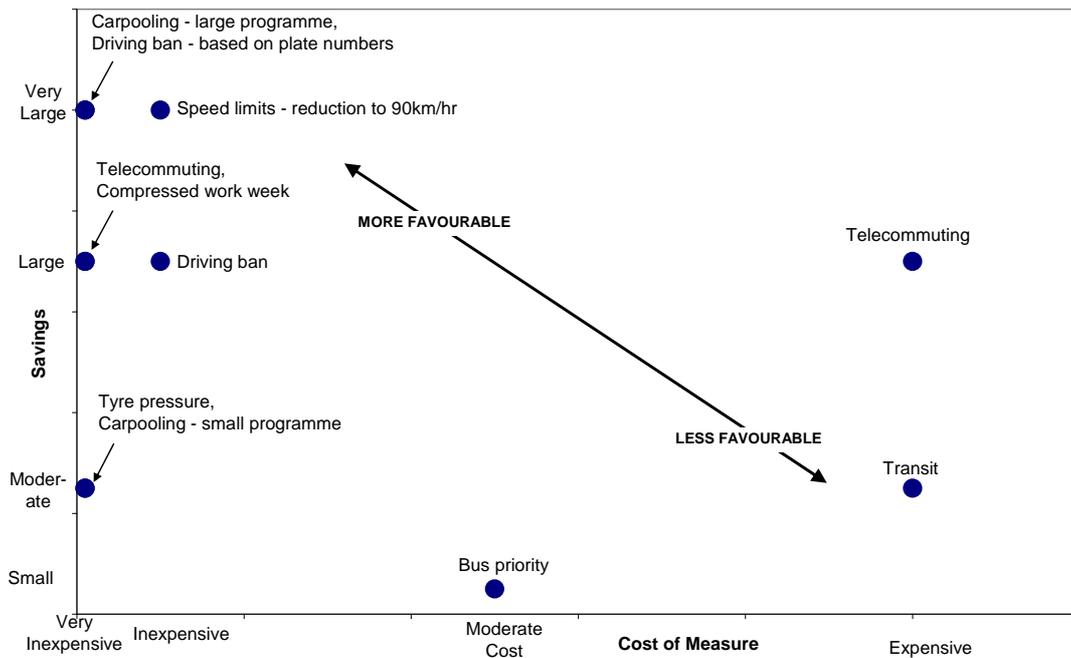
The report also highlighted differences in effectiveness between regions. The following observations were made:

- Level of public transit infrastructure – larger percentage reductions were available in IEA Europe and Japan/Republic of Korea where there were greater levels of public transit infrastructure than North America and Australia/New Zealand;
- Carpooling was more effective in North America and Australia/New Zealand, where levels of solo driving are relatively higher;
- Telecommuting and flexible work policies were least effective in Europe where there were relatively lower levels of solo driving for commute trips;
- Driving bans were more effective in Europe than North America, because of the high average car ownership in North America;
- Speed limit reductions were more effective in Europe and North America where there is relatively higher motorway use than Japan/RK and Australia/NZ (tyre pressure programmes gave similar indications).

3.2.4. Cost Effectiveness

The IEA study provided quantitative analysis by cost per barrel saved. The results used relatively simple assumptions and focused primarily on the direct costs incurred to plan for and carry out emergency measures and not on indirect costs and benefits such as reduced or enhanced mobility, impacts on travel time, reductions in accidents and the macro economic benefits of reductions in oil prices.

Figure 5 Costs and Effectiveness of Policies



Source: Developed from: IEA (2005) Saving Oil in a Hurry: Measures for Rapid Demand Restraint in Transport.

The following comments are about the specific measure considered by the IEA and how they might be tempered for New Zealand circumstances.

Pricing Policies

Although no quantitative analysis of the impact from changes in price was done, the report notes that behavioural effects in response to changes in price are likely to include less driving, more efficient driving styles and more efficient allocation of trip-making decisions. However responses will differ depending on the alternative transport infrastructure available, the ability to offer different modes of travel and fuels taxation regimes.

Increases in price would have less effect in regions with relatively high proportions of tax in fuel cost – New Zealand has a relatively low proportion compared to IEA Europe and Japan/RK. The report notes that regions having higher taxes tend also to have less reliance on personal car travel (more travel options) and therefore tend to have more elastic demand. In other words New Zealand demand in response to price would be

relatively inelastic given the lower level of alternative transport infrastructure available and the relatively low tax rates on fuel.

Provision of Alternative Modes

These include policies aimed at increasing the attractiveness of using alternative modes of transport including public transport, carpools, walking and bicycling by either making these modes less costly (fare reductions) or more feasible either by increasing the level of service or removing the barriers to usage (eg lane prioritisation enhancements). The impact of these types of policies on reducing car travel is acknowledged as being difficult to estimate and depends on the particular circumstances of the public transit system available. Different elasticities have also been cited between the regions and countries, with higher elasticities where there were more flexible travel options. Studies generally showed that commuters are less responsive to price changes than those travelling at other times. In some cases patrons of free public transit services might otherwise have walked in the absence of the free ride.

For New Zealand uptake of alternative modes will depend on how extensive the alternative public transport options are, and the capacity within existing rail and bus fleets to enhance the service level around peak times. Provided capacity is available, there may be significant opportunity to increase the number of commuters using public transport who would otherwise have driven in Auckland or Wellington.

Carpooling Policies

Types of policies include carpool-only traffic lanes, preferential parking and methods of matching potential carpoolers. Some US cities have built carpool only lanes. High occupancy vehicle or HOV lanes are found to be effective when commute lengths are long and commutes are to centralised zones, with high concentrations of employment. Park and ride facilities are also suggested to provide central meeting points for car pool partners and encourage "casual carpooling" but no quantitative analysis is provided. Evidence suggests that commuters do respond to price signals with effectiveness dependent on the type and level of incentive.

Non-motorised Travel and Land Use

Evidence suggests that integrated policy approaches to increase the share of modes such as walking and bicycling can be quite successful. However these policies can require construction that takes many years before they can be implemented. They also require the support of a broad policy package aimed at increasing the generalised cost of car usage relative to the alternatives. In particular urban design can have a major influence on making areas more amenable for walking.

Measures considered included street and town centre closures – closure of some streets has been recognised as likely to see some reduction in vehicle travel – contrary to fears of roads becoming more congested it has been observed that some proportion of the traffic "disappears" i.e. the demand is suppressed by the reduction in road capacity (the opposite of what is commonly known as "induced demand" where the addition of road capacity can actually generate new traffic). Studies cited found a measurable reduction in traffic, with the extent of the result highly dependent on, for example, availability of

public transport, the type of parking controls in place, existing levels of congestion and overall “walkability” of surrounding areas. However it was found that these types of measures were unlikely to show much impact unless implemented on a very large scale and possibly done in conjunction with increasing public transit service.

Work-trip Reduction Policies

Several policy options focus on reducing the number of commute trips needed for individuals to engage in work activities. Policies include:

- Telecommuting or working at home – this is generally understood as working at home but maintaining office contact via telecommunications, either phone or computer. The effect of telecommuting on fuel consumption is difficult to estimate due to the uncertainty and variation in how telecommuters behave (e.g. additional discretionary travel not otherwise made when at work). However, in a fuel shortage, telecommuting can offer the opportunity to remain engaged in economic activity without using fuel for commuting, as reported by Thorpe *et al.*(2002) during the British fuel crisis. The effectiveness of telecommuting would depend on the steps taken prior to any emergency, affecting how easily employees can work from home (provision of a computer with broadband connection to the Internet).
- Flexible/compressed work schedules – sometimes described as alternative work schedules. Compressed schedules allow employees to work fewer days per week but longer days, the effect being to eliminate some work trips altogether and shift remaining trips to earlier or later travel times. Flexible schedules allow employees to choose their start and end times, with the theory behind them being that some employees who want earlier or later work schedules will shift their commuting time to off-peak hours, thereby freeing peak period road capacity and achieving fuel reductions from reduced congestion. During crisis conditions these policies could be relatively easy to implement, with likely greater employer cooperation. However some commuters may have inflexible schedules dictated by other commitments eg child care.

Regulatory Approaches to Traffic Reduction

Policies that expressly forbid traffic from certain areas or during times of the day are another potential policy mechanism. Policy types range from street/town centre closure (discussed above) to mandated “car-free” days (sometimes associated with “odd/even” driving bans⁷ or weekend driving restrictions). These types of policies are likely to be more effective in emergency conditions where people are aware of the need to make changes and their effectiveness will also depend on the availability of other travel options. Households with more than one vehicle may have an advantage for odd/even bans as some trips that would have been possible with only one vehicle can still be taken.

⁷ An odd/even driving ban only allows vehicles with odd (even) registration plate numbers to drive on odd (even) numbered dates. One day in 10 bans are also tied to registration plate numbers.

Promotion of Short-term Behavioural Solutions

Fuel consumption can be influenced by driver behaviour, with excessive acceleration and speed being known to increase fuel consumption. The best fuel efficiencies occur within certain speed ranges, with lower efficiencies outside this range. While speed controls can be enforced, it would be difficult to achieve savings through less aggressive acceleration and braking without 'buy-in' from drivers.

Policies can range from informational programmes to changes in maximum speed limits, although effective enforcement is critical to the effectiveness of setting lower speed limits. Highway speeds may also reduce without formal requirements to do so.⁸

Tyre Pressure and Rolling Resistance

Maintaining proper tyre pressure can have a significant effect on total fuel consumption. Analysis from earlier IEA studies suggests that a significant number of cars have their tyres under-inflated. Also development of tyres with lower rolling resistance could lead to improvements in fuel economy – auto manufacturers tend to have low rolling resistance tyres on new cars but replacement tyres are typically not marketed or bought for their fuel efficiency. Policy options could range between providing information to consumers or mandating specific rolling resistance standards. However the study assumes that policies to increase tyre pressures to optimal levels would mainly rely upon public education.

3.2.5. National Emergency Response Plans—UK

The UK has a Downstream Oil Emergency Response Plan.⁹ It sets out a suite of measures that would be introduced in a supply failure incident (Table 2). We expand on four components of the plan below:

- The Communications Strategy;
- Demand Calming Measures;
- Forecourt Supply Management; and
- The Priority Uses Scheme.

We also discuss the institutional arrangements suggested for implementation.

Communications Strategy

A Communications Strategy will be developed and tailored to the specific event scenario. It will set out the roles and responsibilities for gathering and disseminating information between government, industry and other stakeholders, including the police. It will also identify key messages to be presented via various media.

The Strategy will set out to provide accurate information and to minimise public anxiety and the associated tendency towards impulse buying of fuel.

⁸ The British fuel crisis of 2000 suggested that motorway speeds reduced with no policy change, presumably from attempts to conserve fuel by individual drivers, suggesting that actual shortages can induce some beneficial behavioural responses even without enforced speed limits.

⁹ Department of Trade and Industry (2003) Downstream Oil Emergency Response Plan.

Table 2 Components of UK Downstream Oil Emergency Response Plan

Measure	Description
Bulk Oil Products Allocation Scheme (BOPAS)	Oil products are allocated to priority users Works with Priority Uses Scheme (PUS) and Designated Filling Station Scheme (DFS) National Supply Network (NSN) is established by government to provide regional balancing of supplies and directing supplies to regions in deficit Bulk deliveries to those without Entitled Priority Use may be suspended
Communications Strategy	Strategy for media and public information handling Sets out key messages. Public statements to be made by senior industry figures and the police. Network of industry spokespeople to be identified.
Crude Oil and Imported Products Allocation Scheme (COIPAS)	Allocation scheme to share available supplies of crude and imported products Only triggered if International Energy Programme Emergency Measures have been triggered. If IEA determines that UK has a supply allocation right or obligation, COIPAS used to allocate right/obligation in a reasonable manner
Demand Calming Measures	A series of measures which require government implementation, business/industry support and/or support from the motorist and general public to reduce demand for and consumption of fuel.
Designated Filling Station (DFS) Scheme	A limited number of filling stations to receive priority fuel supplies for Priority Uses Access to these filling stations for priority users only
Emergency Powers	UK legislation allows regulation or prohibition of production, supply, acquisition or use of fuel in an emergency. Can be used to designate filling stations and restrict sales
Forecourt Supply Management (FSM)	Process to restrict retail customers to the purchase of a prepaid fixed quantity of fuel (customers must pay before receiving fuel) and the control of filling station hours. Operates at non-DFS scheme stations This scheme operates to prevent customers from topping up with small volumes. Motorcycles are not covered.
Memorandum of Understanding (MOU)	An agreement between UK government, Scottish and Welsh Executives (devolved administrations), oil companies, trade associations, transport companies, unions and the police to work together in managing a supply failure event.
National Emergency Road Distribution Plan (NERD)	Scheme to requisition oil tankers and use military personnel under emergency powers to deliver petroleum products for Priority Use
Priority Use Scheme (PUS)	Process to define activities that will receive priority supplies and a registration scheme to identify those activities
Regulation relaxation	Process to allow relaxation of regulations affecting the manufacture or distribution of petroleum products
Stockdraw	Process to allow a reduction in the Compulsory Stocking Obligation in the UK to meet an IEA request during an international storage
Use of GPSS	Process to enable the Government Pipeline and Storage System to be used for fuel distribution during a crisis

Source: Department of Trade and Industry (2003) Downstream Oil Emergency Response Plan

The strategy notes key messages to be communicated including reassurance that the industry and government has the situation under control. The lessons from the 2000 crisis are obvious, with the plan suggesting that, in most instances, it is the spread of impulse purchases (panic buying) that creates the fuel shortage, not any disruption to supply. Specific mention is made of ensuring TV footage as soon as possible, of fuel moving out of depots

The Plan suggests that public statements should be made by senior industry figures and the police, rather than the government. This may reflect recent poor public perceptions of the accuracy of government reassurances relating to BSE and foot and mouth.

Implementation of the Communications Strategy is overseen by DTI's Strategic Coordination Group, with day-to-day responsibility with the DTI Emergency Response Team and NEWS team—these different teams are discussed below.

Demand Calming Measures

Demand calming measures are suggested for extended periods of supply restriction. They are regarded as complementary to any rationing or allocation scheme. They include actions which require government implementation, such as

- speed limit reductions;
- promoting public transport;
- measures to reduce travel (government powers to reduce working weeks, reduce shop opening hours, parking restrictions/closing car parks, congestion charges); and
- major media campaigns.

They also include actions which require:

- business/industry support such as company-specific emergency plans (increased working from home, rearranging work hours, encouraging car sharing & use of public transport) and improved energy efficiency (saving heating fuel) and restricting use of company cars; and
- support from the motorist and general public via messages about unnecessary trips, car maintenance (tuning, tyre pressure), journey planning to avoid congestion, reducing weight, steady driving, reducing speed, not idling, reduced use of electrics.

Forecourt Supply Management (FSM)

This measure has clearly originated from the lessons of the 2000 crisis. It is a means for ensuring minimum purchases of fuel and thus preventing topping up of tanks, ie the tendency for drivers to keep their tanks as close to full as possible at all times. In the 2000 event this pattern of behaviour rapidly escalated or created the crisis.

The scheme works through requiring a minimum purchase of fuel and is implemented by requiring drivers to pre-pay for any fuel purchases, ie when they arrive at the station forecourt, they must first pay for the fuel that they will purchase; it is then dispensed. While this does not prevent topping up, it means that to do so may be very expensive on a per litre basis.

It applies only to motor vehicles and does not include motorcycles. While FSM is in place, containers cannot be filled—only vehicle fuel tanks.

The Priority Use Scheme

The Priority Use Scheme is a form of rationing to priority users of fuel. For implementation it requires additional elements of the emergency plan, ie the Bulk Oil Products Allocation Scheme (BOPAS) and/or Designated Filling Station (DFS) tools (Table 2).

There is an initial list of priority use types that is reproduced here as Annex A. There is also a process for registration/verification enabling individual companies/users that fall under these categories to obtain a unique registration number that will be required to obtain fuel. This unique registration number will be required when ordering bulk deliveries or obtaining fuels for Designated Filling Stations (DSFs).

The registration scheme is administered by local authorities; they will assign the registration numbers to Priority Users on application. Local authority staff will be at the DSFs to assess priority users and ensure only registered and verified customers gain access. Police would be present also. The scheme also designates the individual requirements of the priority users and therefore the quantity of allocation; non-essential uses of fuel by Priority Users are not allowed. In addition, reselling of fuel is made an offence.

The priority use list (Annex A) has several levels reflecting different supply scenarios. These range from level 1 (1-2% of normal supplies available) to level 6 (75% of normal supplies available).

This list might provide a starting point for a priority list in New Zealand.

Institutional Arrangements

The implementation of the Emergency Response Plan requires the establishment of a number of teams (Table 3) with distinct roles in strategic, tactical and operational issues.

A Cabinet Office Civil Contingency Committee (CCC) provides the link between the teams of official and industry representative and Ministers. Within the Department of Trade and Industry (DTI) there is a Top Command Team (TCT) of senior officials that determines the principal impacts, provides information to the CCC and recommendation on measures to be introduced, and keeps the government response and public reaction under constant review.

Within the DTI there is also a Crisis team with more day-to-day responsibility for the incident, working with other agencies and local authorities. The development and coordination of the overall DTI response is undertaken by a Strategic Coordination Group of senior officials.

There is also the potential for establishment of a Joint Response Team (called together at the request of the DTI Crisis Team) that would include DTI and industry representatives and would provide a 24-hour link with industry. It would have a role in monitoring and suggesting additional measures. A High Level Industry Team would also be established and could be called on to advise the DTI via the TCT.

National and Regional Supply Networks would be established that had a role in inter- and intra-regional balancing of supplies.

Operational aspects of the plans would be implemented by local authority staff (eg registration of and allocations to priority users), police and industry (eg management of Designated Filling Stations).

Table 3 Roles and Responsibilities of Teams

Team	Roles and Responsibilities
DTI Crisis Team	A dedicated team within DTI that manages DTI's response to the incident. Its role covers liaison with emergency services and local authorities, DTI staffing and incident management, briefing other groups
DTI Strategic Coordination Group	A team comprising senior DTI and Cabinet Office officials which provides overall business policy guidance and support to the Crisis Team. Its role is to develop and coordinate an overall DTI response
DTI Top Command TEAM (TCT)	<p>A team chaired by the DTI Director General of Energy and comprising senior DTI and Cabinet Office managers. This team provides a DTI response strategy and proactively manages national issues, which could threaten the economy as a whole. TCT's prime responsibilities are to:</p> <ul style="list-style-type: none"> • determine the principal impact of the crisis, • ensure that information associated with the incident is promptly considered by the Cabinet Office Civil Contingency Committee (CCC), and • decisions of escalation and de-escalation are addressed • review the Government response to the incident and be assured that industry and public concerns, eg media issues, are considered and appropriately managed • review adequacy of information received • recommend to Ministers/CCC, which if any response measures should be implemented
Cabinet Office Civil Contingencies Committee (CCC)	Has responsibilities to liaise with the DTI Teams as appropriate, coordinate regular situation reports and briefings for Ministers, liaise with the Government's Communication and Intelligence Centre on media handling
Joint Response Team (JRT)	<p>Called together at the request of the DTI Crisis Team manager, the JRT will comprise DTI and industry representatives. It will:</p> <ul style="list-style-type: none"> • act as a continuous 24 hour link with the industry; • monitor impacts and advise on possible response measures; • review and advise on technical and industry specific data
High Level Industry Team (HLIT)	A senior industry advisory group that may be called by the chairman of the DTI Top Command Team to advise that team on an ad hoc basis as and when necessary. It will comprise the industry representatives from the Downstream Oil Industry Forum (DOIF)
National Supply Network (NSN)	<p>Can be established by the DTI consisting of DTI, Primary Suppliers and the Office of Fair Trading. Its task is to:</p> <ul style="list-style-type: none"> • provide regional balancing of supplies to terminals, directing supplies of fuel from regions with a surplus to regions with a deficit; • ensure each region is consistent in its implementation of the Emergency Response Tools used; and • communicate with JRT the National fuel supply position.
Regional Level, Regional Supply Networks (RSNs)—	May be established by DTI comprising local Oil Industry terminal managers and Government Office of Regions to ensure matters are dealt with in an open and reasonable manner. RSN will deal with intra-regional supply issues; NSN with inter-regional supply issues

Source: Department of Trade and Industry (2003) Downstream Oil Emergency Response Plan

3.3. Restraint for Other Products—Electricity

Requirements for rapid reductions in electricity demand have been seen in New Zealand on a number of occasions, and electricity demand can also be managed in novel ways. The electricity restraint options investigated here are:

- The Auckland Power Supply Failure of 1998;
- The 10% demand reduction programme in 2003; and
- Peak load management.

3.3.1. Auckland Power Supply Failure

Power supply to the Auckland central business district (CBD) failed in February 1998. It was caused by a series of thermo-mechanical failures.¹⁰ This was a sudden and complete supply outage and required some adaptation by virtually all residents and firms located in the CBD. There was a major effort to import diesel generators which were sited on footpaths throughout the city. However for many firms, the only feasible options were to close for the duration of the outage or to relocate to another part of metropolitan Auckland.

The outage showed that people adapt rapidly to a critical supply failure, but it was not particularly relevant to oil demand restraint for two reasons:

- It was geographically isolated, so alternative supplies were available nearby; and
- It was a complete and sudden outage rather than a situation requiring conservation and monitoring.

3.3.2. Dry Year Demand Reduction

Recent dry years in New Zealand have led to calls for reductions in electricity use by industry and households. The most recent event was in 2003. There are a number of lessons that have emerged from this event.

- The government made a decision to hand over day-to-day management of the issue to the electricity industry rather than managing the issue itself. There were a number of reasons including the fact that industry would be better able to¹¹:
 - brief call centres;
 - provide financial rewards to low income households; and
 - send information to households (with their electricity bills).

For saving oil, any decision to have industry rather than government lead the response is likely to be based on similar practical questions, but will also reflect

¹⁰ Auckland Power Supply Failure 1998. The Report of the Ministerial Inquiry into the Auckland Power Supply Failure. Ministry of Commerce.

¹¹ Heather Staley (EECA) personal communication.

levels of trust—who will the public have most confidence in during the crisis? The trust issue is addressed in more detail in Section 3.5.

- The response to the calls for voluntary reductions developed over time as households and individuals discovered what they could do. The importance of the issue was cemented over time, increasing raising of consciousness in the general population. Keeping an issue front-of-mind is a critical part of ensuring long term reductions and this was believed to be part of the reason that levels of electricity use rose again after the publicity ended—obviously it might also have been because the crisis was over and the perceived need to make the reductions (at some personal cost) was no longer there.
- Information was provided to the public in the form of a national risk meter. It was regularly updated and summarised the analysis of security of supply risk based on water inflows to the hydro system and levels of electricity savings achieved. It was a simple way to communicate to the public the extent of the problem and whether there was a need to find additional savings.

There was a significant public response to the call for reductions, despite the fact that we were facing a potential outage, rather than an actual one.

3.3.3. Peak Load Management

Peak Load Management (PLM) involves a set of measures that ensure that supply of electricity can equal demand during periods of peak load. It provides a more systematic set of tools that can be used to limit demand.

For example, the Peak Load Management Alliance (PLMA) summarises design principles important in gaining customer participation in demand response measures.¹² It notes that the fundamental need is to develop value propositions for customers where the benefits or values received exceed the costs or risks of participation. It does so around three types of criteria:

- Participant criteria that determine attractive customer characteristics;
- Operations criteria by which the load resource is called or dispatched;
- Settlement criteria describing the financial arrangements.

Examples of programmes are summarised in Table 4.

These systems translate to oil with more difficulty. Generally they operate via a price reward system. However, they are based on the existence of supply contracts which can be used to modify levels of supply. It is difficult to see this operating for fuel because of the absence of contracts, widespread availability and anonymous purchasing.

¹² Peak Load Management Alliance (2002) Demand Response: Design Principles for Creating Customer and Market Value. (www.peaklma.com/files/public/CustomerPrinciples.pdf)

Table 4 Demand Response Measures

Programme	Description	Customer Perspective
Load Response		
Direct Load Control	Equipment that can be cycled or turned off for limited periods of time. Communication to switch the equipment is via power-line carrier or wireless networks managed by the party calling for load reductions.	Customers agree to limited number of events over a time period. They earn a credit payment, eg per month for participation.
Curtable Load	Facility managers or central control operator of customer responsible for managing response to call for curtailment. Communication 30 minutes to 2 hours ahead	Participation voluntary if called but failure to meet target reductions results in reduced payments or penalty costs Payments on basis of load reduction below agreed baseline.
Interruptible	Facility managers of large operations reduce load or are disconnected	Participation mandatory if called Incentives take the form of rate discounts throughout the term of the agreement. Non-compliance penalties.
Price Response		
Emergency	Aimed at large industrial users. Similar to load curtailment programmes	Variable payment based on locational marginal price or some high minimum payment (eg \$500/MWh)
Economic	Participants see a proposed set of prices for a day ahead and offer load reductions or participants bid load reductions and bid prices.	Payment based on price bid
Real-time pricing	Customers observe real-time energy use and forward prices	Customers respond to price voluntarily
Time-of-use rates	Meters measure consumption during different periods. Prices differ.	Customers respond to price voluntarily

Source: Peak Load Management Alliance (2002) Demand Response: Design Principles for Creating Customer and Market Value. (www.peaklma.com/files/public/CustomerPrinciples.pdf)

3.4. Restraint in Other Products—Water

Measures to reduce demand for water include those that aim to encourage longer term reductions in demand, such as labelling schemes introduced to encourage purchase of water-efficient appliances and moves to encourage water efficiency in business such as via pricing structures and efficiency audits, grants and encouragement, much as for electricity efficiency.

In Australia, there is recognition of a long term imbalance of supply and demand for water. The emphasis has been on longer term measures to reduce total demand and to achieve more sustainable use of water. For example, there is a programme of Water Efficiency Labelling and Standards (WELS)¹³—there is a move to introduce the labelling aspects of this to New Zealand. Some US states, eg Arizona¹⁴ have introduced similar approaches aimed at achieving long term reductions in demand.

In contrast, the UK has experienced a number of dry years recently that are regarded as unusual, set against the historical record. While there have been some moves to encourage reduced demand overall, there have also been steps taken to better manage supply and demand during drought conditions. Specifically, the Water Act 2003 makes

¹³ www.deh.gov.au/water/urban/scheme.html#strategic

¹⁴ Governor's Draft Task Force (2004) Arizona Statewide Water Conservation Strategy.

it a statutory requirement for water companies to produce drought plans.¹⁵ Regulations are being drafted that will specify the details.

3.4.1. Drought Planning

UK

UK water companies have a statutory duty to provide domestic customers with a supply of water and thus must plan to manage periods of low supply. Although this might provide sufficient incentive for the production of plans, the need for further intervention has been identified as being required to ensure¹⁶:

- that plans are effective;
- consistency across water companies;
- adequate consultation;
- that environmental protection is not compromised in meeting supply obligations during water shortages;
- transparency;
- avoidance of, or limits to, third party financial losses if abstraction for other uses is diverted to public water supply.

A water company drought plan must be produced with widespread public and stakeholder consultation and include measures to reduce demand and obtain alternative supplies, plus monitoring requirements.

The Environment Agency's guidelines for company drought plans include the following suggested demand measures¹⁷:

- Extra promotion of water efficiency;
- Appeals for restraint;
- Pressure management;
- Enhanced leakage reduction;
- Hosepipe and sprinkler bans;
- Restrictions on non-essential use (proscribed uses order).

All water companies have plans¹⁸. Figure 6 shows the elements of the Drought Contingency Plan of United Utilities, a UK water, wastewater and electricity distribution company. It shows a transition from information programmes—“ask customers to minimise non-essential uses of water”—to mandatory measures—hosepipe ban and drought permits/orders.

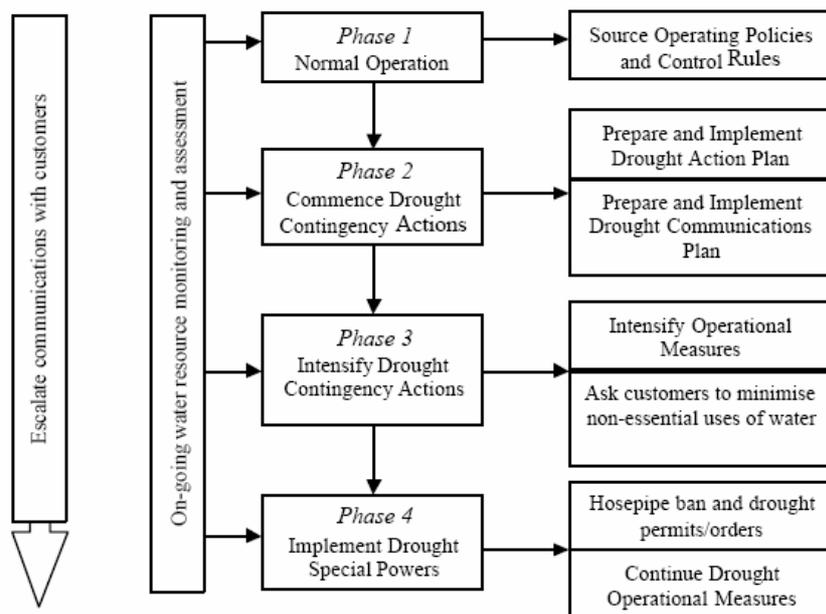
¹⁵ Department for Environment, Food and Rural Affairs (2004) Consultation on water company drought plan regulations. (www.defra.gov.uk/corporate/consult/droughtplan/consultdoc.pdf)

¹⁶ Regulatory Impact Assessment of Drought Plan Regulations. (www.defra.gov.uk/corporate/consult/droughtplan/consultdoc.pdf)

¹⁷ Environment Agency (2002) Drought Plan Guideline. (www.environment-agency.gov.uk/commondata/acrobat/dplans.pdf)

¹⁸ Environment Agency (2003) Review of water company drought plans. Report to Government. www.environment-agency.gov.uk/commondata/acrobat/review_drought_03.pdf

Figure 6 United Utilities Drought Programme



Source: www.unitedutilities.com

USA

In the US, drought planning is organised at the State level.

As an example, in Missouri, the Drought Plan¹⁹ includes initial assessment phases followed by conservation and drought emergency phases. The elements of the different phases are outlined in Table 5. As for the UK plans, there is a transition from education and advice to more stringent measures; the initial voluntary measures are estimated to be able to achieve a 5-15% reduction in demand. Of note, the Missouri scheme includes:

- categorisation of uses by importance (Table 6) that are used as the basis for use restrictions;
- price mechanisms that enable prices to be increased to cut-off demand; and
- rationing at the individual level via maximum allowable use.

The plan defines water uses into different categories reflecting their importance (Table 6). This is used as the basis for restrictions introduced on activities.

In Arizona a “naming and shaming” approach is suggested for severe shortages—publishing through the media, the names of customers with the highest water use.²⁰

¹⁹ Missouri Department of Natural Resources (2002) Missouri Drought Plan revised by Water Resources Program 2002. Water Resources Report Number 69. (www.dnr.state.mo.us/geology/wrp/WR69.pdf)

²⁰ Governor’s Drought task Force (2004) Arizona Draft Preparedness Plan. Operational Drought Plan. (www.water.az.gov)

Table 5 Components of Water Shortage Response Plan—Missouri

Phase	Measures
1 Advisory —conditions indicate potential for serious water-supply shortages	<ul style="list-style-type: none"> Notify public and request voluntary conservation expressed as percentage of normal or specific gallon amount Conduct intensive public information campaign Develop action plan for alternative supply sources Establish water conservation ordinances that have enforceable measures for non-compliance
2 Drought Alert —visible or measurable signs that supplies are significantly lower than normal	<ul style="list-style-type: none"> Choose and implement voluntary measures, restrict specific non-essential uses (see Table 6) and incorporate enforceable water use restrictions Implement educational effort to encourage water conservation Develop firm commitment to alternate supply sources
3 Conservation —drawdown and static water level of a well continues to go down	<ul style="list-style-type: none"> Implement stringent conservation measures Enact pricing measures and additional mandatory restrictions (economic rationing) <ul style="list-style-type: none"> Indicate Class 2 and Class 3 (see Table 6) use restrictions Expand educational efforts and explain pricing measures Put water conservation ordinance in place Assess penalties for non-compliance
4 Drought Emergency (Water Rationing) —water supply is clearly inadequate to meet predicted demand	<ul style="list-style-type: none"> Set maximum allowable usage per capita

Source: Missouri Department of Natural Resources (2002) Missouri Drought Plan revised by Water Resources Program 2002. Water Resources Report Number 69. (www.dnr.state.mo.us/geology/wrp/WR69.pdf)

Table 6 Defined Categories of Use in Missouri Drought Plan

Class	Uses
1 Essential	Domestic, health care, firefighting, health and public protection, electric power generation, military, telephone communications, water and waste-water systems
2 Socially or economically important	Irrigation; commercial nurseries; arboretums and public gardens of national, state or regional significance; turf industry; revegetation following earth moving; commercial laundromats; restaurants, clubs and eating establishments; commercial air conditioning; schools, churches, motels/hotels and similar commercial establishments
3 Non-essential uses	Outdoor commercial and non-commercial watering; fountains and pools; gardens, lawns, parks, playing fields and other recreational areas without access to grey water; filling and operation of public or private swimming pools; watering of golf courses; washing motor vehicles; testing of fire hydrants and sprinkler caps; flushing of sewers and hydrants, except if needed to protect public health; air conditioning and refilling cooling towers, except for refilling for start-up at the beginning of the cooling season

Source: Missouri Department of Natural Resources (op cit)

3.4.2. Information Programmes

Information programmes are used by a number of countries to encourage reduced demand.

In the UK, a Water Demand Management group within the Environment Agency (England & Wales) provides advice to householders, business and the public sector.²¹

²¹ www.environment-agency.gov.uk/subjects/waterres/286587/?version=1&lang=_e

There is also a programme of annual Water Efficiency Awards. Water efficiency advice is also provided by water companies.

The information programmes provide practical advice on how water use can be reduced. This provides ongoing information but also a useful source of information to turn to when there is a need for rapid demand restraint.

In Australia, the Senate Environment, Communications, Information Technology and the Arts Committee²² investigating options for water conservation, noted that knowledge of consumer behaviour is incomplete and that this could explain why demand management programmes do not always deliver the gains anticipated:

Public information is regarded as crucial to achieving changes in water use. However, the Australian Senate report notes²³ that there is a widespread lack of understanding of the natural water cycle, of the effect that urban water systems have on the environment, and of the need to manage water more sustainably. Further, an uninformed community will have poorly formed opinions which impedes change towards more sustainable use.

The other use of information that is common in many of the drought plans is that of providing the public with information regarding the nature and scale of the problem, eg the current levels of water in reservoirs and expected rainfall, in a similar way to the provision of information to electricity consumers in the New Zealand Save 10% campaign in 2003.

3.4.3. Bans on Non-Essential Use

Bans or restrictions on non-essential and low priority uses are included in drought plans in the US and the UK.

The Missouri example provided a listing of uses under three classes of use.

In the UK bans have been limited to hosepipe bans that limit use of water for gardens and car-washing. Both are significant uses of water but both are non-vital.

In the UK, there have been warnings in early 2005 of a possible hosepipe ban this summer following the third driest winter on record. Currently households in several areas are being advised to be conservative in their use of water but there are warnings of hosepipe bans if these are not successful.²⁴ Some local water suppliers have introduced bans already, eg The Sutton and East Surrey Water Company, which

²² Senate Environment, Communications, Information Technology and the Arts Committee (2002) The Value of Water. (www.aph.gov.au/senate/committee/ecita_ctte/completed_inquiries/2002-04/water/report/contents.htm)

²³ Senate Environment, Communications, Information Technology and the Arts Committee (op cit) p116-117

²⁴ Dry winter may lead to hosepipe ban. Guardian 22 March 2005. (www.guardian.co.uk/weather/Story/0,2763,1443533,00.html)

supplies water to many areas within Surrey has announced a sprinkler and unattended hosepipe ban effective from 22 April²⁵.

Concerns over hosepipe bans include the limited means for enforcement. This is particularly so in the UK because of the very low rate of household metering of water use. Voluntary restraint is also not helped because of public perceptions that much of the problem owes to poor infrastructure in the form of leaking pipes.

3.4.4. Drought Permits and Orders

One of the mechanisms available to UK water companies is temporary powers that authorise abstraction, impounding, diversion or appropriation of water. For these powers to be granted, it is necessary for the Secretary of State (in the case of drought orders) or the Environment Agency (in the case of drought permits) to be satisfied that²⁶:

- **either** a serious deficiency of supplies of water exists in any area **or** such a deficiency exists in the flow or level of water in any inland waterway as to pose a serious threat to any flora or fauna which are dependent on those waters exists or is threatened; and that
- the reason for the deficiency is an exceptional shortage of rain.

Prior to allowing use of these measures, a water company must have used all reasonable means of supply available, eg publicity campaigns, hosepipe bans, bans on non-essential uses, leakage control and pressure reduction²⁷.

3.4.5. Emergency Pricing

The Missouri system allows the use of emergency pricing measures to reduce demand, although it is suggested that it will not be effective in the absence of educational effort. Suggested components include²⁸:

- On any system—seasonal rates, a drought surcharge, increasing marginal charges; and
- On metered systems—conservation discounts, excess use charges, flat charges above baseline, disconnect/reconnect charge.

Emergency pricing for oil products is addressed in Section 3.6.

²⁵www.surreycc.gov.uk/sccwebsite/sccwspages.nsf/LookupWebPagesByTITLE_RTF/Hosepipe+ban?op=endocument

²⁶ Drought Orders and Drought Permits. Information from the Department of the Environment, Transport and the Regions, the Welsh Office and the Environment Agency. 1998. (www.defra.gov.uk/environment/water/resources/drought/guidance.pdf)

²⁷ *ibid*

²⁸ Missouri Department of Natural Resources (2002) Missouri Drought Plan revised by Water Resources Program 2002. Water Resources Report Number 69. (www.dnr.state.mo.us/geology/wrp/WR69.pdf)

3.5. Behavioural Change²⁹

This section discusses practical strategies to promote and support rapid *voluntary* behaviour change which may be required as a result of a sudden interruption in oil supply. In doing so, it follows the International Energy Agency (IEA) by focusing on urban passenger transport behaviour, given that this group is identified as having the single greatest potential for rapid reduction in fuel use³⁰.

The considerations and practical recommendations presented here are based on a review of literature on environmental psychology, social marketing, and travel behaviour change as well as a review of past experiences in rapid fuel shortages and other crises. In light of these reviews two significant points can be made. Firstly, greater voluntary responses to travel behaviour can be expected during a crisis that during a 'business as usual scenario'. Secondly, the size and rapidity of response can be increased through a strategic approach to communications and the provision of supporting infrastructure and services.

With these in mind, the rest of this section covers the following:

- Strategic overview—recommending a coordinated approach by central and local government in promoting and supporting rapid behaviour change.
- Example of rapid behaviour change—highlighting the voluntary changes observed during the UK fuel supply restriction in 2000 and the lessons learned.
- Communications and information—outlining the factors that affect peoples' responses to information and the resultant effects on their behaviour. Specific recommendations are given for the development of communications and information during a sudden fuel shortage.
- Supporting infrastructure and services—the potential for rapid mobilisation of infrastructure and services to support voluntary behaviour change.
- Supporting policy and regulations—recommending the development of emergency guidelines to enable authorities to review policies and develop provisions, to support rapid behaviour change.

Table 8, at the end of this section, provides a summary of practical strategies and suggests roles for implementation at both national and local levels.

3.5.1. Strategic overview

An integrated approach to strategy design and implementation is recommended. This will require coordination between central and local government (Table 7).

²⁹ This section has been prepared by Bill Smith, independent consultant specialising in the development of strategies to promote voluntary changes in environmental and transportation behaviour

³⁰ IEA (2005)

These items are developed further throughout the rest of this section and are summarised with specific examples in the table at the end of this section.

Whatever the actual arrangements, there is a requirement to identify clear roles and responsibilities with regards to the supply and provision of information, infrastructure and other services. This will not only ensure a coordinated approach to a rapid behaviour change strategy but also help to present the vital impression that the country is prepared.

3.5.2. An example of rapid behaviour change – UK fuel supply restriction 2000

In 2000, protests in the UK lead to a sudden restriction in fuel supply over one week. As reported in three subsequent studies³¹ (and summarised in Section 2), rapid responses were observed during this time with only minor public appeals to altruism and very little preplanning. These responses are summarised below as they help to highlight the overall importance of communications and infrastructural support in a crisis situation.

During the fuel shortage, the following travel behavioural responses were observed:

- Overall reduction in trip lengths particularly during off-peak periods and for non-essential travel;
- Overall reduction in average speed, although there was an initial increase in speed due to lower congestion. Speed reductions were also observed at night;
- Commuters shifted to public transport modes;
- Informal car-pooling increased;
- Numbers walking to school significantly increased;
- Increases in telecommuting (eg working from home).

In addition, there was significant hoarding behaviour of both fuel and food with many shops and supermarkets running out of basic foodstuffs.

There was a general perception that the disruption was not very significant due to the existence of an extensive and reliable public transport network. However, a significant proportion of people (29% of 1001 surveyed) indicated a lack of preparedness, actually running out of fuel during the one week period³². In addition, concern was expressed about the security of supply for emergency services operation.

Even from this very brief summary, it can be seen that there are significant changes in behaviour during a crisis situation at least in the short term. In the UK, it appears that the existence of a reliable and widespread public transport system, coupled with appeals to altruism, reduced the effects of a very short-lived disruption to the fuel supply. However, given the potential for more significant disruptions (either over a longer time period or where alternative modes are not so readily available), communications and information become the central tools in promoting voluntary behaviour change. These are discussed below before considering some of the other

³¹ Eves, D., et al. (2002); Thorpe et al. (2002); Noland et al. (2003).

³² Thorpe et al. (2002)

infrastructural and policy measures that can be taken to support rapid voluntary change.

Table 7 Roles of Central and Local Government

	Central government	Regional and local authorities
Overview	<ul style="list-style-type: none"> • National coordination and implementation • Determination of national, regional and local authority roles and responsibilities • Development of regional and local guidelines 	<ul style="list-style-type: none"> • Local co-ordination, negotiation and implementation
Communications	<ul style="list-style-type: none"> • Development of national communications strategy • Guidelines for local authorities 	<ul style="list-style-type: none"> • Development of local communications strategy based on national guidelines and local networks • Provision of local information coordinated with relevant service providers
Supporting infrastructure and services	<ul style="list-style-type: none"> • Implementation of national supporting infrastructure and services • Provision of guidelines to enable a local authority review of infrastructure and services • National endorsement of strategies outlined in the guidelines including calls for cross-sector support • Negotiations with service providers (eg public transport) at national level as required • Provision of resource and financial support to local authorities as required 	<ul style="list-style-type: none"> • Review of local infrastructure and services • Identification of potential infrastructural and service upgrades • Negotiations and partnerships with local organisations (eg schools, businesses) as required • Application for central government assistance if necessary
Policy and regulations	<ul style="list-style-type: none"> • Development of provision to enable fast-track emergency legislation to support infrastructural and other changes as required • Provision of guidance for local policy review 	<ul style="list-style-type: none"> • Review of local policy • Application for fast-track legislation as required

3.5.3. Communications and information

Voluntary behaviour change strategies are, first and foremost, strategies of communication. They rely on trying to persuade and motivate an audience to act in a certain way in a given situation.

Environmental psychology and behaviour change research suggests that there are a number of factors that affect how people respond to information and how this, in turn, affects their behaviour³³. These relate both to the source and style of the communications and also to the design of the information itself. These issues are discussed in turn with direct relation to a fuel supply shortage.

³³ See Fischer et al. (1984) for a discussion of environmental psychology.

Trusting the Information Source

An individual's or community's perception of a specific issue, or particular agency, may have been conditioned by previous events and relationships. For example, local willingness to respond to a fuel shortage could be affected by past media reports suggesting government or fuel company impropriety in a given situation. This can manifest itself in terms of distrust of an organisation, and the messages that they produce. As a result, messages relating to a fuel shortage need to be presented, or be directed, through a source that the target audience respects. Nationally, this is more likely to be through central government, than through fuel companies. Having said this, it is important that all sectors present a united front with regards to the facts of the situation, to avoid confusion and potential panic. To this end it is essential that the independent media recognise their responsibilities, particularly that they are part of the national effort to mitigate the effects of a sudden reduction in fuel supply.

As a guiding principle, all information should be as factual and transparent as possible, though it is recognised that there are times where this may not be practical.

Appealing to and Directing Social Norms

Social norms are the common values that direct socially appropriate or acceptable patterns of behaviour within a given community in a particular situation. In some cases they provide a strong motivation to individuals to adopt new behaviours in order to conform or fit in with community efforts.

Social norms are transmitted through formal and informal education, across and within generations and through role models. They can be appealed to, strongly influenced, and in some cases generated, through mass media particularly when modelled by respected or admired individuals. Social norms are often utilised in social marketing campaigns to stop smoking, stop drink driving or speeding on the roads.

Research suggests that communications that use social norms are more effective where the target behaviour is modelled (ie shown to be normal) rather than creating negative messages around an undesired behaviour³⁴. This would imply, that widespread, positive, messages and images of people carpooling (for example) will help to promote this as a *normal*, socially desirable, behaviour. These and other target behaviours could then be reinforced with appropriate communications and information at a local level.

Story telling is a derivative of modelling where people and families from all walks of life describe their positive experiences and feelings in working towards a collective goal.

Non-Threatening Communication

Forceful or overplayed messages can sometimes leave people feeling that their freedom of choice is being restricted. This can lead to instances where they ultimately reject a message that they would otherwise have agreed with. In some instances, where people feel obligated to act, either through strong messages or regulations, they may experience

³⁴ Bator et al. (2000)

a state of tension or *cognitive dissonance*. This can be heightened if they feel the intended behaviour is not actually necessary or justified.

When choices can be made in the absence of such strong arguments, and people feel they come to a conclusion for themselves, they are more likely to adopt and maintain a behaviour. This generally suggests that strategies that adopt voluntary change tactics, and use regulatory measures only as a last resort, will be more acceptable to the public³⁵. It also further reinforces the notion that the use of 'negative' social norms that make people feel uncomfortable, or that their behaviour is socially unacceptable, is not conducive to long-term behaviour change.

Overcoming Feelings of Helplessness

People's desire or ability to actively engage in activities to mitigate problems directly relates to their belief that they can affect the situation. In a sudden fuel shortage situation there will always be some people who feel helpless to act or feel that their actions will be inconsequential. Positive solution-orientated messages, coupled with information that explains specifically how to act, will help to keep this number to a minimum. In addition, reporting the effectiveness of communal efforts will help enforce feelings that things can be changed.

Appealing to Altruism

Based on past experiences of sudden fuel shortages, IEA suggests that altruism is a key factor in motivating rapid behavioural response³⁶. In this case it is likely that altruism is directly linked to social norms, that is, that the propensity to take part in a community effort (with little or no reward) is based on feelings that others are also doing the same thing. Again this enforces the requirement for high level, widespread messaging, and, where regulations are concerned, the feeling that everyone is facing the same situation.

Creating a Sense of Personal Satisfaction

The role of intrinsic satisfaction is, perhaps, one of the most useful concepts to bear in mind when considering strategies to promote voluntary behaviour change³⁷. Intrinsic satisfaction relates directly to an individual's sense of pride in themselves. It can be activated in a number of ways which directly relate to travel behaviour including;

- Community contributions—Pleasure is gained by contributing to a community effort particularly where that effort is considered important and is seen to really make a difference. This is fundamentally different from the concept of altruism, as described above, as there is a definite personal pay-off or reward in terms of the increased satisfaction that is gained. Reciprocal acts that directly assist the individual or recognise their contribution will enforce this satisfaction.

³⁵ IEA (2005) summarises the preplanning approaches adopted by the governments of Norway and Greece where there is an emphasis on voluntary measures prior to regulatory measures.

³⁶ This relates to the UK fuel shortage 2000. See Kaplan (2000) for further discussion on altruism.

³⁷ See DeYoung (2000) for a full account of the factors affecting intrinsic satisfaction.

- Frugal resource use—Satisfaction is gained through the efficient use of fuel. This is not necessarily related to cost savings but more an exhibition of competence as described below.
- Behavioural competence—Satisfaction is felt when an individual learns a new behaviour or solves a problem. Further, a sense of pride can be heightened when an individual feels prepared for an event (particularly where they feel others may be less prepared than they are).

Given that the ability to make community contributions or efficiently use resources also requires certain skills, behavioural competence appears to have a significant role in both enabling and motivating behaviours. Opportunities to enhance competence should be a key consideration in designing information to encourage voluntary rapid behaviour change. Opportunities to celebrate exhibitions of competence should also be identified. These include personal stories of problem solving and the development and use of indicators to highlight increases in fuel efficiency at both national and local levels.

Utilising Social Capital and Networks

The role and importance of social capital is gaining increasing prominence in behaviour change research. As a general definition, social capital refers to the value that arises from the spirit of reciprocity (ie the inclination of people to do things for each other) that maintains all social relationships and networks within and across different groups and communities³⁸. The actual level of reciprocity is dependent both on practical need and on the prevailing social norms of a particular group. As such, social capital can both influence, and be influenced by communications provided that efforts are made to identify the social networks and how they operate.

At a local level, for example, different groups maintain very different social networks, (eg Pacific Islander networks tending to be farther reaching than those maintained by Europeans). In addition the communications channels that bind these networks together may also be different, for example some groups may pay more attention to the radio as a means of listening to the news. Others may favour community meetings. Key influencers, or social drivers, within those groups may also be very different. Some cultures respect the views of older generations and look to them for guidance whereas others take their lead from local or national role models. Local authorities should already have some idea of what the networks are in their area and how they function. As a result, they are best placed to design and deliver locally relevant information including, for example, whether translated material is necessary.

At a national level, communications and messages can be used promote a general spirit of reciprocity. Again, story telling and modelling will be effective.

Designing the Information

The above discussion, coupled with a review of travel behaviour change strategies, provides strong direction when designing the style and content of information that will

³⁸ See Baron et al. (2000) for a fuller account

tell people what behaviours to undertake in a sudden fuel shortage. Specific types of information are outlined below and summarised in Table 8 which also provides suggestions as to whether they should be centrally or locally produced.

Key Messages

As suggested above, general or key messages need to be widespread, coordinated, positive, and provide a sense of collective responsibility. In addition, they need to be versatile and utilise a range of visual and printed media. Where statistical information is provided this needs to be factual and transparent. Where possible, the independent media should be recruited as key players with a role in proactively promoting the required changes in behaviour.

Procedural Information

In this case, procedural information refers to information which informs people of what actions they can take in a fuel crisis and, specifically, how they can take them. It is useful at a number of levels as it can both develop and enhance competence, thereby generating satisfaction. Procedural information can either be general, (eg improving efficient driving or how to set up a car-pool club) or specific to a particular audience or location. The latter might include information on where the local walking school buses are or what time and from where public transport leaves. Table 8 highlights a range of behaviours that require procedural information and includes:

- How to avoid travel (walking, cycling and telecommuting)
- Efficient driving behaviour
- Journey planning and trip chaining
- Car pooling
- Public transport use

The table also suggests whether central or local governments are best suited to provide the procedural information for each of these behaviours, given that both have a wider role in promoting these actions generally. It is recommended that these responsibilities are clarified and that a full review of existing information is undertaken to avoid unnecessary duplication.

Personalisation

Directly related to the need for procedural information is the requirement that it should be as personalised as possible. The more personalised the information, the more relevant and useful it is to the individual. Providing facilities where individuals can access personalised journey plans detailing alternative options for specific trips (either over the phone, at a transport centre or through the internet) helps to avoid redundant information. This increases the convenience of the information and can further enhance feelings of competence. As above, local authorities are best placed to provide personalised information that is locality specific.

Feedback

National or regional indicators of fuel use provide direct feedback on the effectiveness of the communal effort. At a personalised level, supplying people with the means to

measure their own fuel use (eg a simple 'cut-out' table in a newspaper) can further enforce their sense of contribution. Indicators also provide an opportunity to celebrate competence when goals or milestones are reached.

Communications and Risk

All communications, messages and information, need to be continually appraised from a user-perspective. This will help to ensure that they combine to have the desired effect and also assist in testing the 'trustfulness' of the source. Focus groups or street-based 'quick-reaction' surveys can be used to quickly trial communications and assess their potential impact across social and cultural groups. This is an essential part of identifying and managing potential risks which is required in any communications strategy. In this case, the importance of identifying risk will increase where behaviour change is required over a prolonged period and regulatory measures may become necessary.

Supporting Infrastructure and Services

The following discussion considers the mobilisation and implementation of supporting infrastructure and services to support voluntary behaviour change during a sudden fuel shortage.

Assuming that authorities will be unable to predict the length or extent of the disruption, infrastructure and service measures are likely to follow calls for voluntary action and precede regulatory enforcement. Central and local authorities will have to make a judgement regarding timing. However, given that the role of supporting infrastructure and services will become increasingly important during extended shortages (when regulations may have to replace calls for voluntary action) it is suggested that preparations are made as close to the start of the shortage as possible.

Table 8 outlines the range of infrastructure and services that could be deployed on short to medium notice given varying levels of base infrastructure and resources. It includes consideration of the following:

- **Public transport**—identifying opportunities to expand services and promote increased use through:
 - Facilities to provide information
 - Ticketing
 - Increasing services
 - Increasing public transport priorities
- **High occupancy vehicles**—Considering the provision of infrastructure, services, network support and incentives required to support multi-occupancy vehicles including:
 - Car parking requirements
 - Carpooling network services
 - HOV lanes

- **Travel to work, school and study**—measures to supply services and support networks to encourage cross-sector contributions to fuel efficiency.

Again Table 8 considers both central and local roles in infrastructure mobilisation and service provision. Given that service provision is, by its nature, locality specific, it is suggested that central government’s main task is to provides support, endorsements and resources where necessary. As in the case of communication and information provision, it is suggested that central government also provides guidelines to regional and local authorities to enable them to assess existing infrastructure and services and plan the mobilisation of further support as and when it is needed.

3.5.4. Supporting policy and regulations

National, regional, and local policies and regulations related to the use and mobilisation of infrastructure need to be reviewed to ensure they support voluntary behaviour change in an emergency. For example, during the recent Auckland bus strike, motorists were fined for using bus lanes. In a fuel shortage, provisions to enable van and car-poolers to use these lanes need to be considered.

Again, guidelines can be prepared by central government for regional and local authorities to assist them in reviewing their policies and regulations. In addition the guidelines could provide procedures for gaining approval for ‘emergency’ provisions if required.

Table 8 Strategies to support rapid voluntary behaviour change

	CENTRAL GOVERNMENT	REGIONAL AND LOCAL GOVERNMENT
COMMUNICATIONS		
Key messages	<i>Development of positive solution-orientated messages and information</i> Everything is under control Community-minded messages promoting individual responsibility for national benefit	<i>Key messages co-ordinated with central government to ensure consistency</i>
Procedural information	<i>Widespread promotion of solutions through printed and visual media using 'story telling' and 'behaviour modelling'</i>	<i>Distribution of location specific solutions including promotion of information outlets</i>
Avoiding travel	Health benefits of walking & cycling Walking school buses Teleshopping (where available) Telecommuting	Promotion of local activities and events Promotion of local walking school buses, including information on how to set up a walking school bus Negotiations with local shops to provide services and information where appropriate Work with local business to support telecommuting & provide information
Efficient driving behaviour	Recommended speeds, braking and acceleration practices, correct tyre pressure, identifying most fuel efficient car in household (as promoted by EECA) Distribution of household fuel-use charts (eg through national & local press) to monitor contribution to	

	CENTRAL GOVERNMENT	REGIONAL AND LOCAL GOVERNMENT
Journey planning	national effort Trip chaining - planning more tasks or linking tasks together for each trip	
Carpooling	Setting up a local carpool club	Information on undertaking 'safe' carpooling to work, school and shops Encourage setup of local carpool networks to work, school, study, shop and leisure
Public transport use	Promotion of public transport	Promotion of outlets for public transport timetables and journey planning information (eg Rideline)
Feedback	Continual updates / indicators of national progress	Regional indicators of progress
Communicating regulations	Clear and specific information on national regulations and enforcements as required	Information on regional / local regulations and enforcements
Celebratory messages	Celebrating achieved milestones / goals. Promoting individual stories and achievements	Celebrating regional contributions to national progress. Promoting local individuals' contributions
SUPPORTING INFRASTRUCTURE & SERVICES		
Public transportation	<i>Promote the development of supporting infrastructure and services. Consideration of subsidies where necessary</i>	<i>Strategies considered and co-ordinated with relevant authorities, service providers and institutions</i>
Information services		Increased resources and capacity for information centres
Ticketing	Consider subsidising public transport	Subsidised / free public transport services
Increasing services	Review regulations on mass-transit carriers	Identify extra vehicles for public transport use including potential licensing of private carriers Training stand-by mass-transit drivers
Increasing public transport priorities	Increasing road space allocation, and priorities for bus use, for roads under national authority Provision of national signage	Identifying local areas to enhance bus priorities Provision of local signage
High occupancy vehicles		
Parking	Encouragement of strategies as appropriate across sectors	Identifying and negotiate use of temporary local park and ride-share sites (eg supermarket car parks, transport centres)
Carpooling		Identify local hitching points on main routes to & from the CBD Provide networking resources for community carpooling including webspace and administration
HOV lanes		Review legislation enabling HOV use of bus-lanes
Travel to work, school & study		
Workplace	<i>Promotion of cross-sector contributions to fuel reduction</i> Promoting flexitime arrangements Promoting dedicated HOV car parking spaces Promoting telecommuting and teleconferencing	<i>Supporting and encouraging networks</i> Encouraging development of flexitime Encouraging revised car parking policies Working with businesses to identify 'hotdesk' sites and teleconferencing facilities for CBD based employees
School travel		Encouraging schools to develop carpool networks

	CENTRAL GOVERNMENT	REGIONAL AND LOCAL GOVERNMENT
	Travel to study	Working with colleges and universities to identify feasibility of on-line lectures Encourage student carpool networks
POLICY & REGULATION REVIEW	<i>Wide-ranging review of regulations and policies to enable rapid implementation of supporting strategies at national, regional, and local level.</i>	<i>Review of regional and local policies to enable rapid mobilisation of resources and adoption of supporting strategies.</i>

3.6. Efficient Rationing

One of the options for managing a fuel supply shortage is through rationing. In this section we examine the options and the ways in which rationing can achieve more or less efficient outcomes.

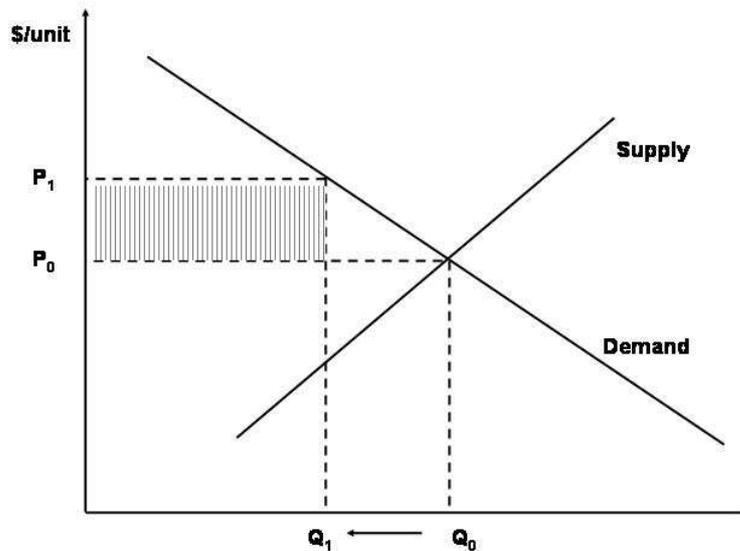
Rationing is efficient if the last person served has a higher valuation for the good than any people not served. This is illustrated in Figure 7, where the available quantity falls from Q_0 to Q_1 . As is standard in such diagrams, the units of demand are arranged along the horizontal axis from left to right in descending order of their valuation by customers. Considering the demand initially served before rationing (ie up to Q_0), consumers attach the least value to the quantities located between Q_0 and Q_1 . Rationing will be socially efficient (ie it will result in the smallest aggregate loss of surplus) if these are the users that remain unserved once rationing is introduced.

One way to achieve this outcome is to allow the price to rise to the point where the market clears at the available quantity. In Figure 7, this is P_1 . This so-called “price rationing” will generally be efficient. However it is likely to be politically difficult to achieve because it involves a potentially significant transfer from consumers to producers, equal to the area of the shaded rectangle in Figure 7. If producers are predominantly foreign this option will be even less tenable.

Price based mechanisms need not simply be aimed at fuel prices of course: other prices associated with different transport modes could be targeted. Some of these (eg bus fares, vehicle registration taxes) are feasible targets for government intervention. There are also circumstances in which the prices will rise: a worldwide shortage will cause higher world prices and these will flow through to the local market. While some price rationing can and will occur it has been argued³⁹ that additional price rationing could be difficult to implement during a short-term emergency when fuel costs may be rising rapidly.

³⁹ IEA (2005) Saving Oil in a Hurry: Measures for Rapid Demand Restraint in Transport.

Figure 7 Efficient Rationing



There may also be equity concerns with price-based rationing. The short run elasticity of demand for oil is quite low, around -0.1, reflecting the fact that many users have low levels of flexibility to change their behaviour at short notice.⁴⁰ For example, there may be many users who commute to work and have few realistic alternatives. Large price increases may eliminate much discretionary usage but impose a significant burden on working people.

For these reasons there is a practical interest in non-price rationing schemes that might approximate the efficient rationing objective.

3.6.1. Non-Price Rationing

There is an extensive existing literature relating to non-price rationing. Such rationing occurs routinely in the health care sector for example, where demand often exceeds supply at prevailing prices and waiting lists are consequently widespread. This differs from an oil supply disruption in two ways however. It is a chronic rather than acute issue, and it affects a subset of the population rather than everyone.

Rationing issues can also arise in financial markets, including the issuing of credit in developing countries and during banking crises. The latter is getting closer to an oil supply emergency but is critically distinct in having a significant moral hazard aspect. Specifically, response plans to cope with bank failure face the problem of how much protection to offer to depositors in failing banks without inducing the bank itself to take excessive risks ex-ante. This issue does not arise in the oil sector, or at least not to anywhere near the same degree. There is of course some direct experience with the rationing of oil products in New Zealand and elsewhere, as discussed in section 3.2.

⁴⁰ Griffin JM and Schulman CT (2005) Price Asymmetry in Energy Demand Models, *The Energy Journal*, 26(2), pp 1-21.

In light of this from prior experience, the options for non-price rationing of oil can be divided at a high level into two categories:

- **Allocation Mechanisms**, where constraints are placed on the volumes available to customers; and
- **Usage-based Mechanisms**, which focus on the consumption of oil as distinct from its purchase.

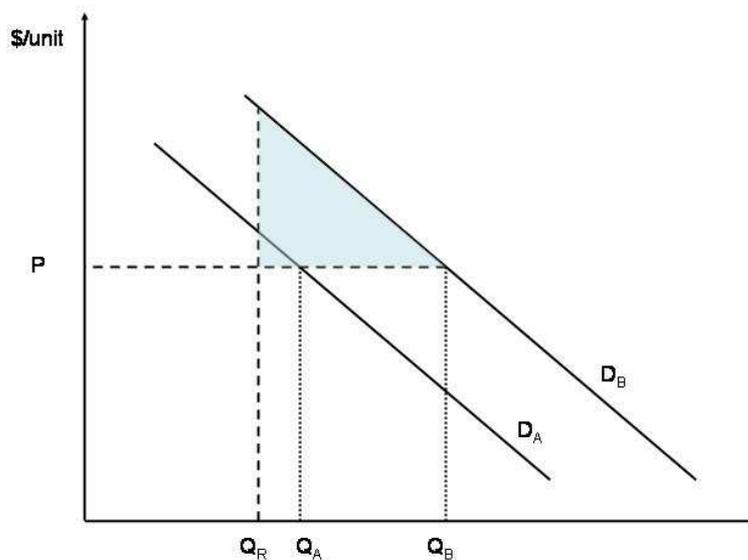
We begin by analyzing the efficiency properties of these general classes of rationing device.

3.6.2. Allocation Mechanisms

When allocation is constrained, users retain the flexibility to prioritise their own usage. By definition, the rationed allocation will be below normal requirements for many, if not most, users. These users can be expected to pay considerable attention to their consumption decisions. Within each allocation, rationing will therefore be approximately efficient.

The inefficiencies arise between allocations. The individual demand preferences of users varies considerably, and those with high valuations for large quantities would be located towards the left hand end of the horizontal scale in Figure 7. Constraining this demand in a similar proportion to less highly valued demand would introduce inefficiencies. The idea is illustrated in Figure 8 where there are assumed to be two types of user: A types who have low valuations and use low volumes at the prevailing prices, and B types who have the opposite characteristics. The diagram shows the weekly demand for petrol for each type of user, and a rationed quantity Q_R which restricts the allocation available to people of each type.

Figure 8 Inefficiency of Allocation Based Rationing



In this example, the area of the shaded triangle represents the surplus lost by each type B consumer, and the much smaller triangle located in the bottom left corner of this area represents the surplus lost by each type A user.

For the quantities of petrol between Q_A and Q_R far more surplus is lost from each type B user than from each type A user.⁴¹ Inefficiencies of this type could be substantially reduced if it was possible to identify the type B users and allocate them more, or to allow users to trade allocations. In this example, each user is allocated Q_R units of petrol per week. Type B users would be willing to pay enough to more than compensate type A users for some of their weekly entitlement. The resulting trades would increase the efficiency of rationing.

In practice, allocation systems rely on clear evidence of an allocation right, such as a ration card, possibly containing multiple units like a multi-trip bus ticket. An immediate issue arises as to the way such cards would be shared out. Equal rations to all vehicle owners is an obvious option, but may unreasonably penalise those who already economise on vehicles, such as large families with one vehicle. Equal rations to all persons above a certain age would better reflect the fact that transport services are needed and desired by individuals, whereas vehicles are an intermediate input into those services. We discuss these issues in more detail in section 4.9.

3.6.3. Usage-based Mechanisms

The efficiency of usage-based rationing devices relies on accurate centralised assessment of the value of particular uses. Mechanisms in this category include:

- Prohibitions on motor sports such as car racing and pleasure boating;
- Implementing lower speed limits on highways;
- Cancelling other forms of fuel-intensive recreation, such as weekend sports;
- Day of the week restrictions on using private motor vehicles; and
- Mandatory car-pooling during rush hours.

It is difficult to argue that such measures are even approximately efficient. I may derive the same amount of enjoyment from taking children to sports games on weekends as you do from going to the movies on a Wednesday evening. If these use the same amount of fuel, then there is no efficiency reason to prohibit one and not the other,⁴² nor to exclude from prohibition a much wider range of recreational activity, such as book clubs and card evenings and musical concerts and visiting art galleries.

This analysis suggests that usage-based mechanisms could be reasonably efficient if they were extremely severe. For example, if we were to ban the use of private motor vehicles completely, or allow them to be used only one day per week. In such cases, an entire class of demand is eliminated, so we need be less concerned about making efficiency distinctions within that class.

⁴¹ This does not imply that it would be efficient for type A users to make all of the savings.

⁴² One could make efficiency distinctions if it was much easier to ban sports games than movie screenings, but this seems unlikely.

3.6.4. Moral Suasion

So far, we have only considered rule-based mechanisms. Experience in other shortage situations shows that advertising campaigns are frequently used. Indeed, even if a rule-based mechanism is used there would probably need to be an education (advertising) campaign alongside it. We should therefore consider moral suasion without rules as an option.

From a pure efficiency standpoint, moral suasion has some attractions. Just as people vary in their sensitivity to price, people also vary in their sensitivity to guilt. In the face of an openly declared national need to conserve oil, but a complete absence of rules enforcing particular measures, some will make greater savings than others. Other things equal, the greatest savings will be made by those for whom the value of using oil is lowest. The fact that some people simply will not care is unfortunate from the perspective of total stocks, but it does indicate that they would need to experience significantly greater levels of social opprobrium before being inclined to moderate their behaviour. Putting up with guilt is a form of cost, to which some people are more sensitive than others.

3.6.5. Transactions Costs

The cost of implementing any rationing scheme is an important consideration. We have noted that all non-price rationing schemes will require a publicity campaign. There is no reason to suppose that such a campaign would be much more costly for some forms of rationing than others, and indeed even price-based rationing would probably require some form of public information programme. So our working assumption is that advertising costs are essential and common to all forms of rationing.

Rationing through usage based schemes is likely to be less costly than allocation schemes. The direct costs of usage rationing are mainly enforcement costs the intensity of which is a decision variable: with relatively low-level enforcement, a usage based scheme will appear more like a pure moral suasion method. Formal allocation systems require several ex-ante costs, some of which could be substantial. Some form of ration card (or other identifier) would need to be produced and distributed to all eligible persons, and a backing system for redemption of allocations (or part thereof) would also need to be established.

3.6.6. Summary

Price rationing is generally efficient but (apart from purely internal disruptions) oil prices will in any event be rising during an emergency. Price rationing also raises some equity concerns regarding the sharing of the burden across the population and may impose a relatively heavy financial burden on the working population. For these reasons, there is an interest in non-price rationing.

All non-price mechanisms would require a publicity campaign. A pure appeal for savings is likely to be quite efficient and to have no greater cost than any other non-price method. Usage based schemes vary in their efficiency and have costs which are primarily enforcement related. For some such as lower speed limits, enforcement costs

are already being paid and these would therefore be sensible starting points. Allocation based savings schemes require considerable up-front cost and may therefore be better viewed as a lower priority device.

3.7. Lessons for Oil Demand Restraint

This section has provided a wide range of experience that is relevant to the development of a Response Manual.

The review of the UK crisis provided evidence of the types of changes that people made voluntarily. This serves as a useful guide for the types of reductions in vehicle use that would result if there was a crisis in New Zealand and in response to calls for voluntary reductions. However, this experience also highlighted the risks of hoarding and how this response can turn a potential crisis into an actual crisis.

A review of the recent IEA output—*Saving Oil in a Hurry*—provides a long list of suitable measures, some of which build off the UK experience. We use this list as the basis for analysis of potential reductions in the next section.

The UK's Emergency Response Manual has been described. It provides information on institutional arrangements, communications strategy, requirements for a system of rationing (including a list of priority users) and a number of compulsory and persuasive measures.

The review of electricity and drought planning revealed a common pattern of emergency plans. They shift from calls for voluntary restraint through to more mandatory reductions. However, throughout, there is a requirement for effective monitoring and good communication. This is likely to be a useful pattern for oil demand restraint, although the risks of hoarding that could rapidly escalate the crisis, is noted.

Another message coming through the work on water efficiency is the difference seen between conservation programmes and the longer term measures aiming to achieve sustainable water use. However, although reducing baseline demand may make New Zealand less vulnerable, it makes achieving a required additional 7% of savings below the baseline much more difficult. This is a somewhat perverse complicating factor of the IEA's chosen approach.

Theoretical work on behavioural change revealed the kinds of messages that would be required in order for voluntary change to be most effective. It also highlighted the need for preparatory work and raised issues of trust that will need to be considered in deciding who best to manage the crisis.

Rationing is a last resort. A review of alternative approaches highlighted the potential efficiency impacts, particularly the risks of allocating supplies to those that do not value them highly. In the next section we explore options for introducing some tradable element of a rationing regime.

4. Restraint Options

4.1. Introduction

This section provides a discussion of the potential options for oil demand restraint in New Zealand. It begins by examining relevant data on the use of oil, starting at a sectoral level and then providing more detailed analysis for private transport, using the New Zealand Travel Survey.

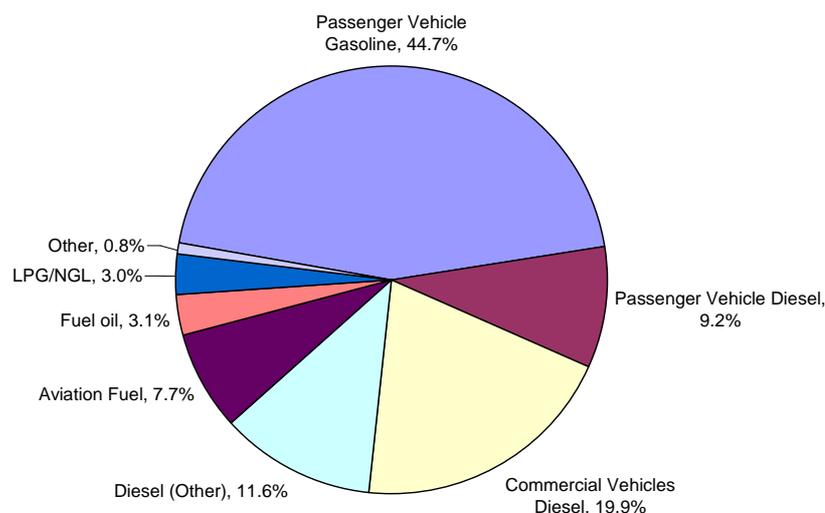
The results of the previous sections are used to scope the kinds of instruments that might be adopted and this, in combination with the data, is used to estimate potential demand reductions achievable.

4.2. Oil Demand in New Zealand

The NZIER review⁴³ of demand restraint measures noted the value of focussing on large users of oil and those with elastic demand, eg because of available substitutes.

Figure 9 shows estimates of the current consumption of oil products in New Zealand.⁴⁴

Figure 9 Consumer Demand of Oil Products in New Zealand



Source: Ministry of Economic Development (2005) Energy Data File January 2005. Energy Supply and Demand Balance September Year 2004; Hale & Twomey

Approximately 75% is for domestic transport use and another 8% for aviation. Other uses of diesel, eg for small generators, make up the remaining large use category.

⁴³ NZIER (2004) Oil supply disruption demand restraint measures. An overview of options for restraining demand. Report to the Ministry of Economic Development.

⁴⁴ In producing this, diesel for domestic transport (30.7%) has been split into commercial vehicles (65% of 30.7% = 19.9%), passenger vehicles (30% of 30.7% = 9.2%) and other (1.5%); the latter is included with Diesel (other).

Consistent with the IEA's *Saving Oil in a Hurry* report, the focus of our assessment of options is on transport use of oil, particularly passenger transport.

Measures aimed at reducing domestic transport demand could take effect through two possible channels:

- decreasing fuel consumption by reducing aggregate demand for travel; and
- holding aggregate travel demand constant, but increasing its efficiency. This might be through greater vehicle occupancy or shifting travel to more efficient vehicles or transport modes (public transport).

In this section we bring together data that can illustrate the likely oil demand reductions that can result from targeting these different types of restraint. To do this, we examine the proportion of trips and trip lengths that fall into each category, using data from the New Zealand Travel Survey (NZTS).⁴⁵

4.2.1. Discretionary Travel

Work on elasticities suggests very low price elasticities of demand for transport fuel. However, there is other work that provides a more complete picture. Michelini⁴⁶ has worked on New Zealand household consumption patterns. He uses Household Expenditure Survey (HES) data from 1983 to 1992 to estimate a series of household demand equations. These show how demand for goods and services are related to prices and household income changes.⁴⁷

Table 9: Michelini Estimates of Income Elasticity

Expenditure Group	Income Elasticity
Food	0.558
Household Operation	0.747
Apparel	1.110
Transport	1.276
Other Goods	1.095
Other Services	1.321

Source: Michelini C (1999) *New Zealand Household Consumption Patterns 1983-1992: An Application of the Almost Ideal Demand System*", N.Z. Economic Papers, 33 (2), 15-26

Michelini used these household demand equations to derive the income elasticity estimates shown in Table 9. These show how consumption of each of the major expenditure categories in the HES change as household income changes. All elasticities are positive, which means that consumption of each item increases as income increases, and vice versa. Moreover, elasticity is lower for truly essential items, such as food and household operation. The elasticity of transport is higher than that of all other items

⁴⁵ First conducted in 1989/90 and repeated in 1997/98, the NZTS is the most comprehensive survey of New Zealander's travel patterns.

⁴⁶ Michelini C (1999) *New Zealand Household Consumption Patterns 1983-1992: An Application of the Almost Ideal Demand System*", N.Z. Economic Papers, 33 (2), 15-26

⁴⁷ Michelini excluded the Housing expenditure group because (at that time) it covered the sale and purchase of property and distorted the analysis. This omission may distort the analysis.

apart from ‘other services’. This indicates that as income falls, transport expenditure will be cut more heavily than most other categories, and vice-versa.

To identify the types of travel that might be more discretionary, we examine the New Zealand Travel Survey (NZTS). One of the primary questions asked by the NZTS is trip purpose. This is taken from the driver’s perspective and is restricted to one of the following:

- Home
- Work - main job
- Work - other job
- Work - employer's business
- Education
- Shopping
- Personal business or services⁴⁸
- Social/ recreational
- Accompanying someone else

Some of the categorisations are ambiguous and confound the clarity of responses. For instance, the category “Home” covers all trips for which the destination is the respondent’s home. This may include trips returning from work, sport or education. Similarly, the category “Accompanying someone else” covers all situations where the primary purpose is to transport someone else. For instance, if a parent drives their child to school, the trip is recorded as “Accompanying someone else” rather than “Education.” We have elected to remove these two categories from the analysis to eliminate ambiguity.

Once these two categories have been removed, the remaining categories can be grouped as in Table 10 to distinguish discretionary trips from non-discretionary ones.

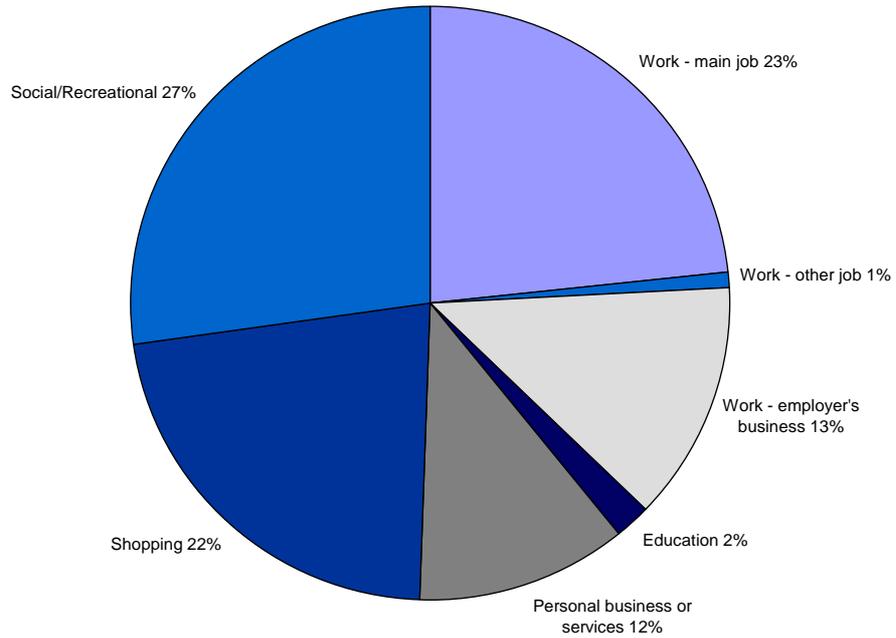
Table 10: Categorisation of Trip Purpose

Category	Reason for Trip
Non-Discretionary	Work - main job
	Work - other job
	Work - employer's business
	Education
	Personal business or services
Discretionary	Shopping
	Social/Recreational

Using the categorisations in Table 10 and the trip shares presented in Figure 10, we can see that 51% of driver trips are discretionary and 49% could be described as non-discretionary. This classification is approximate only, since some shopping is non-discretionary and some people have discretion as to how and when they travel for work, education or personal business.

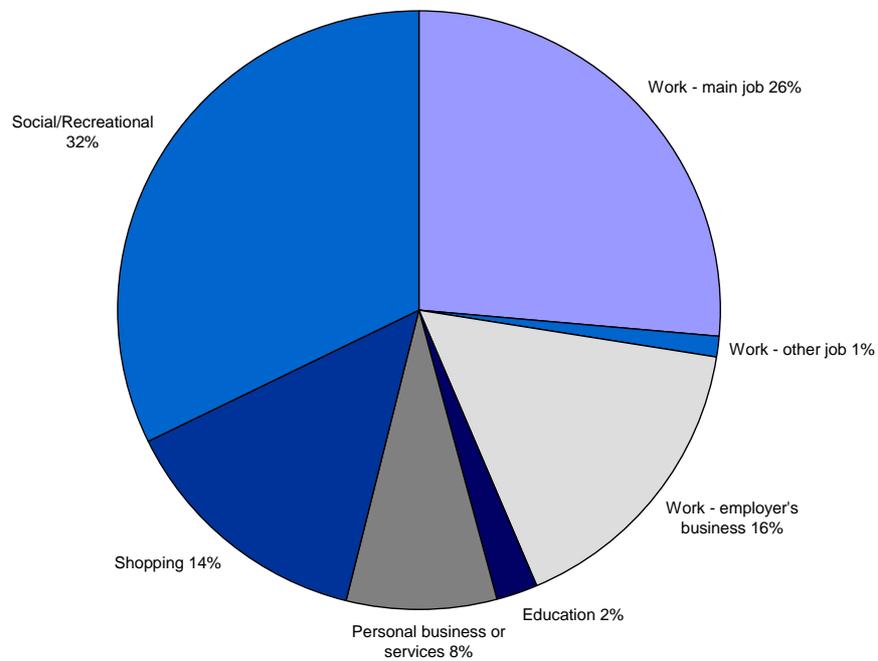
⁴⁸ This includes trips for medical, dental and social welfare purposes.

Figure 10: Shares of Driver Trips by Purpose



However, the most important indicator of scope to reduce aggregate travel demand is perhaps not the proportion of trips that are discretionary, but the proportion of total kilometres travelled that are discretionary. The latter is presented in the figure below

Figure 11 Shares of Kilometres Driven by Purpose

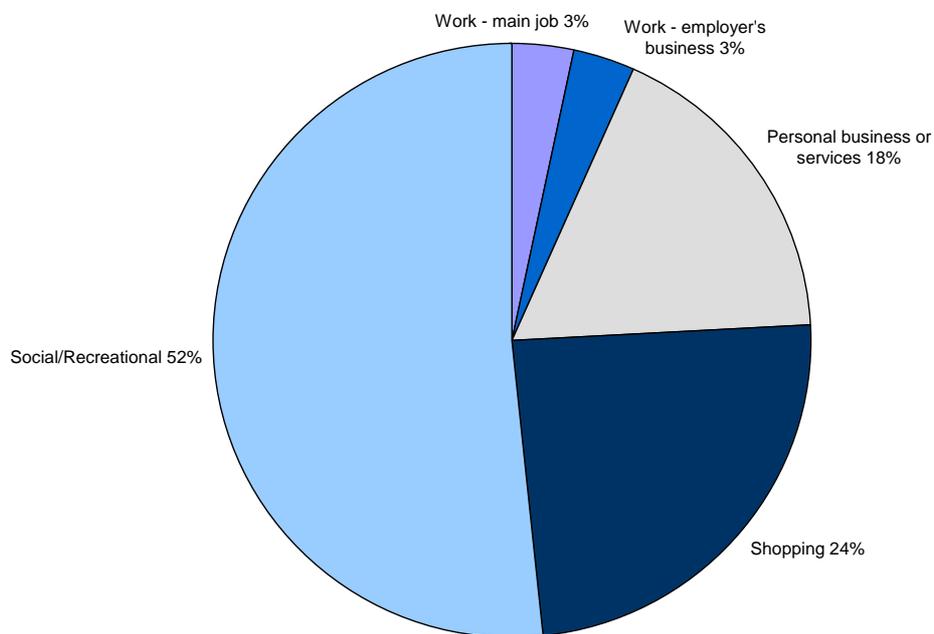


According to Figure 11, 54% of kilometres travelled are for non-discretionary trips and 46% are for discretionary trips. Hence, while not as high as its share of total trips, discretionary travel accounts for nearly half of total kilometres travelled.

Discretionary Travel of Older Drivers

As one might expect, the travel patterns of older drivers differ from those of the general driving population. In particular, discretionary trips make up a higher proportion of total trips (and kilometres travelled) for older drivers. This is illustrated in the figure below, which shows the shares of total kilometres driven for various trip purposes by people aged 65 years and older.

Figure 12: Shares of Kilometres Driven by Purpose (Drivers 65 years +)



Using the categorization of trip purposes in Table 10, Figure 12 reveals that 76% of kilometres driven by people aged 65 years and older are for discretionary reasons. While this high propensity for discretionary travel may lead policy makers to consider this age group a natural target for policy initiatives, these results need to be put in context. Although over three-quarters of kilometres driven by drivers aged 65 years and older are for discretionary purposes, this age group account for only 9% of total trips and 7% of total kilometres travelled. Thus policies aimed reducing travel demand within this group may not yield significant reductions in total fuel consumption. Moreover, there may be significant social costs associated with curbing the travel patterns of this group as that they do not venture out as often as younger people and trips outside the home are highly valued.⁴⁹

⁴⁹ In future, however, as the population continues to age, this age group will account for increasingly higher shares of total travel and may therefore become an important target for policy intervention.

4.2.2. Low Occupancy Vehicles

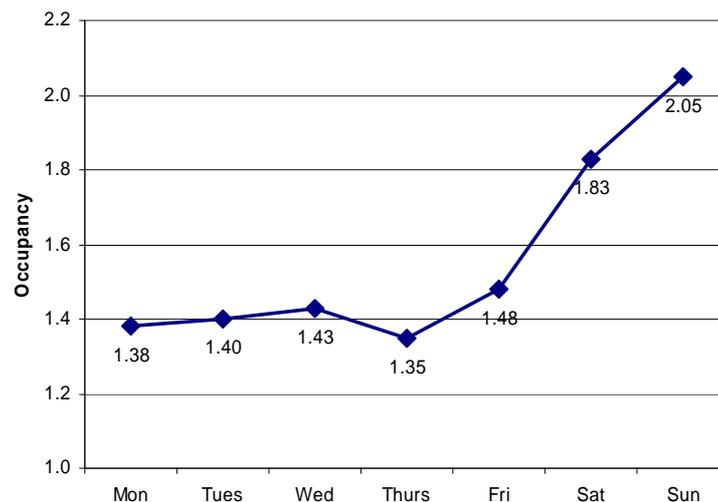
Having considered the extent to which travel is discretionary or non-discretionary, we now analyse the occupancy characteristics of New Zealand private vehicle travel. The basic hypothesis here is that, regardless of whether travel is discretionary or non-discretionary, there may be scope for reducing fuel consumption if a trip is made in a low occupancy vehicle.

Although the official NZTS report for 1997/98 provides little detail on occupancy characteristics, the underlying dataset is very rich. This has allowed a recent research team to link survey responses for drivers and passengers at the unit-record level and provide detailed insights to the occupancy characteristics of New Zealand private motor vehicles.⁵⁰ This section summarises the key results of that study.

Day of Travel

The first set of results presented in the paper by Sullivan and O'Fallon relate vehicle occupancy to the day of travel. Their results are replicated below.

Figure 13: Occupancy by Day of Week



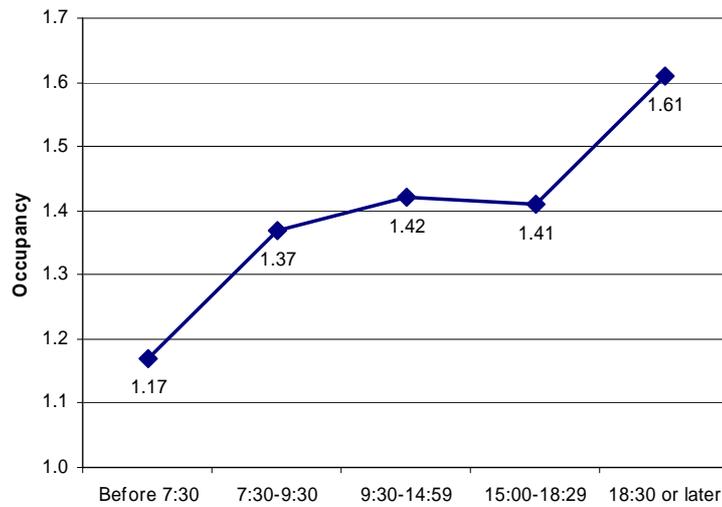
As shown in the graph above, occupancy is much higher on weekends than it is on weekdays. This led the researchers to focus on weekdays in the remainder of their analysis. By default, this means that the remainder of this section is also restricted to weekdays.

Time of Travel

The next consideration was the effect of travel time on vehicle occupancy. The results are shown in Figure 14.

⁵⁰ "Vehicle occupancy in New Zealand's three largest urban areas" by Charles Sullivan and Carolyn O'Fallon. Available on the web at: http://www.pinnacleresearch.co.nz/research/vehicle_occupancy.pdf

Figure 14: Occupancy by Leaving Time (Weekdays Only)

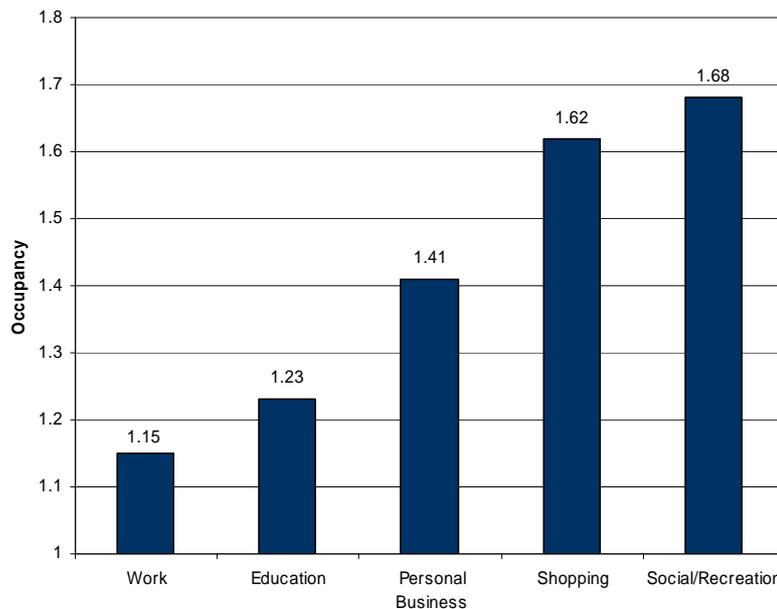


Average occupancy starts low for early morning trips (*ie* trips commenced before 7:30am) and generally increases throughout the day. Trips made after 6:30 pm have significantly higher occupancies than those made early morning. This reflects the impacts of typically low-occupancy work-related trips, which are far more common in the early morning trips than they are in the evening.

Reason for Travel

Figure 15 shows how weekday occupancy varies with trip purpose.

Figure 15: Weekday Occupancy by Trip Purpose

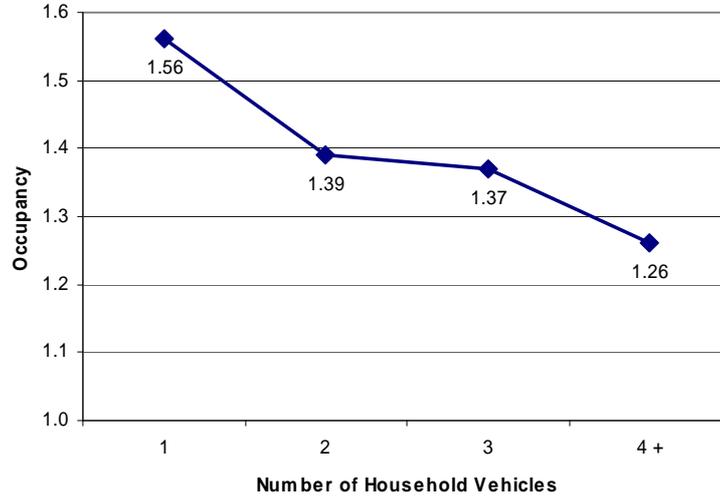


As one might expect, occupancy is lowest for work- and education-related trips and highest for socially-oriented trips.

4.2.3. Number of Vehicles

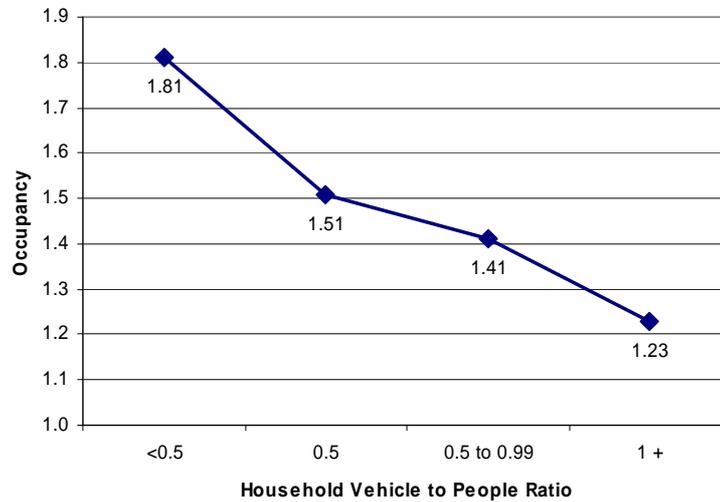
Somewhat intuitively, average occupancy decreases as the number of vehicles in a household increases. This is illustrated in Figure 16.

Figure 16: Occupancy as function of Household Vehicles



However, more important than the number of household vehicles, is the ratio of vehicles to people. Figure 17 illustrates this point.

Figure 17: Effects of Vehicle to People Ratio



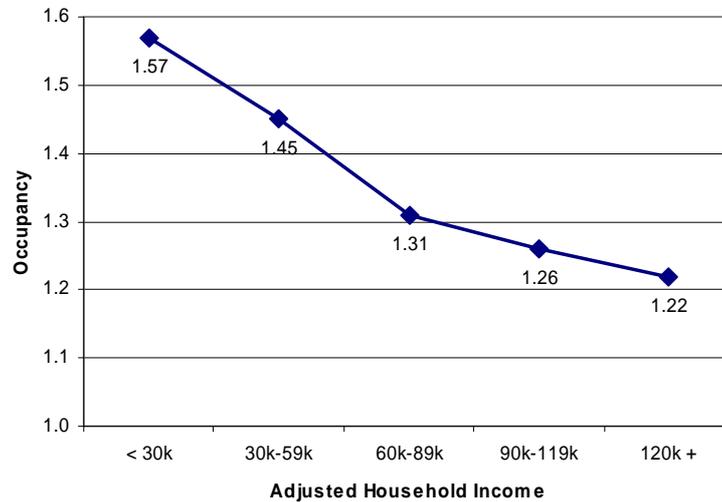
The figure above clearly demonstrates that the vehicle to people ratio has a profound effect on average occupancy levels.

4.2.4. Household Income

With values ranging from 1.47 for the lowest income group to 1.34 for the highest, household income has seemingly little effect on occupancy. However, this is because the

effects of household size have not been controlled for. Once the revised Jensen scale (a standard method for adjusting household income to reflect household size) has been applied, the effects of income become more significant. This is shown below.

Figure 18: Occupancy by Adjusted Household Income



Summary

The work of Sullivan and O'Fallon suggest that vehicle occupancy is:

- higher on weekends than weekdays
- lowest in the morning and increases throughout the day
- much lower for non-discretionary activities than discretionary ones
- similar for males and females
- lower for Europeans than Maori or Pacific Islanders
- increasing in the number of children in a household
- highest for households with a low vehicle to people ratio
- higher for lower-income households

4.2.5. Additional Policy Options

In addition to reducing demand for discretionary travel and encouraging greater vehicle occupancy, there are at least two other possible policy channels available for reducing fuel consumption. First, policies could try to encourage multi-car families to increase the relative usage of their most fuel-efficient vehicle. Second, policies could try to encourage greater use of more fuel-efficient transport modes, such as buses and trains. Both these possibilities are discussed below.

Switching to most Fuel-Efficient Vehicle

According to the 2001 Census, over 630,000 New Zealand households (47%) own more than one vehicle. Thus there may be scope for reducing fuel consumption if policies can somehow encourage households to increase the relative usage of their most fuel-

efficient vehicle. Of course, the extent to which this actually occurs depends, amongst other things, on the willingness of households to reconfigure vehicle usage.

Assuming for now that at least *some* household reconfigure vehicle usage, the logical next question is 'how much fuel could be saved?' Intuitively, this depends on how much more efficient each multi-vehicle household's most efficient car is relative to its least efficient. Unfortunately, however, no reliable estimates of these relativities exist.

In the absence of any local data and for the purposes of illustration, we analysed data from the United States Department of Energy to examine the extent to which vehicle characteristics affect fuel economy. Our analysis showed that, holding all other factors constant, fuel economy is improved by using vehicles that are:

- newer;
- lighter;⁵¹
- smaller engine size.⁵²

Thus, if households substitute towards driving their newest, lightest or smallest engine vehicle, fuel consumption will be reduced. Such substitutions may be able to be induced through well-structured information campaigns.

Switching to more Fuel-Efficient Transport Modes

A final policy option to consider is encouraging commuters to switch to more fuel-efficient transport modes, such as buses and trains. This policy focus will be particularly effective if it targets trips made in low-occupancy vehicles. As shown earlier in this section, low occupancy trips tend to be those that start early on weekdays and for which the primary purpose is travelling to work or education.

Unfortunately, however, these types of trip are not particularly responsive to initiatives aimed at switching transport modes. As summarised by O'Fallon *et al*, this is because private vehicles are often more attractive for such trips because of the:⁵³

- use of company-owned vehicles, which reduces private travel costs
- convenience of on-site parking at work
- need to use a vehicle during the day for work-related purposes

These reasons, combined with perceptions of inadequate public transport systems, suggest that it may be difficult to achieve large fuel savings in New Zealand using hastily deployed mode-switching policies.

⁵¹ The United States National Highway Safety Traffic Administration reports that each 10% reduction in weight improves the fuel economy of a new vehicle design by approximately 8%.

⁵² Our analysis revealed that, for brand new 'compact' cars using regular petrol, 1.3 litre vehicles have 17% better fuel economy than 2 litre vehicles and 52% better economy than 3 litre vehicles.

⁵³ *Understanding Underlying Constraints Affecting Decision-Making by Morning Car Commuters* by Fallon, et al, available on the web at: http://www.itls.usyd.edu.au/publications/working_papers/wp2002/ITS-WP-02-13.pdf

However, encouraging shifts to public transport should be included in any public information campaigns, including shifts in work day hours to minimise public transport congestion.

4.3. Components of a Response Plan

4.3.1. Transition from Voluntary to Mandatory

The analysis in Section 3 has identified a wide range of options that might be used to reduce demand for oil in a hurry.

The experience with other commodities, and the recommendations for handling an oil crisis, suggest an approach that involves a transition from measures that encourage voluntary restraint, to mandatory requirements, depending on the severity of the problem. Monitoring on a regular basis would be used as the basis for a decision on when to shift from one phase to another.

4.3.2. Handling the Hoarding Risk

However, there is a risk for oil that was made clear through the UK crisis and does not apply to other commodities. This is of fuel hoarding. Once there is some inkling of a fuel supply crisis, many fuel users may be tempted to fill their tanks. Typical daily sales of petrol and diesel for passenger vehicles are approximately 10 million litres. If we assume a typical petrol tank size of 50 litres and that they are typically one third full,⁵⁴ filling 3 million vehicles would require approximately 100 million litres, equivalent to 10 days worth of typical sales. This could have considerable impact on the fuel distribution system and would lead to shortages in most parts of the country.

One option to deal with this risk is to immediately bring in some kind of restriction on fuel sales, possibly as a sales minimum. This ensures that users can still obtain fuel but also ensures that those with tanks partly full cannot all fill their tanks. The question of whether to introduce such an immediate step depends on an assessment of relative risks. On the one hand it might be seen as an over-reaction to a situation that is not yet a crisis. On the other hand, if the measure is not taken and panic sets in, eg in response to media reaction, there is a risk of a crisis developing when before there wasn't one.

4.3.3. Overall Structure of a Restraint Plan

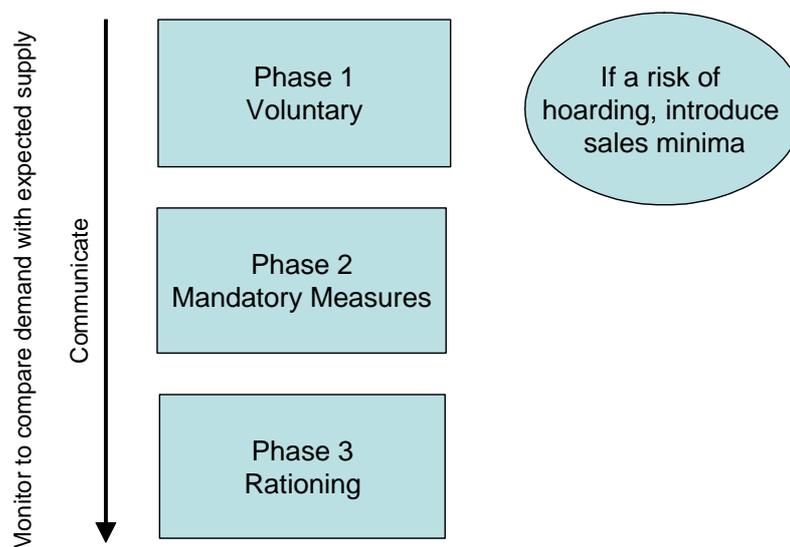
The potential components of a plan are set out in Figure 19.

The different components are discussed in turn below. Other key questions that will need to be determined include those relating to the definition of roles, and specifically:

⁵⁴ If everyone refuelled when they were empty and completely filled their tanks then an assumption of half full might be more appropriate, but many will purchase smaller amounts, eg \$20 worth. We assume that tanks will be, on average, less than half full; one third is an arbitrary estimate.

- whether primary responsibility for managing the programme will rest with government or with industry; and
- the extent to which central government specifies actions or leaves more decisions to be made locally, eg working with local government.

Figure 19 Components of a Restraint Plan



4.4. Roles

4.4.1. Government or Industry?

The question of whether to have the programme coordinated by government or by industry will be an important decision and one that needs to be tackled early in the programme, ideally in advance of any supply threat. It is partly based on questions of trust—who will the public be most likely to believe and respond to? And partly a question of access to information or to the key decision makers.

The question of trust is one that applies both to the direct communication between the government and the public but must take account of the role of the media as a go-between. A crucial component of the programme throughout will be providing consistent and clear messages to the public. If there is a risk that this will be distorted by the media, eg because they wish to pursue some other agenda, handing control over to industry will be an important step.

These decisions require early and brutal honesty amongst the government decision makers. The risks involved are likely to be ones that politicians are very used to weighing up and dealing with.

The question of relationships will depend on the way in which the communications plan will run. But oil companies will have a number of advantages over the government:

- they will be used to making regular use of adverts, although this might not be a large consideration because of the availability of professional help via PR companies and advertisers;
- they will clearly be better placed to provide information at the point of sale—petrol station forecourts.

The other issue is the extent to which the crisis will need to involve coordination amongst the whole supply chain, eg from refining to sales. Here, the oil companies will be much better placed to coordinate activities.

Most likely a coordinating body will need to be established immediately involving government and industry representation. Usefully this could be coordinated by industry.

4.4.2. Working with Local Government

A number of the voluntary measures that will be encouraged will need to be coordinated or implemented by local government. This might include decisions over lanes to be converted from bus-only to multi-occupant vehicle use, information provision through existing channels (including websites), banning vehicles from certain roads and so on. This work could either be done through direct instruction, or more suitably, through encouraging local government to make some local decisions about the most appropriate steps, guided by documents supplied by central government. This might, for example, provide local government with a tool-kit of things that could be introduced locally.

It would also be useful to provide monitoring data locally so that local governments can track progress and it introduces an element of competition that might provide useful motivation.

4.5. Monitoring

Monitoring will be required throughout the programme to compare expected levels of demand with supply. The key component of this will be estimates of:

- demand relative to a counter-factual, to estimate whether demand reductions are being made;
- expected supplies, including the location of product at sea and expected delivery times.

This information is required partly as the basis for setting in train the different phases of the programme, and partly to provide information to inform the public of progress. As for the save 10% electricity campaign, it would be useful to convert this information into some overall measure of risk that could be easily communicated and would drive the public response, particularly in the voluntary phase.

We recommend that MED discuss with the oil industry administrative arrangements to monitor oil demand during any restraint period. In our view the industry would be

best placed to provide the most immediate data on changes in demand, either at the retail site level or from offtake figures from bulk storage terminals.

4.6. Communication

Good communication will be required throughout the programme to:

- encourage demand responses by the public;
- limit the likelihood of panic and resulting incentives for hoarding; and
- provide clear instructions on what to do.

The communications plan will require a number of elements. These will include:⁵⁵

- roles and responsibilities for actions;
- success criteria and evaluation methods;
- activities for monitoring delivery and success;
- identifying existing support materials and any further requirements;
- an estimate of the required budget;
- an assessment of staff resource required; and
- ensuring that those people nominated for media training are given priority to enable media interviews to be undertaken as and when required.

From the public's perspective, it is likely to include:

- TV advertisements/infomercials; and
- Brochures available at petrol stations presenting clear information.

Obvious questions will need to be addressed relating to the language requirements and the detail to be provided.

4.6.1. Key Messages

Key messages that will need to be communicated will include:

- Information on the state of the problem;
- Information on what to do;
- Public reassurance that the crisis is under control.

It will require use of several media, including TV, radio and print media. In addition, the AA has

4.6.2. Costs

The save 10% campaign had a budget of approximately \$4 million, approximately \$2 million of which was spent on communications.⁵⁶

⁵⁵ http://www.environment-agency.gov.uk/commondata/acrobat/sth_dp_2003_651878.pdf

⁵⁶ Cory Franklin, Contact Energy Marketing Manager, personal communication.

It is likely that an Emergency Response communications strategy will cost at least this amount, ie \$2 million.

4.7. Voluntary Phase

In the voluntary phase of a restraint programme appeals would be made to the public to make a number of constraints. These are set out in turn below, alongside estimates of their costs and effectiveness. Greater detail on practical implementation of these options is included in Section 5.

4.7.1. Carpooling

Component	Comment
Description	<p>Carpooling or ride-sharing policies designed to increase vehicle occupancy and thereby reduce the number of vehicle kilometres travelled (VKT). Policy would be directed at commuters with the types of policies dependent on the nature and extent of the supply emergency. Specific approaches could range between:</p> <p>Encouragement/exhortation to carpool by way of publicity campaigns based on the need to save fuel (increasing fuel prices in themselves could induce commuters to take up more car pooling)</p> <p>Creating carpool only lanes on motorways/sharing with bus only lanes to provide commuters with the benefit of faster trip times. An extra inducement would be to offer benefits such as free or subsidised parking spaces</p>
Legislation required	<p>None for voluntary response, although there may be a requirement for some change to the Transport Services Licensing Act 1989 that currently requires licensing of transport services. Some car pooling schemes will fall under this and will not be authorised currently.</p> <p>Regulations covering road use/use of park and ride areas and ability to subsidise designated commercial parking operators for loss of income</p>
Time to implement	Based on the need to carefully design each programme specific legislative requirements would set up on an "as needed" basis. However time would be required to convert motorway signage and lanes although this could also be done before hand.
Investment Required	Minimal investment for public information campaigns; prepared road signage/lane marking; partial and full subsidy of eg parking , with highest cost for direct subsidy
Central/local Govt	Both would need to be involved. Central government would need to coordinate the publicity campaign plus establishment of car lanes (if appropriate) on State Highways. Local government would need to be involved in assigning car pool lanes on local roads.
Information Communication	Comprehensive information campaign (all media advertising combined with Internet based information sharing to match rides with commuters, eg using www.carpoolnz.org or www.carshare.co.nz)
Perverse Outcomes	<p>Potential incentives to encourage commuters away from public transport alternatives, undermining public transport</p> <p>Potential for greater distances to be travelled picking up car-poolers</p>
Expected Costs	Part of total communications plan budget. Additional costs for signage and local publicity of car-pool lanes
Expected Benefits	1.2% saving in aggregate oil demand (see Annex for calculations)
Time to achieve benefits	Will require some time for individuals to associate with others to achieve car pooling. Is likely to take 2-3 weeks to achieve targeted reductions.
Effectiveness over short/long term	Effectiveness likely to increase gradually as behavioural responses adjust to persuasion/exhortation to more valuable financial incentives
Effectiveness for severity of disruption	Probably best if used for specific events rather than always encouraged. Success may depend on altruism of commuters to respond to crisis, although crisis itself may increase price which will add to response

4.7.2. Telecommuting

Component	Comment
Description	In an emergency telecommuting can be encouraged as a way to avoid journeys and save fuel. While there are employer issues such as management of employees who telecommute some of these concerns might be set aside in an emergency situation. Telecommuting is only feasible for the proportion of the population whose work allows such a change. NZ has some experience of increase in telecommuting during the Auckland Power Crisis in 1996.
Legislation required	None
Time to implement	Public Information Campaign – could be available in advance.
Investment Required	Will be more effective if there is greater access to computers and broadband services at homes.
Central/local Govt	Both to encourage
Information Communication	Need Public Information Campaign. May also to have prior discussions with employer groups to see how they might assist in a campaign and what issues are important for them.
Perverse Outcomes	Data shows that telecommuters normally increase other travel offsetting the benefits of the work trip saving. This effect has been built into the savings assumption although we would expect it to be low in an emergency situation compared to normal telecommuting.
Expected Costs	Cost of Public Information Campaign
Expected Benefits	0.4% saving in aggregate oil demand (see Annex for calculations)
Time to achieve benefits	It would take some time for people to organise their work so they could telecommute. We would expect that it would be two weeks at least before the full benefits would be achieved.
Effectiveness over short/long term	Telecommuting is likely to be more effective in the short term as over the long-term issues over management of employees is likely to become more significant. We would expect the benefits to start reducing after one month although there could be some long-term benefits from some employers/employees permanently changing work structures.
Effectiveness for severity of disruption	Telecommuting should be effective for any severity of disruption.

4.7.3. Tyre Pressure

Component	Comment
Description	Vehicles are more fuel efficient when their tyres are at optimal pressure. Optimal pressure reduces rolling resistance. Studies have found that on average the tyres of vehicle fleets are under pressure by on average about 3 PSI. A campaign to encourage people to have the correct pressure will save fuel.
Legislation required	None
Time to implement	Public information Campaign – could be available in advance.
Investment Required	None
Central/local Govt	Own vehicles
Information Communication	Need Public Information Campaign. May also need to have preparations in place with petroleum retailers because of the expected upsurge in use of tyre filling facilities.
Perverse Outcomes	People fill their tanks because they visit service stations
Expected Costs	Cost of Public Information Campaign
Expected Benefits	1.4% saving in aggregate oil demand (see Annex for calculations)
Time to achieve benefits	The public information campaign will take time to build up and not everyone will be able to fill their tyres immediately. We assume that the savings build up to

Component	Comment
	the full amount over the two weeks following the campaign introduction.
Effectiveness over short/long term	This would be expected to be more effective over the short term although once tyres are inflated correctly the benefit should remain for a reasonable period. Over the longer term the campaign may need to be reprised to continue the emphasis.
Effectiveness for severity of disruption	As the consumer gets a benefit this campaign should be applicable for any sort of disruption event.

4.7.4. Compressed/flexible Work Week

Component	Comment
Description	Compressed or flexible work weeks are designed to reduced the number of trips per week or avoid travel in peak times reducing congestion (both vehicle and public transport). Compressed work weeks have the most benefit in an emergency situation as actual trips are saved. Generally the 4/40 (working normal 40 hours per week in four days rather than five) is the most popular of the compressed work week options.
Legislation required	None (but a policy of encouraging employers to be flexible is needed)
Time to implement	Public Information Campaign – coordination with employers and employer groups.
Investment Required	None
Central/local Govt	To act as examples
Information Communication	Need Public Information Campaign. May also need to have prior discussions with employer groups to see how they might assist in a campaign and what issues are important for them.
Perverse Outcomes	Data shows that no-work travel increases on the off work day partially offsetting the benefits. This effect has been built into the savings assumption although one would expect it to be low in an emergency situation as opposed to normal compressed weeks.
Expected Costs	Cost of Public Information Campaign
Expected Benefits	0.2% saving in aggregate oil demand (see Annex for calculations)
Time to achieve benefits	It would take some time for employers and employees to organise the work so compressed weeks were an option. We would expect that it would be two weeks before the full benefits would be achieved.
Effectiveness over short/long term	A compressed working week is likely to be more effective in the short term as, over the long-term, work organisation and structure are likely to become more significant issues. We would expect the benefits to start reducing after two months although there could be some long-term benefits from some employers/employees permanently changing work structures.
Effectiveness for severity of disruption	Reduced working weeks should be effective for any severity of disruption although there will be better employer buy in for international events rather than local.

4.7.5. Encouragement to use more fuel efficient car

Component	Comment
Description	New Zealand has a high proportion of households with more than one car. This creates an opportunity to save fuel by encouraging households to use the more fuel efficient car more frequently or for the longer journeys.
Legislation required	None
Time to implement	Public information campaign – could be available in advance.
Investment Required	None

Component	Comment
Central/local Govt	None
Information Communication	Need Public Information Campaign.
Perverse Outcomes	None
Expected Costs	Cost of Public Information Campaign
Expected Benefits	0.43% (see Annex)
Time to achieve benefits	We would estimate the PIC to have effect over the following x weeks so by x weeks after the campaign began the full savings would be occurring.
Effectiveness over short/long term	This measure will be more effective over the short term as over the longer term people would be expected to return to their normal behaviour and use of vehicles.
Effectiveness for severity of disruption	The measure will be most effective when there is public support for measures although it should be applicable to all disruptions.

4.7.6. Drop Some Unnecessary Trips

Component	Comment
Description	Many trips that are made, particularly for recreational purposes, are discretionary and could be dropped altogether, eg weekend outings.
Legislation required	None
Time to implement	Public information campaign – could be available in advance.
Investment Required	None
Central/local Govt	Local government could provide more local entertainment to discourage long trips
Information Communication	Need Public Information Campaign.
Perverse Outcomes	None
Expected Costs	Cost of Public Information Campaign
Expected Benefits	2.2% saving in aggregate oil demand (see Annex for calculations)
Time to achieve benefits	Benefits could be achieved relatively quickly in response to Public Information Campaign
Effectiveness over short/long term	Could be effective over short term, but long term people would be unwilling to continue to displace trips.
Effectiveness for severity of disruption	The measure will be most effective when there is public support for measures although it should be applicable to all disruptions. Many people doing this could be reinforcing, eg people would recreate together locally.

4.8. Mandatory Phase

4.8.1. Speed Limits

Component	Comment
Description	Reduce the open road speed limit to 90 km/hr. Vehicles are more fuel efficient at the lower speed (by about 11% for 90 km/hr vs 100km/hr) ⁵⁷
Legislation required	May require new legislation. Could be put in place in advance.
Time to implement	Could be implemented very quickly if legislation in place (< 1 week) although it would take some time to change road signage which would mean enforcement would not be possible.

⁵⁷ Saving Oil in a Hurry

Component	Comment
Investment Required	Investment would be required to change all road signage (and back after the event) along with increases in enforcement requirement (more speed cameras). There will also be some costs recalibrating equipment.
Central/local Govt	Central Govt. decision. Police enforcement role.
Information Communication	Need an information campaign to get some impact immediately. However enforcement would need to wait until road signage is in place which is likely to take longer.
Perverse Outcomes	May cause some disgruntlement if it just results in more income in fines. May need to 'recycle' any excess income in some way.
Expected Costs	The costs will be reasonably significant given the volume of road signage that would have to be changed. That may rule out this option as a mandatory measure unless it is for a reasonable period (3 months +). A partial benefit might be obtained in the short term from encouragement to reduce speed without the associated enforcement.
Expected Benefits	1.4% saving in aggregate oil demand (see Annex B for calculations)
Time to achieve benefits	Likely to be phased in as initial savings would only be from voluntary speed reductions. We would estimate it would take a month before signage could be changed and enforcement could begin which would mean full savings would not be obtained until then.
Effectiveness over short/long term	Only effective over a longer term as it is not cost effective in the short term. Overseas experience has demonstrated continued enforcement is necessary to maintain benefits over the longer term. We expect partial benefits could be obtained from a voluntary campaign in the short term.
Effectiveness for severity of disruption	As there could be some public backlash would be most effective for an external disruption event.

4.8.2. Driving Bans/Car-less Days

Component	Comment
Description	Car-less Days, Driving bans – policies that expressly forbid traffic or use of cars in certain areas, certain days or times of the day. IEA SOIH report uses a 1 day in 10 driving ban as the basis of its consensus estimate of % transport fuel saved. NZ experience is a 1 day in 7 driving ban.
Legislation required	Can be undertaken under the Petroleum Demand Restraint Act 1981 but requires a regulation to be drafted
Time to implement	Administrative arrangements (stickers etc) can be pre-prepared. Longer time to train and build policing resource, depending on compliance regime used.
Investment Required	Publicity campaign but mainly extra human resource in policing
Central/local Govt	Both – local government will have role in administration
Information Communication	Public information campaign, which can be pre-prepared
Perverse Outcomes	NZ history of car-less days led to increased purchases of 2 nd cars; this is unlikely for short duration event.
Expected Costs	It is likely that the least valuable trips will be displaced. This will minimise costs to a great extent. However, there will be significant inconvenience costs.
Expected Benefits	Effectiveness will depend on levels of enforcement but might be assumed to be double or more effective than voluntary trip reduction, say 4-5%
Time to achieve benefits	Achieve reasonably quickly provided administration is place (could be part of normal registration process)
Effectiveness over short/long term	More effective over short term if system able to be by-passed.
Effectiveness for severity of disruption	Allows restriction to be tightened according to need – could be built into sticker system – same coding as for 1 in 10 (1 Tuesday every 2 weeks) , 1 in 5 (Tuesday every week) etc.

4.9. Rationing

There are a number of options for a rationing scheme as discussed in Section 3.6. These include price rationing, simple physical rationing and physical rationing with trading.

4.9.1. Price Rationing

It is expected that the price of oil and oil products will rise as a result of an international event but that there will be some reluctance to use price in a domestic event as a means for limiting demand. The oil companies have stated their reluctance to see themselves, individually or collectively, branded as being those that profited from a crisis. The government similarly might have some misgivings about the political fall-out, not to mention the concerns over short-term financial hardships for some essential users of fuel.

Price remains an efficient means for limiting demand, however. And there may be means for offsetting some of the adverse impacts on certain consumers, eg by combining fuel price increases with higher subsidies for public transport to encourage mode-shifting.

A price rationing scheme would require the government to have some means for imposing a short-run tax or levy. This could most effectively be implemented as a levy at the wholesale level, which would be expected to flow directly into retail prices.

4.9.2. Simple Non-Price Rationing

Simple non-price rationing is likely to occur in the absence of any government intervention. The simplest version is first-come-first-served. Here, petrol stations with limited quantities of fuel would simply supply customers until they ran out. It would result in long and early queues for fuel. It would be likely to allocate fuel to those that valued it most, to some extent, but it would also allocate to those that had a low value of time and therefore did not mind the wait for fuel. In contrast, some who valued fuel highly might also have a high value of time; this would apply particularly to business users.

Alternative physical rationing approaches include some combination of maximum and minimum sales and/or identification of priority users.

- **Maximum sales** could be used to ration supplies amongst users. For example, via a simple limit of 25 litres per person per visit. As discussed in Section 3.6, there are considerable efficiency impacts of such simple schemes because of the failure to identify those that value it most, although those that are granted allocations would be expected to use the fuel for their highest value uses.
- **Minimum sales** (eg all sales must be at least 25 litres) are likely to be an important component of any programme. These ensure that drivers do not constantly top-up their cars with fuel. It is a suggested component of the UK Emergency Response

Plan (Section 3.2.5).⁵⁸ Minimum sales are discussed in more detail in Section 4.10 below.

- Listings of **priority uses** can be used either to restrict sales to these users only or to allow these users to obtain greater amounts. A listing of priority users from the UK Emergency Plan is included as Annex A. This does not take account of the considerable financial costs that this might pose for some businesses. The UK scheme requires that individual companies and organisations that are classified under the priority use categories register with a local authority to obtain a registration number that is then used when purchasing fuel. This is a relatively complex mechanism.

4.9.3. Physical Rationing with Trading

An alternative scheme might be designed that is based on a physical allocation model, but that includes tradability, thus allowing many of the benefits of a price-based mechanism to be achieved.

Four desirable features of an allocation scheme are apparent.

- **Tradability.** As discussed above, the main inefficiency with allocation schemes arises between rather than within allocations; tradability mitigates this inefficiency and does so to a greater extent the easier it is to trade allocations.
- **Security.** The method by which allocations are conveyed to people must be secured against predictable methods of theft and/or subversion.
- **Ubiquity.** Ideally, it should be possible to provide allocations to all drivers.
- **Speed.** It should be possible to deploy the allocation system rapidly.

There are some tradeoffs between these features. For example, a ration card printed with the name of the owner is less likely to be stolen from an unsecured mailbox than a standardised ration card that could be used by anyone. However, if fuel vendors check the identity of the card holder, personalised cards are not tradable. The speed and ubiquity features may also be in conflict.

We have considered several mechanisms that provide a mix of these features. All have weaknesses. Table 11 provides an indication of the options considered for the identification of allocation right-holders, for the instruments that could be used to confirm the existence of rights, and for the agencies that might be involved in distributing the rights to their holders.

⁵⁸ Some decision would need to be made regarding sales of fuel in cans. During the late 1970s crisis, there was a 9 litre limit on can sales. This was intended to provide a balance that allowed people to continue to use lawnmowers and the like, while limiting hoarding activity. However there is an off-setting tendency which encourages people to repeatedly refill a 9 litre can and hoard the fuel in a larger container or use the container to fill the car. The UK Emergency Plan includes a ban on sales in cans alongside restrictions of sales to priority users.

These options can be combined in many ways. Several themes emerged from our analysis of these combinations. There is an obvious advantage in using petrol stations as distributors of the instruments, since users will be going there anyway to refuel. Regarding the choice of instruments, we believe that homogeneous tickets are preferable to the other options in two ways: they are likely to be cheaper to produce and more readily tradable. Our preferred identifiers are electoral rolls. We now discuss the issues of deployment, preparation, value and trading.

Table 11 Options for Allocation Schemes

Identifiers	Instruments	Distributors
Vehicle license plates	Personalised tickets	Vehicle registration outlets
IRD numbers	Homogeneous tickets	Accountants & IRD offices
Electoral rolls	Electronic smart cards	Postal outlets
School rolls	Centralised databases	Petrol stations
		Corner dairies
		Direct mail
		Schools

Deployment

For security reasons, homogeneous tickets would need to be handed out from centralized locations rather than posted. This is because many mailboxes are not secure and the simultaneous mailing of ration tickets to all residences would be likely to attract thieves. We propose instead that supplies of tickets be couriered direct to each petrol station in the country, via the oil companies.

Petrol stations would also receive a printed list of all persons on the electoral roll for whom that station is located closest to their residence. Such lists could be prepared in advance by matching the geo-coded addresses on electoral rolls to the location of petrol stations.

All people on the electoral rolls would receive in the mail a personalised letter advising them of the details of the scheme and the location of the petrol station that was holding their ration tickets. Next time they need fuel, they would take the letter and some identification to that petrol station and receive their ration tickets. The station staff would tick their name off the list to avoid duplicate issuing of ration tickets.

Omissions

This deployment scheme will omit those who are eligible to drive but not enrolled to vote, eg those under 18. It will also send incorrectly addressed letters to some people who have recently shifted residence and not re-enrolled to vote, and will omit those not on the electoral roll for any other reason. Those not covered are clearly defined: anyone who is not either correctly recorded on the electoral roll or is too young.

Those omitted who are eligible to vote⁵⁹ could contact the electoral office hotline and either update their details online or dictate them over the phone. In the latter case, there would be a delay while the electoral office posted the completed form out for signing and return, and then another delay while that information was sent to the relevant petrol station.

Those not eligible to vote could be directed to a different hotline for advice and/or be referred to a suitable retail network where documents could be checked and the electoral roll consulted to avoid double-dipping. The electoral roll details of any particular person can be checked online at any internet terminal. Suitable retail outlets could include postal agencies, banks, and court offices.

Preparation

It would be important that the deployment system be prepared for use in advance, though this need not be particularly costly. We have considered the preparations required for the scheme outlined above; similar issues would arise for other rationing schemes. The thoughts provided here are based on the assumption that there would be one week of lead time for the deployment of rationing. The first week of any emergency would focus on advertising and obvious usage-based controls such as speed limits. During this period detailed preparations could be made to deploy a rationing scheme.

Software would be required to geo-code any given version of the electoral database and to link the resulting addresses to the closest petrol station. This would need to include a mail-merge function capable of printing all the letters and the distribution list for each petrol station. Version control provisions would be required, to accommodate the anticipated flood of new electors and revised locations. In particular, the software would need to ensure that revisions to the electoral database could be handled separately, to avoid reprinting letters and lists for the majority of entries following a database revision. The addresses and rolls of all schools should also be maintained within this database and update at least annually. This software development is not a particularly large task; it would be prudent to undertake, test and commission the software in advance.

The ration tickets should be designed in advance with attention given to the tradeoff between printing cost and security. It may be that a hologram could be embedded in a designed ticket for additional security. Any pre-press work required to rapidly execute a large printing run of tickets should be undertaken in advance. Finally it would be prudent to purchase an option on the capacity of a printing company to ensure it was possible to print sufficient tickets in a hurry.

Ticket Value

The approximate value of a ration ticket will also need to be determined during the design stage. There are two main options here, but both have weaknesses due to imperfect divisibility. One option is to require one ticket to be surrendered or cancelled

⁵⁹ This includes New Zealand citizens and permanent residents and people who have lived here continuously for 12 months but excludes some criminals.

each time a vehicle is refuelled. This approach would steer people towards relatively infrequent but large refuelling behaviour. It would also make tickets more valuable when used to refuel a vehicle with a larger tank, which might induce certain inefficiencies such as people reselling liquid fuels rather than reselling tickets. It would have the advantage of avoiding the scenario of everyone filling their tanks at frequent intervals, as seen in the UK fuel crisis.

The second option is to fix a volume entitlement for each ticket or part thereof. In this case, the units should be relatively small, perhaps only 5 or 10 litres. This would limit wastage of part allocations as vehicle fuel tanks reach capacity having taken on board some intermediate volume of fuel.

It may be prudent to not build in a printed volume entitlement to the ticket design so that the value can remain flexible up to the point of the emergency. However if this approach is taken it should be recognised that any later adjustments that might be desired to the face value of the ticket would require a print design adjustment.

Volume and Frequency

Depending on the duration of emergency conditions it may be necessary to make several or many deliveries of tickets. The anticipated frequency of ticket deliveries should be considered in advance along with the volume of tickets to be allocated to each person every time a delivery is made. The ticket volume dispatched will obviously need to be calibrated carefully to the expected availability of product.

Trading

Trading should be quite straightforward with homogeneous tickets. An obvious option is through the popular online platform www.trademe.co.nz. We contacted Sam Morgan of trademe, who advises that they currently have over a million registered traders and would not have a problem coping with a flood of trading in oil tickets, though advance modelling of expected loads might be useful. He also advised that it would be possible to place a tracking facility on the site so that a clearing price of tickets could be observed by any visitor

Value of Surprise

An obvious risk with introducing an allocation scheme is that, where there is warning, which there almost inevitably will need to be for something as complex as described above, there will be incentives to stock-up with fuel before the restricted allocation scheme comes in. This will exacerbate the crisis.

To avoid this, it is likely that an initial inefficient rationing scheme would need to be introduced, ie one that has no potential for trading but simply a system of maximum and minimum purchases.

- A maximum as the source of a limit on total sales; and
- A minimum to ensure that drivers do not make a series of small purchases or constantly fill their car to the maximum level.

A summary of the issues involved in establishing a rationing scheme is provided in the Table below.

Rationing

Component	Comment
Description	Reduced volumes of petrol and diesel are made available for sale. Quantities are allocated via: a priority list and registration system or through a simple reduced maximum quantity made available. An alternative method provides individuals with a tradable right to obtain fuel.
Legislation required	Can be undertaken under the Petroleum Demand Restraint Act 1981 but requires a regulation to be drafted
Time to implement	A simple allocation (maximum sale for each visit) would require little time to establish. Priority list categories should be established in advance. Some time (2 weeks) will be required for individuals to register as being eligible and for establishment of registration centres. Trading approaches are likely to take longer to establish, requiring public education, printing and distribution of coupons and ensuring that adequate trading platforms exist.
Investment Required	Publicity campaign, printing of coupons
Central/local Govt	Central government will need to establish rules, including priority lists. Local government would be required to register companies/individuals under a priority use scheme
Information Communication	Public information/education campaign, which can be pre-prepared
Expected Costs	Costs of lost trips, which will be higher if there is inefficient rationing (no trading). Administrative costs (priority users, coupon distribution)
Expected Benefits	Rationing can be used to achieve any targeted level of fuel use or to distribute any limited supply level.
Time to achieve benefits	Benefits will be limited by the time taken to establish a rationing scheme. Vehicles will start with some fuel already but this is unlikely to take long to draw down
Effectiveness over short/long term	More effective over the long term
Effectiveness for severity of disruption	A necessary component for severe disruptions

4.10. Minimum Sales

A minimum sales requirement can be used regardless of whether other forms of rationing have been introduced. As discussed above, the objective is to prevent hoarding, and thus an escalation in oil demand, as opposed to any reductions in demand.

If introduced, a minimum sales requirement would need to be in place very rapidly. Filling stations would need to be provided with clear instructions on the approach to be taken, eg whether customers would have to pay before their fuel was dispatched. One issue that was raised as a result of the UK crisis relates to sales from credit cards, and specifically the legal requirement to honour sales using a credit card. If \$30 of fuel was purchased but only \$5 worth actually delivered (because the tank was then full), there may be a legal responsibility to deliver the fuel if purchased by credit card. A solution to this issue would need to be agreed with credit card companies.

Decisions would need to be made on whether the measure was to be introduced nationwide or if people in particular locations were more likely to panic buy.

Publicity material should be produced in advance and oil companies should be encouraged to develop a plan for rapid roll-out of the measure.

Component	Comment
Description	Sales of fuel are limited to a specified minimum, For example, all sales would have to be at least 25 litres. In practice this means that the purchaser is charged for 25 litres worth if the purchase is for less than this amount.
Legislation required	Can be undertaken under the Petroleum Demand Restraint Act 1981 but requires a regulation to be drafted
Time to implement	Clear instructions would need to be provided to all filling stations. Warning of this as a possibility should be provided as early as possible so that it can be implemented very quickly. If required, this measure will need to be introduced very rapidly.
Investment Required	Minor. Need for instructions and publicity material
Central/local Govt	Central government need to make a call on the need for minimum sales restrictions
Information Communication	Publicity requirement via media and at filling stations. Clear instructions required for filling station attendants
Expected Costs	Minimal costs for publicity material
Expected Benefits	Avoidance of rapid problem escalation. Immediate filling of tanks could total as much as 10 days of consumption.
Time to achieve benefits	Benefits are immediate
Effectiveness over short/long term	Will obtain benefits throughout the programme
Effectiveness for severity of disruption	Prevents a disruption escalating in severity.

4.11. Potential Measures for Other Transport Forms

4.11.1. Commercial Road Transport

There is some scope for savings in freight transport in response to unexpected supply disruptions. The Road Transport Forum⁶⁰ (RTF) advises that one initiative that could be implemented quickly would be to increase legal weight limits. The theory is that increased heavy vehicle limits will enable fewer fully laden and partly laden trucks to perform the specified road freight task, by carrying increased payloads. This could be achieved by a change in the regulations, thus providing a quick response, but would only really be an option for trucking operators who could take advantage of increases in the maximum limits.

We reviewed a cost/benefit analysis commissioned by Transit New Zealand in May 2001⁶¹, the Heavy Vehicle Limits Project, to consider the effect of increasing weight limits. The study indicated a maximum reduction of 29.6 million kilometres travelled for an increase in the limit, from 44 to 50 tonnes⁶². The total truck fleet travel distance in 2003 for the categories of heavy vehicles likely to be affected by the limits, was 1.37

⁶⁰ Telephone conversation with Tony Friedlander, CEO, Road Transport Forum NZ

⁶¹ Report 7, Overview, www.transit.govt.nz/news/content_files/HeavyVehcileReportOverviewPart1Amended_16July2001.pdf

⁶² page 14

billion kilometres travelled.⁶³ The Transit study would see a reduction of 2.2% based on 2003 figures. Using a fuel consumption figure of 55 litres/100 kilometres this equates to a reduction of approximately 0.6% of total diesel demand

The RTF indicated that it might be possible to achieve fuel reductions from lighter vehicle operators by, for example, reducing expectations around delivery frequency. Such initiatives would need to be part of a wider campaign to gain public acceptance.

4.11.2. Aviation

For aviation the best responses are likely to be voluntary restraint, including encouraging alternatives to travel, such as video conferencing or not taking some trips. We see limited scope for mandatory reductions in air travel.

4.11.3. Marine

Given the nature of the industry we do not see scope for specific measures to reduce demand. It is likely that demand from the sector would reduce anyway in the face of rising fuel prices.

4.12. Summary of Analysis

The analysis suggests the reductions in fuel use that are possible are those listed in Table 12. The table includes estimates of the reductions possible if the individual measures are introduced in isolation, or if all measures are undertaken. The detailed calculations are shown in Annex B. In addition, it is estimated that compulsory restrictions on car use, eg a return to car-less days, could provide additional reductions of 4-5%.

Table 12 Potential Reductions in Aggregate Oil Demand

Measure	Anticipated Savings (individual measures taken)	Anticipated Savings (all measures taken)
Drop 10% of discretionary Trips	2.16%	2.16%
Switch to More Efficient Vehicle	0.43%	0.43%
Carpooling	1.23%	1.23%
Telecommuting	0.40%	0.39%
Compressed Work Week	0.17%	0.17%
Mandatory Speed Limit Reduction	1.42%	1.41%
Tyre Pressure	1.40%	1.32%
Total Saved	7.20%	7.11%

Source: Annex B

⁶³ Mueller TH and Baas PH (2004) Profile of the Heavy Vehicle Fleet: Update 2004. Transport Engineering Research New Zealand Limited.

5. Conclusions and Recommendations

5.1. Conclusions

The review of international material suggested:

- there is a very wide range of responses that people are likely to make in response to limited supplies of fuel. These will include those related to work and residential use of fuel;
- there is a real risk that talk of any kind of supply constraint could lead to hoarding behaviour that could escalate the situation to a supply crisis;
- a common pattern of emergency plans is a shift from calls for voluntary restraint through to more mandatory reductions. Rationing is a last resort; and
- all plans require monitoring and good communication throughout.

In response to this, the recommendations below include steps that need to be taken now, including wider consultation in the process of developing an Emergency Response Manual, and suggested contents of an Emergency Response. For some of the suggested measures, steps will need to be taken now in preparation for a potential future event.

The key components of a plan will include:

- institutional arrangements that govern the implementation of the emergency response;
- measures that include communications to encourage voluntary reductions, mandatory measures and some form of fuel rationing.

These various components are discussed below.

5.2. Steps to be Taken Now

5.2.1. Work with Industry

The development of an Emergency Response Plan should involve those that will be involved in its implementation. This will include central government, the oil industry, local government and emergency services. Government should work with representatives of these organisations to:

- discuss and agree roles and responsibilities;
- agree the measures to be adopted;
- identify barriers to implementation;
- compile an Emergency Response Manual.

Some of these issues have been addressed in this report, but it would be useful to consult, particularly with industry, prior to inclusion in an Emergency Response Manual.

5.2.2. Legislation

There are a number of issues for which legislation might be required.

- **Speed Limits:** Responsibility for setting speed limits on their roads was formally passed to road controlling authorities (principally territorial local authorities and Transit New Zealand for State Highways) in April 2004. The requirements placed on councils as a result of these new responsibilities are contained in the Land Transport Rule: Setting of Speed Limits 2003 (Rule 54001). The rule allows road controlling authorities to set temporary speed limits but this is designed to deal with roadworks and for reasons of safety. It is not clear that this provision could be used to deal with a national emergency. And, it requires action by every road controlling authority rather than the government.

An alternative mechanism might be the Emergency powers under Section 163 of the Land Transport Act 1998. It allows a temporary rule to be in place for 90 days, and extended for a further 90 days. Officials are currently examining the procedures for rule setting under the Land Transport Act, including those provisions dealing with emergencies. Input to this process could be a useful way to pursue options.

- **Car-Pooling:** Some changes may be required to the Transport Services Licensing Act 1989 that currently requires licensing of transport services. Some car pooling schemes will fall under this and will not be authorised currently.

The Petroleum Demand Restraint Act 1981 gives the government very wide-ranging powers to restrain demand or reduce consumption of petroleum products, where there is likely to be a supply constraint. It includes powers to make regulations to:

- Control, regulate or prohibit the acquisition, distribution, supply, storage, sale or use of petroleum products;
- Restrict, regulate or prohibit the use of motor vehicles or any class of motor vehicles;
- Prescribe a scheme of rationing, determine or alter the value of coupons issued under a rationing scheme, and enable coupons issued under a rationing scheme to be transferred (traded).

This legislation provides the basis for any rationing scheme and prohibitions on use of vehicles, such as car-less days, if desired. In advance of any emergency, the drafting of regulations to be introduced by Order in Council under this legislation would be useful.

A supply disruption can be defined as an emergency under the Civil Defence Emergency Management Act 2002. This provides for the development of plans for an emergency. It also is a means for requiring plans to be developed by local authorities and oil companies, defined as lifeline utilities under the Act and for the provision of information.

Any measures undertaken requiring the oil industry to act collectively, eg with regard to coordination and/or prioritisation of supplies, would need to take into account the provisions of the Commerce Act. The Act prohibits collective behaviour that could have the impact of lessening competition in the marketplace. This could affect or limit the extent of cooperation from the industry unless there was some provision suspending the Act in time of crisis or specific authorisation of any specific plan. The response plan design needs to take into account the Commerce Act and the options available in that legislation to remove any barriers to implementation.

5.2.3. Development of Guidance Documents

The development of a set of guidance documents will be a necessary task in developing an Emergency Response Plan. They will need to include practical information on how to implement the measures identified in Sections 4.7 and 4.8. This will include guidance on:

- institutional arrangements;
- communications;
- implementation of specific measures; and
- timeframes and trigger points.

These issues are addressed below.

5.3. Institutional Arrangements

A number of teams will need to be established to coordinate and implement the emergency plan. Given New Zealand's smaller size, it does not need to be as complex as that in the UK Emergency Response Plan (Section 3.2.5). Some of the arrangements already exist, but building on these existing arrangements, will require:

- A **Senior Officials Coordination Team** that would handle the day-to-day management of the event for the government. It might have the following roles:
 - coordinating the collection of information on the emerging crisis;
 - providing advice to Ministers on measures to be implemented in consultation with the Industry/Government Management Team;
 - liaising with industry, local government and emergency services on implementation issues

It would be made up of senior officials and could include representatives of industry and the emergency services.

- An **Industry/Government Management Team**, probably in the form of the current **National Emergency Sharing Organisation (NESO)** a committee of oil industry representatives that is chaired by the MED.⁶⁴ It would make decisions on

⁶⁴ Under the International Energy Agreement, every IEA member is required to have a NESO. It exists to make arrangements for sharing oil supplies between member countries in the event of a severe emergency. New Zealand also uses the NESO committee to assist with invoking lower level or non IEA emergency measures.

industry responses and provide advice to Ministers either directly or via the Coordination Team.

- A **Communications Team** that would design and implement a communications strategy. It would include officials, communications experts (contracted in) and industry representatives.
- A **Supply Network/Stock Coordination Team** that would coordinate inter- and intra-regional allocation of supplies. This would be a grouping of the oil companies and might include government representation.

In addition, the emergency management teams of individual oil companies would be drawn on for advice on logistical issues.

Local government would have a significant role in relation to several measures and regional/local teams would need to be established also with the role of identifying local opportunities and communication avenues.

5.4. Communications Strategy

A communications strategy is required that will provide information to the public on the state of the problem and what to do. It would aim both to help achieve desired public responses and to avoid undesirable outcomes through providing public reassurance that the crisis is under control. This latter point is raised, not as a cynical exercise in duping the public into believing that there is no crisis, but because simple provision of information may not be sufficient to avoid panic buying which risks escalating an event into a crisis. This requires the Coordination team to work closely with the media in providing information and messages, and ensuring access to industry and government spokespeople. It also requires careful monitoring of the level of supply and demand and of signs of panic buying so that additional measures can be introduced swiftly.

A number of components of the Communications Strategy are discussed below.

5.4.1. Media Interaction

It will be vital that there is a good working relationship between the media, the government and industry during a supply shortage. The media (TV, radio, print and internet) will be a source of information on the scale of the problem and on what individuals and companies should do. Any risk of elements of the media working against the government, eg through seeking to assign blame, could undermine the messages and escalate the problems.

The government response has to be through professional management of the media, providing accurate and regular information and through being available. Building trust with the media will be a key component of crisis management.

As noted above, a dedicated team will be required, including professional help as required.

5.4.2. Publicity Material

Some publicity material might be prepared in advance. But more importantly, up to date information will need to be kept on the measures that will be suggested to the public. This might be compiled and maintained in a form that rapidly could be provided to advertising/PR companies for deployment. This material will need to be evaluated periodically for its relevance and content. It should set out clear guidance relating to the following voluntary steps:

- car-pooling;
- telecommuting;
- tyre pressure change;
- compressed work-week;
- using the more fuel-efficient car;
- dropping some unnecessary (eg recreational/business) trips;
- optimal speed.

The information will need to be turned into a series of easy-to-remember messages for the public. Experience gained by the oil industry and EECA in addressing the most recent electricity supply failure risk will be useful here.

Also it will be useful to have given early thought to ways to communicate the scale of the problem to the public. This would be some form of graphic device that explained the scale of the problem and progress towards solving it.

5.4.3. Mechanisms

The eventual media programme will be delivered through a mixture of TV, radio, print media and the internet. In addition, direct contact with drivers might be achieved, eg through the AA's member database which includes email addresses for a significant number of members.⁶⁵

The actual mechanisms and style of approach that will be most effective will change over time. For example, there may be significant developments in TV technologies and approaches to watching that reduce the prevalence, effectiveness or characteristics of TV adverts.⁶⁶ The approach to adopt for an Emergency Manual should be either to develop a plan that is regularly reviewed, in consultation with the communications/advertising industry, or to plan simply to immediately obtain advice in a hurry when a crisis emerges.

The immediate mechanisms are likely to be through press releases and holding press conferences. TV schedules are normally booked 6 weeks in advance, but as for other

⁶⁵ Currently the AA holds email contact details for approximately 175,000 members

⁶⁶ For example, if multi-channel digital TV or internet protocol TV become more prevalent, free-to-air TV paid for by advertising may diminish.

sudden events (eg the recent Pope’s funeral and election of the new Pope), schedules can be disrupted at short notice. For advertising time, there is likely to be greater flexibility in timing.

5.4.4. Working Directly with Schools and Business

The analysis of behavioural change suggests that public messages should target individuals by 'modelling' desired travel behaviour in many situations (eg travelling to school and workplace). The messages can then be reinforced through more direct routes.

Local and regional authorities hold school and business directories and should be able to compile a contact list and mailing/faxing/emailing out messages and calls for action in a short timeframe.

Increasing numbers of schools are running school travel plans and walking school buses each with their own assigned coordinator. They could act as a focal point for the dissemination of emergency transport related messages. Where they do not exist, an individual/group within the school could rapidly be nominated to take this responsibility. This information can then be passed on to parents, teachers and pupils to discuss localised solutions. Representatives from the local authority or police could attend school events to add weight to the need for action.

Few businesses will currently have engaged with their staff on travel issues, eg through a travel plan. Messages to businesses might be sent via business organisations, eg Chambers of Commerce. Otherwise direct mailouts of information to all businesses need to be undertaken. Communications could highlight messages regarding, eg car-pooling, teleworking, changed business hours and shorter working weeks.

5.5. Components of a Response Plan

The analysis in Section 4 suggests a response plan that includes a transition from voluntary to more mandatory measures. The suggested approach is as set out in Table 13. The different components are explained in turn below.

Table 13 Components of Response Plan

Size of Supply Shortfall	All durations	Short (<3 months)	Long (>3 months)
Large (>25%)	Voluntary measures Speed limits Minimum sales requirement	Rationing: full priority use allocation, no trading	Rationing: full priority use allocation, plus trading
Medium (7-25%)	Voluntary measures Speed limits Minimum sales requirement	Rationing: limited priority use allocation, no trading	Rationing: limited priority use allocation, plus trading
Small (7% or less)	Voluntary measures Speed limits Minimum sales requirement if hoarding likely		

5.5.1. Voluntary Measures

Voluntary measures should be sought immediately and would include encouragement through publicity at national and local levels of:

- Dropping discretionary trips;
- Car-pooling;
- Tele-commuting;
- Compressed work weeks;
- Tyre pressure reduction;
- Modified driver behaviour

5.5.2. Speed Limits

The speed limit on the open road to be reduced, eg to 80km/hour. This could be introduced immediately as a mandatory measure or started initially as part of the voluntary package—encouragement of reduced speed on the open road.

5.5.3. Minimum Sales

A minimum purchase requirement is a useful component of a scheme if there is a perceived risk of a crisis emerging through hoarding. It ensures against frequent topping up if sales of fuel is otherwise available but discouraged via the communications strategy. It will also be a vital component if there is an announcement that another form of rationing scheme is to be introduced in the future.

There would need to be a very rapid decision made on whether this was necessary so that it could be introduced quickly.

5.5.4. Rationing

The choice of rationing approach will differ with the expected degree of severity and expected duration of any emergency. There are two main approaches:

- Allocation to defined priority users
- Allocation plus trading.

There is also the potential for a combined approach. The favoured approach would depend to a great extent on the expected severity of the supply constraint.

Allocation to defined priority users can ensure that those that most need or value fuel can obtain access. The UK scheme allocates initially to the emergency services and the military, ie those for whom there is significant public benefit. The risk with a priority use scheme is that it does not allocate to those with a high economic dependence, eg companies or individuals that rely on using a vehicle for their work. And it will never be possible to be comprehensive in developing lists that covers all of these individuals.

Tradability enables those that value fuel highly to obtain it. However, if tradability is introduced without greater allocation to priority users, emergency services that have high value uses from the public perspective, but not necessarily high ability to pay, may

not be able to obtain supplies. Where there is very reduced availability of supplies, the value of fuel under traded coupons may rise to very high levels.

Thus a recommended approach is to use some combination of priority use categories and tradability. Table 13 sets out the recommended series of measures to be adopted, depending on the expected duration and severity of the supply shortfall. Where there is a large shortfall in supplies expected (or a very significant reduction in demand required), the rationing approach should include allocation to a wide list of priority users. Where the rationing requirement is reduced, we suggest that the list of priority users is limited to emergency services.

For a supply restraint of limited expected duration, it will not be worthwhile establishing an efficient rationing scheme with tradability as described in Section 4.9.3. This is because it will take some time to educate the public and industry as to the way that the tradable coupon scheme will work, to produce coupons and to establish effective trading platforms.

If the supply shortfall is expected to last for longer duration, so there is time to establish a trading scheme and educate the public, a tradability element should be introduced. Without it, there is a risk that those that value fuel highly will not be able to obtain supplies.

The introduction of allocation based on priority use requires identification of priority users. The UK scheme provides a useful starting point, but it is an approach that would require wider consultation to agree a suitable list for New Zealand.

The question of how to ensure that priority users obtain supplies is addressed in the UK approach through compiling the initial list of priority user categories but requiring individual priority users to be registered with their local authority. The local authority would check the credentials of the applicant against the critical use category, register them and assign a number. Usefully the process would also identify the quantity requirements of the priority user such that the registration process would register both a user and a quantity allowed.

The scheme would work best through allocating fuel for priority users to a set of dedicated filling stations. Fuel that was available but surplus to requirements of the priority users could then be made available through other filling stations.

5.6. Groundwork for Individual Measures

A number of individual measures require provisional work to ensure that they can be implemented effectively.

5.6.1. Car-Pooling

The pre-requisites for a car-pooling scheme include the means for individuals to find others to share with and designations for some roads. There are some legislative issues that might need to be investigated also (see Section 5.2.2).

Some mechanisms for linking people to shared vehicles will occur spontaneously at work places or in communities, and the communications strategy can encourage these links to be made. However, the internet will be a useful tool. There are a number of existing websites that provide practical means for linking potential drivers and passengers.⁶⁷ It is important that these, or similar sites, exist when an event occurs and are able to handle a surge in demand. This should be kept under review.

5.6.2. Reduced Speed Limits

Reducing speed limits in a hurry may require new legislation. The ability to use the existing rule making powers under the Land Transport Act is not clear-cut. MED should liaise with the officials (including MoT and Transit New Zealand) currently considering rule setting mechanisms to ensure that an effective mechanism is in place.

5.6.3. Rationing

A rationing scheme will be required in the event of severe supply shortages or if there is a risk of fuel hoarding. Rationing can be used to distribute any level of available supply. Legislation to introduce a rationing scheme, including tradability, is provided by the Petroleum Demand Restraint Act 1981. Design of Regulations under this Act would be a useful step in advance of an emergency.

A rationing scheme will be complex and will require additional design beyond the scope of this project. This includes:

- the compilation of a list of priority users;
- a mechanism for registration, agreed with local government or some other registration body;
- the design of the coupon for trading.

5.7. Information and Monitoring Systems

Monitoring systems will be required to check the status of the emerging supply problem and to provide information for communication to the public. It requires an assessment of supplies—those en route to New Zealand, stocks in the country and at the refinery, plus expectations of future deliveries. Up to date information on consumption will be essential also. Ideally, fuel sales on a daily basis would be supplied centrally so that progress can be tracked.

This will involve close collaboration between the different oil industry members but this data provision task should be undertaken by industry and supplied to the government on a daily basis during the crisis. MED should come to an agreement with industry before any emergency arises, eg via a Memorandum of Understanding, to ensure the delivery of accurate and timely information.

⁶⁷ eg www.carpoolnz.org/ and www.carshare.co.nz/

The development of a system for communicating this information is an important component of the Communications Strategy. The data should be used to develop a risk monitor that provides information on the balance of supply and demand and how it is changing over time. Usefully this could be developed beforehand by MED working with industry.

5.8. Timeframes and Trigger Points

Section 5.2 sets out a number of steps that should be undertaken now in developing an Emergency Response Plan. In this section we explore the timeframes and trigger points once a supply constraint event occurs.

The recommended programme will depend on the scale of the problem and is set out in generic terms in Table 14.

Table 14 Components of an Oil Demand Restraint Plan

Time	Institutional	Communication/ Information	Measures
Immediate	Establish Coordination Team, Strategic Management Committee, Communications Team and Supply Network/Stock Coordination Team	Identify a figurehead(s) to front the interaction with the public and media	Decide whether there is a risk of hoarding. If so, introduce an immediate requirement for minimum sales
Next step	Work with local government and industry to provide necessary guidance documents and information packs surrounding the different voluntary measures	Develop a monitoring system including measures of consumption, business-as-usual levels of consumption and supply levels Design a risk meter as the basis for public communication Establish targets for demand reductions against which progress is monitored Identify and work with an advertising/PR company to manage the communication with the public throughout the crisis	Assess risk (severity and duration of supply shortage/reduction requirement). Introduce measures as suggested in Table 13 above

It suggests that the decision will be made at the beginning of an emerging supply shortage and will lead to the introduction of measures as outlined in Table 13 above. In practice, the type of measure to be employed might need to shift over time, eg if voluntary measures are insufficient, additional measures might need to be taken to achieve greater reductions, eg stepping up from voluntary measures to mandatory speed limits or to rationing.

This process will be one that occurs over time as an event unfolds, and in response to monitoring of the event, both on the supply and demand side.

5.9. Review

A regular review of any Emergency Management Plan will need to be undertaken to ensure that it is up to date and that it takes account of new information as required.

Annex A: UK Priority Uses

Priority Uses List for Bulk Delivery

Priority	Percentage of normal fuel supply available	COMMERCIAL DELIVERIES					RETAIL DELIVERIES
		Fuel Oil	Gas Oil	Kerosene (Including Aviation Kerosene AVTUR)	Diesel	Petrol	Petrol Diesel
1	1-2%	<p>Hospitals. Military. Prisons. Blue light:</p> <ul style="list-style-type: none"> - Hospitals. - The armed forces. - Prison service and other custodial institutions. 	<p>Hospitals. Military. Prisons. Blue light. Public information:</p> <ul style="list-style-type: none"> - Health or social services. - The police, the armed forces, the fire services, customs and excise, coastguard and lifeboat search and rescue services. - Administration of justice, the prison service and other custodial institutions. - TV, radio and publishing for Government public information - Operation of air traffic control, air navigation and helicopter flights for upstream oil and gas fields. 	<p>Hospitals and healthcare centres:</p> <ul style="list-style-type: none"> - Hospitals - Health or social services - The police, the armed forces, the fire services, customs and excise, coastguard and lifeboat search and rescue services. - Helicopter flights for upstream oil and gas fields 	<p>Hospitals. Military. Prisons. Blue light. Public information:</p> <ul style="list-style-type: none"> - Health or social services. - The police, the armed forces, the fire services, customs and excise,, coastguard and lifeboat search and rescue services. - Administration of justice, the prison service and other custodial institutions. - Essential power generation - <u>Essential Critical National Infrastructure services (gas, electricity, telecommunications, water)</u> - Essential operations at nuclear / hazardous sites 	<p>Hospitals. Military. Prisons. Blue light. Public information:</p> <ul style="list-style-type: none"> - Health or social services. - The police, the armed forces, the fire services, customs and excise, coastguard and lifeboat search and rescue services. - Administration of justice, the prison service and other custodial institutions. - <u>Essential Critical National Infrastructure services (gas, electricity, telecommunications, water)</u> - Essential operations at nuclear / hazardous sites - TV, radio and publishing for Government public information 	<p>All retail sites closed, fuel only available to Priority 1 use:</p> <p>Deliveries coordinated by Police</p>

Priority	Percentage of normal fuel supply available	COMMERCIAL DELIVERIES					RETAIL DELIVERIES
		Fuel Oil	Gas Oil	Kerosene (Including Aviation Kerosene AVTUR)	Diesel	Petrol	Petrol Diesel
					sites - TV, radio and publishing for Government public information		
2	5%			Domestic Fuel Distribution - Depots for domestic fuel distribution			700 Designated Filling Stations: See retail priority use list for Priority 2
3	10%	Industry. Marine. Schools/Education: - Essential operations for maintaining major hazardous sites. - Operation of fishing vessels. Marine safety, navigational (including pilotage), shipping and ferry services, operation of docks or harbours.	Fuel Distribution. Animal welfare. Utilities. Public Transport. Food refrigeration. Food distribution warehouses. Crematoria, if any: - Depots for fuel distribution - Emergency services essential to maintain the safety of gas supply. - Maintenance of water supplies or operation of sewerage and drainage services.	Jet fuel for regional airports for emergency flights:	Fuel Distribution. Animal welfare. Local Government Emergency Services. Public Transport (excl. excursions). Truckstops (included in 700 Designated Filling Stations). Utilities. Food distribution depots - Depots for fuel distribution - Retail sites for trucks (included in the 700 designated sites) - Essential central government or local government functions.	No requirement	700 Designated Filling Stations: See retail priority use list for Priority 3

Priority	Percentage of normal fuel supply available	COMMERCIAL DELIVERIES					RETAIL DELIVERIES
		Fuel Oil	Gas Oil	Kerosene (Including Aviation Kerosene AVTUR)	Diesel	Petrol	Petrol Diesel
		- Schools and essential childcare services.	<ul style="list-style-type: none"> - Operation of railways (overground or underground), tramways, coach or bus services (excluding excursions or tours). - Manufacturing, processing, storage, packaging, collection, distribution or sale of food for human and or animal consumption. - Movement or slaughter of livestock for the production of food or of animal feeding stuffs or for veterinary reasons, or rendering of waste from slaughterhouses. -Veterinary services - Funeral services including cremation. 		<ul style="list-style-type: none"> -Transmission of money or of social security and other essential official payments or documents. - Movement or delivery of cash or cheques. - Operation of payment, clearing or settlement services. - Environmental and environmental health services and related emergency services. - Operation of railways (overground or underground), tramways, coach or bus services (excluding excursions or tours). - Operation of any of the following transport services: Services provided by employers of labour for taking their employees to or from work by means of vehicles adapted to 		

Priority	Percentage of normal fuel supply available	COMMERCIAL DELIVERIES					RETAIL DELIVERIES
		Fuel Oil	Gas Oil	Kerosene (Including Aviation Kerosene AVTUR)	Diesel	Petrol	Petrol Diesel
					<p>carry nine or more passengers.</p> <p>- Marine safety, navigational (including pilotage), shipping and ferry services.</p> <p>- Supply, distribution, or transmission of all domestic fuels including the provision of emergency services to the consumer.</p> <p>- Maintenance of water supplies or operation of sewerage and drainage services.</p> <p>- Manufacturing, processing, storage, packaging, collection, distribution or sale of food for human and or animal consumption.</p> <p>- Movement or slaughter of livestock for the production of food or of animal feeding stuffs or for veterinary reasons, or rendering of waste</p>		

Priority	Percentage of normal fuel supply available	COMMERCIAL DELIVERIES					RETAIL DELIVERIES
		Fuel Oil	Gas Oil	Kerosene (Including Aviation Kerosene AVTUR)	Diesel	Petrol	Petrol Diesel
					from slaughterhouses. -Provision of veterinary services		
4	25%	Industry: -Essential industrial use.	Agriculture. Airport Services. Industry. Marine. Schools /Education: - Agriculture or horticulture for the production of food or animal feeding stuffs. - Operation of air traffic control, airports including airport bus services, air navigation and civil airline services or air marine safety or navigational services. - Search and rescue	Jet fuel for regional airports for essential scheduled flights	All remaining Truckstops. Agriculture. Non-critical medical & pharmaceutical deliveries: - Agriculture or horticulture for the production of food or animal feeding stuffs. - Non-critical medical & pharmaceutical deliveries.		

Priority	Percentage of normal fuel supply available	COMMERCIAL DELIVERIES					RETAIL DELIVERIES
		Fuel Oil	Gas Oil	Kerosene (Including Aviation Kerosene AVTUR)	Diesel	Petrol	Petrol Diesel
			<p>services not included in Priority 1. Operation of fishing vessels. Marine safety, navigational (including pilotage), shipping and ferry services, operation of docks or harbours.</p> <p>Operation of schools and essential childcare services.</p>				
5	35%	No requirement	<p>Power Generation:</p> <ul style="list-style-type: none"> - Routine operations for maintaining at nuclear or other major hazardous sites. - Production, supply, distribution, or transmission of all fuel types. 	No requirement	<p>Delivery of mail:</p> <ul style="list-style-type: none"> - Operation of postal and telecommunications services, broadcasting, newspaper production and distribution 		
6	75%		No requirement		<p>Bulk commercial deliveries made but not necessarily to full stocks.</p>		<p>The majority of retail sites open, but not necessarily fully stocked. All priority uses from the existing list.</p>

Retail Priority Use list

PRIORITY	KEY PERSONNEL
1: All retail sites closed, deliveries coordinated by [Police]	<ul style="list-style-type: none"> • Health or social services. • The police • The armed forces • The fire services • Customs and excise • Coastguard, lifeboat search and rescue services • Administration of justice • The prison service and other custodial institutions • Essential power generation • <u>Essential Critical National Infrastructure services (gas, electricity, telecommunications, water)</u> • Essential operations at nuclear / hazardous sites • Vital central government or local government functions • TV, radio and publishing for essential government public information
2: 700 Designated Filling Stations (lower stock levels)	Key personnel for fuel distribution
3: 700 Designated Filling Stations	<ul style="list-style-type: none"> • Operation of railways, tram, coach/bus services (excluding excursions/ tours) • Services provided by employers of labour for taking their employees to or from work by means of vehicles adapted to carry nine or more passengers • Operation of air traffic control, air navigation and civil airline services at regional airports for emergency flights • Transmission of money or social security & other essential official payments or documents • Movement or delivery of cash or cheques • Operation of payment, clearing or settlement services • Schools and essential childcare services • Emergency services essential to maintain the safety of gas supply • Environmental and environmental health services and related emergencies • Supply, distribution, transmission of all domestic fuels including the provision of emergency services to the consumer • Maintenance of water supplies or operation of sewerage and drainage services • Provision of veterinary services; Manufacturing, processing, storage, packaging, collection, distribution or sale of food for human/ animal consumption; Movement or slaughter of livestock for the production of food or of animal feeding stuffs or for veterinary reasons, or rendering of waste from slaughterhouses • Operation of fishing vessels. Marine safety, navigational (including pilotage), shipping and ferry services, operation of docks or harbours • Operation by a severely disabled person of a private motor vehicle • Foreign diplomatic missions for essential purposes • Funeral services including cremation
4	<ul style="list-style-type: none"> • Non-critical medical & pharmaceutical deliveries • Essential operations for maintaining nuclear or other major hazard sites. • Production, supply, distribution, or transmission of solid or liquid fuel, of gas or electricity, or provision of emergency services to the consumers of such fuels. • Operation of air traffic control, airports including airport bus services, air navigation and civil airline services or air marine safety or navigational services for essential scheduled flights.
5	<ul style="list-style-type: none"> • Delivery of mail • Routine operations for maintaining nuclear or other major hazard sites. • Production, supply, distribution, or transmission of all fuel types • Operation of postal & telecom services, broadcasting, newspaper production and distribution • Licensed hackney carriages and licensed private hire vehicles
6: Majority of retail sites open, but not necessarily fully stocked.	All priority uses from Priority 1 to 5

Annex B: Calculations of Effectiveness of Measures

Table 15: Savings from Reducing Open Road Speed Limit to 90km/hr

Component	Petrol	Diesel	Source
Total VKT (y.e. sept 2004)	33,587,394,222	28,959,031,456	http://www.lincoln.ac.nz/trrec/trrecpub/report%2054.pdf
Share on state highways	49%	49%	http://www.med.govt.nz/irdev/econ_dev/infrastructure/reports/pwc-audit/pwc-audit-08.html
VKT on State Highways	16,581,369,518	14,296,447,003	
Proportion Affected by New Limit	50%	25%	Hale & Twomey assumption
VKT Affected	8,290,684,759	3,574,111,751	
Std Fuel Economy	9.20	6.60	Carpooling worksheet
Economy Improvement	11%	11%	Hale & Twomey assumption
New Economy Level	8.29	5.95	
Old Fuel Consumption (litres)	762,742,998	235,891,376	
New Fuel Consumption (litres)	687,155,854	212,514,753	
Fuel Saving (litres)	75,587,144	23,376,623	
petajoules/million litres	0.04	0.04	Energy Data File January 2005
pj saved	2.65	0.89	
Total Savings (pj)	3.53		
Annuual consumption (pj)	249		Energy Data File January 2005
% Oil saved	1.42%		

Table 16: Savings from Carpooling (Assuming a 10% Average Occupancy Increase)

Component	Petrol	Diesel	Source
Total Fuel Consumption y.e Sept 2004 (000s tonnes)	2,398	2,256	Energy Data File January 2005
% Private vehicles	96%	23%	http://www.med.govt.nz/ers/oil_pet/fuelquality/resource/resource-06.html (petrol), H&T (diesel)
Private Vehicles fuel consumption (000s tonnes)	2,302	508	
kg/litre	0.75	0.84	Energy Data File January 2005
Total Litres Consumed (private vehicles)	3,090,040,268	603,567,182	
Fuel economy (litres/100km)	9.20	6.60	http://www.lincoln.ac.nz/trrec/trrecpub/report%2054.pdf
VKT	33,587,394,222	9,144,957,302	
Proportion of Trips to work	16%	16%	New Zealand Travel Survey 1997/98
Proportion of Trips from work to home	16%	16%	New Zealand Travel Survey 1997/98
% available for pooling	80%	80%	Covec assumption
Total % VKT available	26%	26%	
Total VKT	8,629,036,467	2,349,457,940	
Occupancy for work trips	1.13	1.13	http://www.pinnacleresearch.co.nz/research/vehicle_occupancy.pdf
PKT	9,750,811,208	2,654,887,473	
Occupancy Increase	10%	10%	Covec assumption
New Occupancy level	1.24	1.24	
New VKT	7,844,578,607	2,135,870,855	
VKT Savings	784,457,861	213,587,085	
Fuel economy (litres/100km)	9.20	6.60	http://www.lincoln.ac.nz/trrec/trrecpub/report%2054.pdf
Fuel Savings (litres)	72,170,123	14,096,748	
petajoules/million litres	0.04	0.04	Energy Data File January 2005
pj saved	2.53	0.54	
Total Savings (pj)	3.06		
Annuual consumption (pj)	249		Energy Data File January 2005
% Oil saved	1.23%		

Table 17: Savings from Telecommuting

Component	All Fuels	Source
# of employees that could feasibly telecommute (TE)	299,180	Covec estimate based on Stats NZ Employment Figures March 2005
Average commute trip length, one-way (L)	10.59	New Zealand Travel Survey 1997/98
Modal share of commute trips currently done by car (C)	71%	New Zealand Travel Survey 1997/98
Average car occupancy rate - R	1.13	http://www.pinnaclearsearch.co.nz/research/vehicle_occupancy.pdf
Average fuel intensity of vehicle fleet (F = liters/100km)	8.64	http://www.lincoln.ac.nz/trec/trecpub/report%2054.pdf
Max Saving per week (litres)	692,746	assumes that 2 out of 5 days are telecommute
less 25% for increase in non-work trips (litres)	173,187	"Saving Oil in a Hurry"
Net Savings per week (litres)	519,560	
petajoules/million litres	0.037	Energy Data File January 2005
pj saved per week	0.02	
weekly consumption (pj)	5	Energy Data File January 2005
% Oil saved	0.40%	

Table 18: Savings from Compressed Work Week

Component	All Fuels	Source
# of employees that could feasibly telecommute	254,615	Covec analysis of Stats NZ Employment Figures March 2005
Average commute trip length, one-way	10.59	New Zealand Travel Survey 1997/98
Modal share of commute trips currently done by car	71%	New Zealand Travel Survey 1997/98
Average car occupancy rate	1.13	http://www.pinnaclesearch.co.nz/research/vehicle_occupancy.pdf
Average fuel intensity of vehicle fleet (litres/100km)	8.64	http://www.lincoln.ac.nz/trec/trecpub/report%2054.pdf
Max Saving per week (litres)	294,778	assumes that work week is compressed from 5 to 4 days
less 25% for increase in non-work trips (litres)	73,695	Saving Oil in a Hurry
Net Savings per week (litres)	221,084	
petajoules/million litres	0.037	Energy Data File January 2005
pj saved per week	0.01	
weekly consumption (pj)	5	Energy Data File January 2005
% Oil saved	0.17%	

Table 19: Savings from Dropping 10% of Social/Recreation Trips (or switching to public transport)

Component	Petrol	Diesel	Source
Total VKT (y.e. sept 2004)	33,587,394,222	9,144,957,302	Carpooling worksheet
% Social/Recreational	41%	41%	Covec analysis of NewZealand Travel Survey data
VKT for Social/Recreational Trips	13,769,751,651	3,749,138,444	
Share of Such Trips Dropped	10%	10%	Covec (10% of these trips are either dropped or switch to bus/train etc)
VKT Reduction	1,376,975,165	374,913,844	
Std Fuel Economy	9.20	6.60	Carpooling worksheet
Fuel Saving (litres)	126,681,715	24,744,314	
petajoules/million litres	0.04	0.04	Energy Data File January 2005
pj saved	4.43	0.94	
Total Savings (pj)	5.37		
Anuual consumption (pj)	249		Energy Data File January 2005
% Oil saved	2.16%		

Table 20: Savings from Switching 10% of Social/Recreation Trips to More Efficient Vehicle (Petrol only)

Component	Petrol	Diesel	Source
Total VKT (y.e. sept 2004)	33,587,394,222	9,144,957,302	Carpooling worksheet
% Social/Recreational	41%	41%	Covec analysis of NewZealand Travel Survey data
VKT for Social/Recreational Trips	13,769,751,651	3,749,138,444	
Share of Such Trips Switched	10%	10%	
VKT Reduction	1,376,975,165	374,913,844	
Std Fuel Economy (l/100km)	9.20	6.60	Carpooling worksheet
2nd Car Fuel Economy	7.00		
Fuel Saving (litres)	30,293,454		
petajoules/million litres	0.035		Energy Data File January 2005
pj saved	1.06	0.00	
Total Savings (pj)	1.06		
Annuual consumption (pj)	249		Energy Data File January 2005
% Oil saved	0.43%		