



The Sustainable Energy Forum Inc.

October 2005

New Zealand's Response to Peak Oil: Land Transport

Executive Summary

This report outlines the effect that the peaking and subsequent decline in world oil production is likely to have on the land transport sector in New Zealand. It discusses some of the complexities and uncertainties of the issue, notably the fact that the date of the peak, and the rate of decline in production beyond the peak, are not yet known.

It then outlines three ways in which the transport sector's dependence on fossil fuels can be reduced:

- 1) Using less private transport.
- 2) Using transport energy more efficiently.
- 3) Using other forms of energy for transport.

A range of actions and options within each of these areas are considered.

The recommendations of this document are principally addressed to national government. Key recommendations include:

- Developing an integrated national strategy to model the effects of Peak Oil on New Zealand under various conditions, and develop the appropriate strategies to prepare for and respond to a range of Peak Oil scenarios.
- Developing policies to integrate the present range of vehicle use charging measures, and introduce new measures, to create a consistent, effective taxation and charging regime which rewards low fossil fuel use and low emissions, and penalises high fossil fuel use and high emissions, in the New Zealand vehicle fleet.
- Commence research programmes that investigate the potential interactions between the effects of Peak Oil and the effects of climate change.
- Create and implement a national strategy to integrate all modes of transport into a system in which fossil energy use is minimised, and lowers over time.

Introduction

Human activity in New Zealand is heavily reliant on abundant and cheap energy, much of which we get from oil. Yet oil is a finite resource, and one that the world is rapidly using up. At present, world conventional light crude oil production is barely keeping up with rising demand. At some point, conventional light crude oil production will peak, and then decline - a phenomenon commonly known as "Peak Oil".

This document focuses specifically on Peak Oil as it affects the land transport sector. For SEF's overview of the Peak Oil problem as it affects New Zealand, please see "Peak Oil: An Urgent Issue for New Zealand", available at <http://www.sef.org.nz/papers.html>

98% of New Zealand's transport energy comes from fossil fuels (mainly oil, with some gas). Therefore, if the price of oil becomes substantially higher, and not enough oil is available to meet requirements, the current transport infrastructure will be severely affected.

Such a situation will compel a reduction in the use of fossil fuels for transport energy. There are a number of potential ways of mitigating the effects of this. They include:

- 1) Using less private transport.
- 2) Using transport energy more efficiently.
- 3) Using other forms of energy for transport.

Dimensions of the Issue

Before going into more detail on what could be done in each of these areas, there are a number of general points to be considered.

- The International Energy Agency requires that the Government make preparations for dealing with a short-term disruption to oil supplies. A report on the options has recently been released by the Ministry of Economic Development, and is available on the Web at http://www.med.govt.nz/ers/oil_pet/demand-restraint/index.html. This document does not deal with such short-term supply disruption issues. Instead, it deals with the long-term issue of the peak and decline in world oil production, and New Zealand's response.
- This is a complex area with a lot of inherent uncertainty. Peak Oil has never happened before. Previous "oil shocks" have been the result of politically-imposed restrictions on supply, rather than the inability of suppliers to pump enough oil to meet demand. There is now widespread agreement that world oil production will peak and subsequently decline, but much less agreement over when this will occur, with credible assessments ranging from the Association for the Study of Peak Oil (ASPO) projected date of 2007, to the International

Energy Agency (IEA) estimate of some time in the range 2013-2037. It is likely that oil prices will rise steeply in the run-up to the peak, but oil prices can also rise steeply in response to other factors - for example, short-term supply disruptions. Therefore, the actual year of the peak will be able to be established only in retrospect.

- Since we do not know the date of the peak, nor how steep the decline in oil production will be on the other side, it makes sense to develop scenarios that cover a range of timings and rates of decline. Some mitigation and adaptation measures will be common to each scenario, while others may be appropriate in one set of circumstances, and not in another. This scenario development work is currently going on within SEF, and will be used to inform future versions of this document. This version suggests priorities for action and investigation that are not tied to specific scenarios.
- In the run-up to the peak, using less oil is of financial benefit to individuals and organisations, but will not make much difference to the rate at which oil is consumed worldwide. It is vital, however, that we use the comparatively cheap oil to which we now have access to build the systems that will enable us to use much less energy, and in particular much less fossil energy, in the future.
- This document focuses on land transport. Air and sea transport will also be affected by Peak Oil. To keep the present document manageable, we will address non-land transport in a separate document. However, all forms of transport need to be considered when planning an integrated, efficient transport strategy.
- Vehicle fleets and transport systems take a long time to replace, or even to substantially upgrade. Policy changes can, for the most part, occur more quickly. Any set of proposals to change our transport system will need to contain a mix of short-term and long-term proposals. The higher the technological component of a proposal, the longer it is likely to take to implement to the point at which it has a significant effect on our transport system, although its benefits may be more substantial over time.
- Similarly, new fuels, e.g. biofuels, for internal combustion (IC) engines can be introduced more quickly than can vehicles that use non-IC engines. Therefore, changes to fuel for IC engines should be part of short- to medium-term proposals, whereas large-scale adoption of vehicles using non-IC engines will be part of longer-term strategies.
- Although some, such as ASPO president Kjell Aleklett, have argued that the peak in world oil production will itself act to restrain global CO₂ emissions and hence human-induced climate change, the potential interactions between efforts to mitigate climate change and efforts to mitigate peak oil are complex. Many policy and technological changes will help with both problems, but other possible efforts to adapt to Peak Oil, such as using processes to convert coal into oil, are likely to exacerbate climate change. Proposals to respond to Peak Oil need to be considered in the light of their effect on other issues, such as climate change, as well.

- We know that we need a sustainable energy future, but we do not know the energy costs of the future sustainable energy infrastructure. If, as discussed below, we plan to use electricity for more of our transport energy needs, then we need to know whether we will be able to build the infrastructure to generate the needed electricity - and whether this can be done sustainably.
- There is always the possibility of unintended consequences in actions designed to mitigate the effects of Peak Oil and/or climate change. It is one thing to introduce a new policy, or bring a new product into New Zealand, but quite another to do so without causing a negative impact on existing market expectations or infrastructure constraints - an example is the effect of the availability of cheap air conditioners on Auckland's electricity supply. Modelling the effects of policy changes before adopting them, to minimise such unintended consequences, is a vital part of any mitigation and adaptation strategy.
- Finally, these complexities should not be viewed as reasons for inaction. As the Hirsch Report (*Peaking of World Oil Production: Impacts, Mitigation and Risk Management*, now available in PDF format (1.2 MB) from <http://www.aspousa.org/assets/pdf/hirsch0502.pdf>) makes plain in the US context, speed is of the essence in commencing the mitigation and adaptation process. Some proposals will prove to be blind alleys; others may make things worse. We need to decide on the best steps to take, take them, and then make sure that the effects of our actions are subject to evidence-based evaluation.

Proposals

1. Using less private transport

Note: Any reduction in the use of transport energy, whether from private or public transport, will help reduce the impact of high oil prices and/or oil shortages. Because private transport energy use is the area in which savings can most readily be made, this section concentrates on it. Other uses of transport energy are discussed in (2) below.

Many aspects of the culture of Aotearoa/New Zealand have been built on the assumption that petrol will always be cheap and freely available. This can be seen in the structure of New Zealand cities, with most people living in suburbs that are well away from their places of work, many of which are serviced by little or no public transport. It can also be seen in the veneration with which powerful cars and aggressive drivers are viewed by large sectors of New Zealand society.

A sustained, sharp rise in the price of petrol is likely to cause demand destruction - that is, to reduce the collective propensity of people to undertake journeys, especially discretionary journeys, by private transport. But there are other interventions that could be made to reduce the use of private transport.

These interventions can be either "negative" - that is, they can impose restrictions on existing use - or "positive" - that is, they can provide alternatives to existing use. Negative interventions lead to resentment and cheating, need to be policed to be effective, and are likely to become increasingly ineffective over time. Therefore, it is important that creative thinking is done to come up with positive interventions, as well as the better-known negative interventions discussed below.

One possible positive intervention would be for the Government to increase present subsidies for public transport, even to the point of making public transport free. This option should be investigated to see whether it is cost-effective when whole-of-economy costs, including the health and environmental costs imposed by private transport, are taken into account.

One form of negative intervention is rationing. Various rationing schemes have been developed and used to deal with short-term fuel shortages, and development of these methods is continuing, as shown by the recent IEA "Saving Oil in a Hurry" workshop. However, rationing schemes that are effective in the short term tend to become ineffective over time, and the various possible schemes need to be evaluated in this light.

A form of rationing currently being considered in the UK is Domestic Tradable Quotas (DTQs), which are concisely explained at <http://www.dtqs.org> as "a scheme for rationing, and rapidly reducing, the use of fossil fuels, by sharing out access to fuel among every individual and organisation in the economy."

The proposal, now being considered by the British Government's Sustainable Development Commission, is that every adult would have the same annual carbon allocation, and would be given an electronic "carbon card". This card would have points deducted every time non-renewable energy was purchased - either directly, as at a service station, or indirectly, as in buying air travel. High energy users would have to purchase points from low users, or from a central "carbon bank". The overall allocation level would be based on an annual Carbon Budget, which would reduce over time. A proportion of the overall allocation would be made to individuals, and the rest to companies and organisations.

This scheme was developed to help the UK meet its Kyoto Protocol obligations. It could also be used to deal with shortages of oil and other fossil fuels. Such a scheme would be complex, and may incur unacceptably high transaction costs. However, the Government should look into the British discussion of this proposal to see whether DTQs have merit in New Zealand.

Consideration should also be given to prioritising uses, and users, of transport. In a time of scarcity, market mechanisms will allocate scarce fuel resources to those who can best afford them. The Government should decide which uses of fuel (for example, transport of food) are the most important, and what allocation of fuel is needed to meet those needs. Allocation measures can be brought into effect progressively as fuel becomes harder to obtain.

In addition to these "hard" measures, there is much that can be done by "soft" interventions, also known as social marketing. Social marketing has been used, for the

most part successfully, to diminish the proportion of people smoking and drink-driving. During the past two decades, due to deliberate social interventions by successive Governments, drink driving has gone from being perfectly acceptable to being severely frowned on by most of the population. Unnecessary use of oil needs to be viewed the same way, and social marketing may have a part to play in this. Further investigation, and a review of the literature on the successes and failures of past social marketing campaigns, is needed to determine what approach social marketing can best play in this area. However, social marketing takes time to work, so it will play less part in scenarios in which the peak is close.

There are presently many proposals to build new roads, including urban motorways. Such proposals are based on the assumption that current growth patterns in road traffic can be reliably projected into the future. If oil prices continue to increase and oil becomes scarce, then unless a comprehensive alternative fuel system is in place, road traffic is likely to decline. Therefore, proposed spending on new roads should be re-evaluated. New roading proposals should be subject to a rigorous audit that must demonstrate clear energy efficiency, environmental or public health benefits before road construction is approved. The audit should include consideration of the impact the proposed new road will have on the transport network as a whole.

2. Using transport energy more efficiently

The focus in this section is on using oil more efficiently; however, the efficiency of use of non-oil fuels also needs to be maximised, so these can be stretched as far as possible and can substitute for fossil fuels to the greatest possible extent.

Both road and rail freight are heavily dependent on fossil fuels, but, using technologies currently available, it is more feasible to electrify rail freight transport than road freight transport. This provides a potential saving in fossil fuels, but is likely to be expensive. A careful analysis needs to be conducted of the costs and benefits of increasing the proportion of freight carried by rail, the electrification of additional sections of the rail network, and setting up local rail networks to move foodstuffs from farm to town. Consideration should be given to rebuilding branch lines, especially where these provide an alternative to road transport for the transport of critical goods. The increased use of sea transport for freight should also be investigated.

Similarly, electrification and expansion of urban rail, including urban light rail, may lead to fossil fuel savings. The costs and benefits of the following options should be investigated: renewing and expanding existing urban passenger rail systems, adding urban light rail, and restoring long-distance rail passenger transport on existing lines.

Bus networks also need to be improved in the run-up to Peak Oil, so that the necessary capacity is in place. Either by introducing congestion charges for cars, subsidising bus fares more heavily, or both, bus transport in cities should be made more financially attractive. The frequency and reliability of bus services also needs to be improved, and bus-only lanes (or bus and carpool lanes) can help with this. We should modernise and improve urban bus fleets, retain trolleybuses wherever possible, and expand trolleybus coverage if possible. In those rural areas where rail passenger

transport is not feasible, bus passenger transport networks should be created or enhanced, with innovative use of minibus services.

Integrated ticketing systems should be introduced, so that one ticket can be used to access all types of public transport. These systems are common, and work well, in Europe and Australia.

We intend to prepare a separate paper on urban design, but briefly, urban design should focus on discouraging commuting by car - both by reducing the distance between work and home, and by privileging other commuting options. New housing developments should not be permitted unless the provision of public transport is an enforceable part of the proposal. The present school zoning system encourages a large amount of energy expenditure in transporting children from homes to distant schools. The costs and benefits of a change to the school zoning system, designed to minimise this expenditure, should be investigated. The policy of closing small rural schools should be reviewed in the light of the extra transport energy use that results. A special working party should be set up on Peak Oil's implications for Auckland.

New Zealand's current vehicle fleet wastes an enormous amount of fuel. Everything from incorrect tyre pressures to poor maintenance contributes to this, but one of the main causes is that our vehicle fleet has far too many cars with low fuel economy. We should provide strong financial incentives, and where necessary introduce regulations, to ensure high fuel efficiency and high emission standards across the vehicle fleet. Road user charges, fuel tax regimes, and vehicle importing and licensing regulations should all be designed, and integrated, to reward high fuel efficiency and low CO2 emissions, and penalise the reverse. Incentives for having a well-performing vehicle could include reductions in registration cost, better tax deductions, and feebates dependent upon low CO2 emissions or high fuel efficiency. This is an area in which the Government can act now.

The low loading of private passenger vehicles contributes to the inefficiency of their operation. Car-pooling and car-sharing schemes have the potential to improve the load factor of private transport, and their uptake might be accelerated if some form of tax or access benefit (e.g. car-pool lanes), which would have to be carefully researched and administered, was granted to those using such schemes. An example of a private initiative in this area is <http://www.carshare.co.nz>

New technologies to make the internal combustion engine significantly more efficient should also be encouraged. Within the government sector, there should be policies to replace present fleets, as they near the end of their life, with hybrid IC/electric vehicles, IC vehicles with high fuel efficiency, or plug-in electric vehicles. There need to be incentives and pilot programmes to encourage, or mandate, the adoption of highly fuel-efficient vehicles in the general vehicle fleet. As company cars form a large proportion of new vehicles, incentives aimed at companies and institutions may be particularly effective. Similarly, increased use of low-powered motorcycles, scooters, and other comparatively low-impact personal transport systems should be encouraged.

3. Using other forms of energy for transport

Walking and cycling are forms of transport that use comparatively little embedded energy and consume no fossil fuels. Whereas existing urban design policies tend to put cycling and walking at the bottom of the available transport options, future policies should put them at the top, so that these forms of transport, especially to and from work or school, become a realistic option for more people.

As noted above, some forms of public transport can readily be electrified, and we should be looking to adopt these wherever possible.

When it comes to private cars (and motorcycles), we can look either to use alternative fuels in internal combustion engines, or to use cars that do not depend, or do not depend wholly, on internal combustion engines. In the long term, non-IC engines may be the best prospect, but in the short to medium term, alternative fuels for IC engines are likely to make a greater contribution. Before considering any of those alternatives, we need to look at issues with alternative fuels. These include:

- a) energy density
- b) absolute embedded energy, and embedded energy from oil
- c) competing uses
- d) side effects
- e) infrastructure issues.

These are now discussed in more detail.

- a) "Energy density" is the amount of energy stored in a given system or region of space per unit volume. Oil has the highest energy density of any of the transport fuels currently in use or under development. Some other fuels, such as biodiesel, closely approach the energy density of oil, while others fall well short.
- b) "Embedded energy" (sometimes called *emergy*) is the number of units of one type of energy needed to create a unit of another type of energy. Therefore, embedded energy from oil is the number of units of energy from oil needed to create one unit of another type of energy. There is embedded energy in all transport fuels - for instance, it takes a certain amount of energy to find, produce, refine, deliver, and sell a barrel of oil. In some cases (for example, hydrogen used in fuel cells), the amount of energy used to create the fuel is greater than that released by using it. If an abundant form of energy can be used to create a fuel that replaces a scarce source of energy, then it may still be worth creating a fuel that contains more embedded energy than the energy it produces, but a carefully quantified Full Fuel Cycle Assessment would be necessary.
- c) Because creating fuels consumes resources, some fuels may be advantageous from the point of view of embedded energy and energy density, but cause problems because they require a disproportionate amount of a scarce resource to produce. An example may be crops grown solely to produce biodiesel: these crops require farmland that could otherwise be used for growing food. Another

example is cars that draw energy from mains electricity: their impact on electricity demand needs to be factored into the creation of a sustainable electricity generation, distribution and use system.

- d) The many negative side-effects of the use of oil as a transport fuel are already well-known; they range from particulate pollution to CO2 emissions. Many alternative fuels, such as oil from coal, also have negative side effects.
- e) One final issue with alternative fuels is that, even if they meet all other criteria, there is a lengthy lead time between the decision to adopt them, and the point at which production, distribution and sale facilities can be "ramped up" to a scale at which these fuels can meet a significant proportion of the present demand for oil.

None of these issues mean that we should not investigate and adopt alternative fuels in New Zealand, but they do mean that it's important to analyse the various options thoroughly before choosing which to adopt. The alternatives include:

Oil from coal: The liquefaction of coal to produce oil is proven technology, and has already been adopted by wartime Germany (a direct hydrogenation process) and apartheid-era South Africa (an indirect synthesis process) to produce oil. Using existing technologies, this conversion is relatively inefficient. Ballpark thermal efficiency figures for the proven coal liquefaction technologies are 30-50% for oil from coal. The maximum theoretically achievable thermal efficiency from coal to oil conversion is about 70%. However, again as a ballpark figure, the total CO2 emissions from coal mine to wheel per kilometre travelled, is about double that of emissions from oil well to wheel. This is a major argument against the use of oil from coal, as is the fact that coal is also a fossil fuel resource that will ultimately reach its own peak of production, although that peak may still be some centuries away at present usage rates. Nevertheless, despite the negative climate consequences, the use of oil from coal is likely to be a major response to Peak Oil internationally. (The same issues and concerns apply to the production of transport fuels from oil shales and tar sands.)

Biofuels: These can be derived either as a byproduct of existing processes, or by growing plants specifically to produce biofuels. Using byproducts has the advantage that additional land and energy inputs are not required to grow the fuels. Biodiesel can be derived from cooking oil or tallow, and bioethanol as a dairy byproduct. Waste wood can also be used to produce biofuels. Given the "wall of wood" which is coming due for processing in New Zealand, the production of bioethanol from wood should urgently be investigated as way of getting the best value from this crop. (A Canadian firm, Iogen Corp, has developed an energy efficient enzymatic process for converting cellulose to ethanol.) This added value available to forest owners is also likely to encourage the replanting of land in trees. Purpose-grown biofuels should be investigated as a longer-term option, with an awareness of the land-use difficulties these may create.

Plug-in hybrids: As distinct from existing hybrid cars, whose battery is charged ultimately from the use of the IC engine in the car, plug-in hybrids can be recharged from mains electricity. The plug-in hybrid would give the local environmental benefit

of predominantly electric power use around town while not sacrificing the range and ease of refuelling of liquid fuel for long journeys. Given the low proportion of generation from oil and other fossil fuels in the New Zealand electricity system, the net effect of this would be to lower fossil fuel use. While existing lead-acid battery technology is unsuitable for use in plug-in hybrids, battery technology is developing quickly, and the next generation of hybrid vehicles may have this plug-in technology. This needs to be taken into account when planning future electricity systems. (For more on plug-in hybrids in the US context, see <http://www.calcars.org/>)

Electric cars: Once heavily promoted as an alternative to IC cars, the public credibility of early electric vehicles suffered from their poor performance and the need for frequent recharging. However, improvements in battery and other technologies are making electric cars more usable and more viable. Such vehicles are still some way from commercial-scale deployment, so must be regarded as part of a long-term strategy until and unless they become commercially available in New Zealand; but they would offer major advantages to a country that could meet the resultant increase in electricity demand from renewable sources.

Hydrogen: The "hydrogen economy" has often been touted as the long-term replacement for an economy based on fossil fuels, with cars powered by hydrogen fuel cells being the transport component of this economy. However, there are many obstacles in the way of this vision becoming a reality. Hydrogen is an energy carrier rather than an energy source - in other words, energy from some other source must be used to make the hydrogen that powers the cars. Furthermore, fuel cell vehicles are not commercially available, and infrastructure to support their use would be difficult to implement in New Zealand. Hydrogen must rate as, at best, a long-term option only.

Priorities for further investigation and action on land transport

This document suggests a range of possible actions to assist land transport in New Zealand to deal with the effects of Peak Oil, and notes potential difficulties that may be encountered. For this document to be converted into a strategy for mitigation and adaptation, more work needs to be done on developing and modelling various scenarios of the date and severity of Peak Oil, and the most appropriate responses under these scenarios. Commencing this strategy development work is the first priority. The priorities suggested below for 2006 are measures that can start to produce results quickly. The priorities suggested "by 2008" would form aspects of an integrated strategy.

By mid-2006

- Introduce emissions testing for all vehicles into the Warrant of Fitness.
- Introduce integrated ticketing on major public transport networks.
- Introduce minimum fuel usage standards per kg of gross weight for all newly registered or modified vehicles.

- Develop policies to integrate the present range of vehicle use charging measures, and introduce new measures, to create a consistent, effective taxation and charging regime that rewards low fossil fuel use and low emissions, and penalises high fossil fuel use and high emissions, in the New Zealand vehicle fleet.

By the end of 2006

- Make fuel use meters compulsory on all new cars.
- Introduce tamper-proofing of diesel injector pumps.
- Introduce a moratorium on all new roading projects except those that can be demonstrated to produce energy efficiency, environmental or public health gains that outweigh the project's true cost.
- Commence a programme of major investment in urban public transport.
- Remove policy and technical obstacles to the increased use of biofuels in New Zealand vehicles, and ensure that the growth and production of biofuels is integrated into New Zealand's wood processing and land use strategies, and that biofuels become available in sufficient quantities, and with sufficiently wide distribution, to meet an increasing demand.
- Commence research programmes that investigate the potential interactions between the effects of Peak Oil and the effects of climate change.

By 2008

- Create and implement a national strategy for energy-efficient movement of freight.
- Create and implement a national strategy to integrate all modes of transport into a system in which fossil energy use is minimised, and lowers over time.
- Integrate the planning of the transport system with that of the electricity system, so that both move towards sustainability.
- Continue and extend the public transport investment programme, where net energy efficiency benefits can be demonstrated.

About the Sustainable Energy Forum

The objective of SEF is to “facilitate the use of energy for economic, environmental and social sustainability”. SEF is a group of individuals and companies interested in promoting information and supporting action which will help move New Zealand toward a sustainable energy future. SEF has a membership around 150 ranging from staff in major energy companies to students and retired people. Many members are active in small-scale sustainable energy supply and energy efficiency businesses. See <http://www.sef.org.nz> for further information and membership.