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Vulnerability assessment of the impacts of peak oil on the Canterbury Region

Report to Environment Canterbury

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Executive Summary

This work seeks to explore particular vulnerabilities that an uncertain future for oil supply and price might have on communities and businesses in the region. The work has focused on developing an understanding of the current dynamics of the international oil market, and dialoguing with stakeholders through semi-structured interviews to gauge their views on future oil vulnerability.

Over the last decade there has been a substantial and fundamental upward shift in mainstream international thinking about future oil supplies and price. Over the last two years the International Energy Agency (IEA) has warned about the costs and uncertainty of supplies to meet the rising demand for oil in the future. While the international economic recession caused downturn in demand and price in 2008/09, this might be short-lived. The IEA is predicting rising prices in real terms over the next two decades.

Interviewees in this study, by and large, accepted that the era of cheap oil is over and that oil supply in the future will be characterised by underlying higher prices with significant price volatility. However, there was not a sense of ‘crisis’, or indeed a sense that the world was ‘running out of oil’. Rather, the general view coming through was that this was an ongoing challenge to address through combinations of new forms of supply, alternatives to oil, efficiency improvements, fuel conservation, new technology, etc. Indeed for most this issue had already faded from its prominence of mid-2008 and was considered to be less of an immediate concern compared with the effects of the recession, international terms of trade, climate change policies etc.

Interviewees in general did not identify a particular role for Environment Canterbury (ECan) on this issue going forward. Three recommendations for follow-up are made based on ECan utilising its facilitator capacity and practical experience to help players in the region better plan for the future:

Preparedness for a short term fuel emergency – A majority of interviewees considered there was a reasonable likelihood of some kind of fuel supply disruption in future years, but at present there seems little awareness of the current plans that are in place (or being developed). ECan could take the lead to facilitate a stakeholder briefing around oil security and oil emergency response procedures.

Electricity supply and grid architecture – The issue of the quality and security of regional electricity supply has been previously addressed in the Canterbury Regional Energy Strategy Project (CRESP). The added dimension of oil supply vulnerability is the potential for electric vehicles (EV) to start substituting for light petrol/diesel cars and the effect this will have on electricity supplies and grid design. This reality is now with us, albeit in a very small way and at the very start of a long term market transformation. The CRESP project should factor in aspects of electricity supply and local grid architecture that would be required to meet a growing market for EVs in the future.

Risk management – Based on mainstream views of the future oil price, organisations should be planning for higher oil prices. In addition there is the core uncertainty around the timing and trajectory of increases – price volatility is a characteristic of the short-term oil market, while longer term price scenarios are characterised by a wide range of price possibilities. ECan could highlight the need for regional organisations to adopt appropriate risk management strategies to deal with a range of oil price pathways and short term volatility in prices.

Contents

1 Introduction

Environment Canterbury's (ECan's) energy portfolio role is to influence and advocate for sustainable energy and energy efficiency[1]. One aspect of this brief, which has assumed a greater priority over the last few years, is the future security of oil supply in the region in the light of concerns over the depletion of current oil reserves, and particularly the notion of 'peak oil'. Peak oil is understood to mean the time at which the global production of oil reaches its maximum rate of extraction. Beyond that point oil supply will inevitably decline because of the geology and extraction characteristics of oil fields. Much debate has been generated about the peak oil concept in recent years, in particular when the point of global peak oil will be reached, and what the economic and social impacts will be in the post-peak oil period.

In 2007 ECan commissioned a study to assess the impact of peak oil on its activities within the region[2]. The main points raised concerning future oil supply issues were:

- energy demand is rising by 3-4% p.a. in Canterbury communities, in particular oil-based fuels used for transport;
- Canterbury is highly dependent on imported transport fuels with no ready substitutes available;
- fuel shortages and price rises are expected to occur within the LTCCP planning period (2006-2016), and pose rising economic and social risk for the region; and
- Canterbury has a relatively short timeframe to begin planning to build resilience into current governance, social, and economic systems.

In the two years since this report was written the oil market has been through a period of turmoil and is currently characterised by volatility. This current work builds on the earlier study and seeks to explore particular vulnerabilities that an uncertain future for oil supply and price might have on communities and businesses. The work has focused on two aspects:

(a) Developing an understanding of the dynamics of the international oil market, focusing in particular on the extraordinary movement in prices seen over the last two years, and

(b) Dialoguing with local stakeholders ('interviewees') through semi-structured interviews to gauge their views on future oil vulnerability[3]. Questions were focussed around 4 aspects:

> (1) basic information on the oil dependency of the organisation (or sector they were involved in)
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> (2) their assessment of possible oil supply futures
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> (3) the implication of possible oil futures on their organisation/sector
>
> (4) what, if anything, should be done to better prepare for the future.

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[1] http://www.ecan.govt.nz/Our+Environment/Energy/Policy

[2] *Peak Oil and Climate Change Effects: Issues facing Environment Canterbury* (report U07/71) http://www.ecan.govt.nz/Our+Environment/Energy/plansandreports/PeakOilIssuesFacingEcan.htm

[3] Note that interviewees were not representative of sectors as such (see Appendix 1 for further comment).

As a means of assisting the dialogue four qualitative scenarios of future oil supply/pricing were constructed and used in the discussion with a number of the interviewees (see Appendix 2).

The findings are set out in this report as follows:

Section 2 provides a brief update of the international oil supply position, and provides an overview of the oil supply chain in NZ and in Canterbury.

Section 3 summarises, and comments on, the main findings from interviewees.

Section 4 makes recommendations on steps Environment Canterbury could take from here to disseminate the findings and facilitate further dialogue with stakeholders, with the aim of reducing future oil supply vulnerabilities in the community.

This piece of work is also intended to:

- Assist the ECan-facilitated process for developing recommendations for, and implementing, the Canterbury Regional Energy Strategy in FY 2009-10;
- Inform ECan's triennial review of the Regional Land Transport Strategy (RLTS). The review is now underway with the aim of having a new RLTS in place by mid-2011[4]; and
- Inform the ongoing implementation of the Greater Christchurch Urban Development Strategy (UDS) and related proposed regional policy and plan changes, noting the importance of urban form in improving transport energy efficiency.

[4] See: http://ecan.govt.nz/get-involved/have-your-say/pages/regional-land-transport-review.aspx

2 Oil supply overview

2.1 International context

In the lead-up to the international financial crisis in late 2007 the world economy was in a period of substantial growth led by the emerging economies of China and India. Oil demand had been increasing at an average of about 1.2%pa for the previous 10 years. However the margin between supply capacity and demand was tightening; a number of long standing oil supply sources were in permanent decline (e.g. North Sea oil), and there was a struggle to bring new supplies on line in an orderly manner. One-off, relatively minor events such as an unscheduled shut-down of a refinery began impacting on an increasingly nervous oil market. At the same time the global economy entered a period of severe contraction with the onset of the worst worldwide recession in decades. With a collapsing faith in previous 'safe' investments (financial institutions, property) investors began investing in commodity futures including oil. These factors created a 'bubble'[5] with oil prices escalating from about $US70/barrel in early 2007 to reach $US147/b in July 2008 before they crashed to a low of about $US37 in February 2009 (Fig 1[6]).

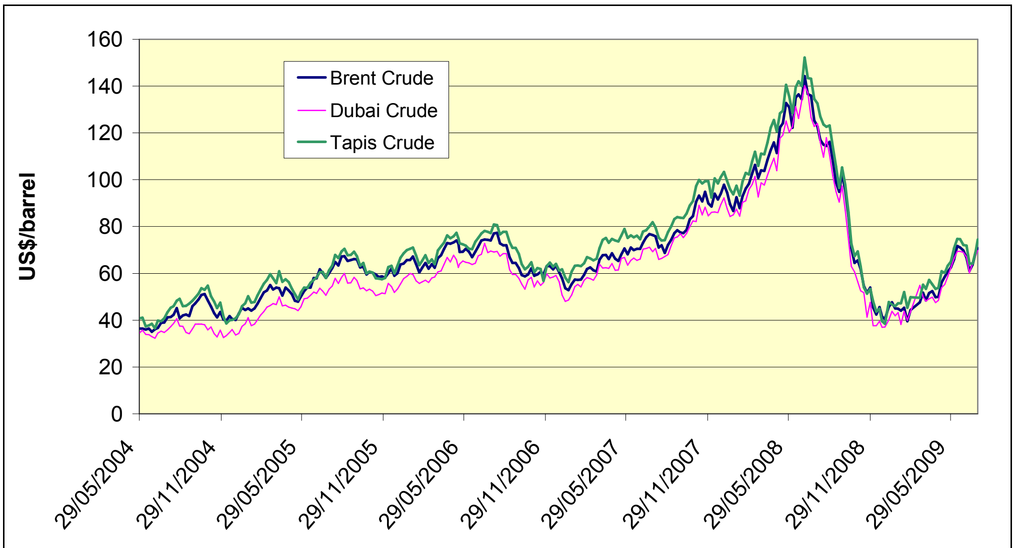

Figure 1. Crude oil prices (May 2004- end-July 2009)

In November 2008 the International Energy Agency (IEA) released their annual World Energy Outlook, warning that *"the world's energy system is at a crossroads*[7]*. Current global trends in energy supply and consumption are patently unsustainable*". The IEA called for a decarbonisation of the world's energy system in order to prevent *"catastrophic and irreversible damage to the global climate"*, and warned that:

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[5] Some commentary at the time suggested the price spike was being driven by a speculative bubble, and recent analysis has supported this. See: http://www.iie.com/publications/pb/pb09-19.pdf

[6] Data provided by Neil Mander, Auckland-based independent energy analyst

[7] See: http://www.worldenergyoutlook.org/favicon.ico

> *"the sources of oil to meet rising demand, the cost of producing it and the prices that consumers will need to pay for it are extremely uncertain, perhaps more than ever".*

This was an unprecedented warning from the IEA, who previously had been promoting an optimistic view of oil supplies in the future global energy economy. There seem to be two main reasons behind the IEA's rethink. First, the IEA undertook a comprehensive worldwide review of flow rates from existing oil fields and found a general pattern of higher decline rates with newer oil fields (Fig 2). Projecting forward they concluded that the production weighted average decline rate worldwide would rise from 6.7% in 2007 to 8.6% in 2030. Second, projecting ahead an increased oil demand of about 1%pa indicated a situation where a rapidly increasing proportion of future oil supply would rely on:

- over the next 5-7 years bringing oil to the market from fields currently discovered but yet to be developed
- beyond about 2015 bringing oil to the market from fields yet to be discovered (Fig 3).

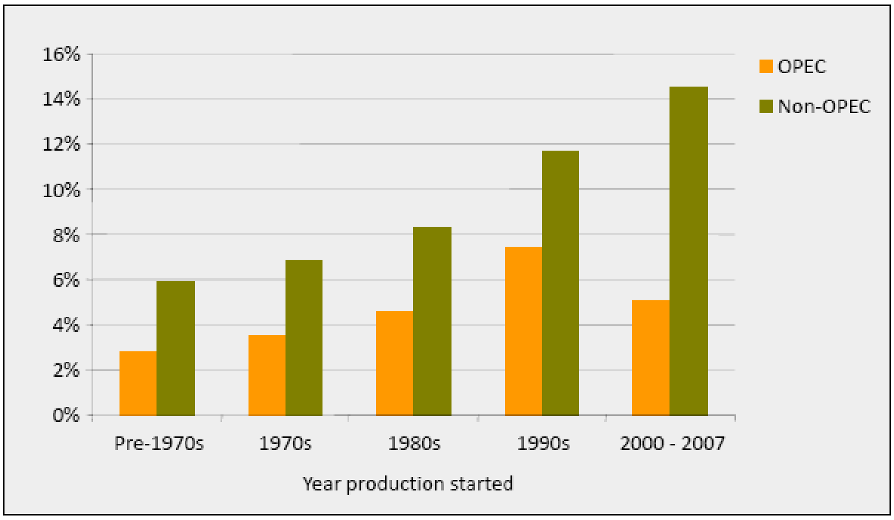

Figure 2. Oilfield decline rates (IEA, see Ref 7)

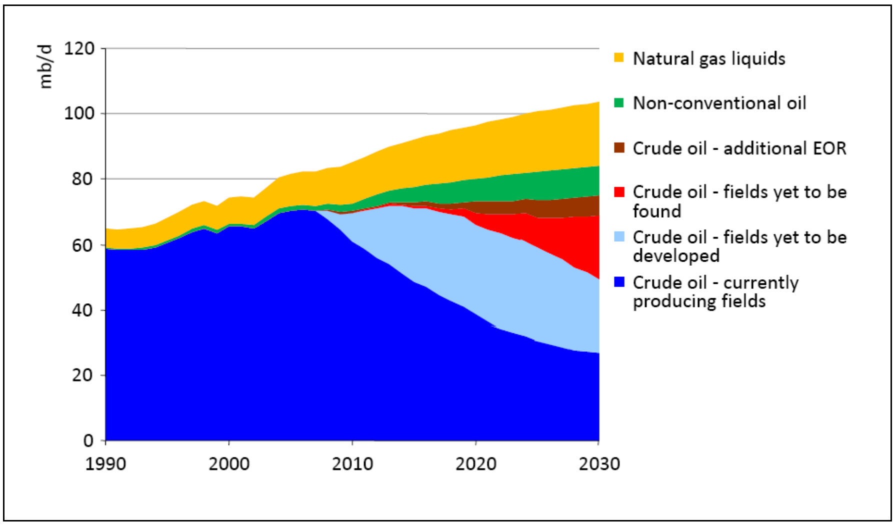

Figure 3. Projections of oil supply (IEA, see Ref 7)

Shell Oil has also sounded similar warnings. In a global energy scenario exercise published in 2008 Shell prefaced the report by stating that"*by 2015, growth in the production of easily accessible oil and gas will not match the projected rate of demand growth"*[8]. Both the IEA and Shell note that in order to maintain current levels of oil supply in the face of declining low cost oil fields, let alone increase supply, very large levels of investment will be required with adequate lead times.

In October 2009 the UK Energy Research Centre (UKERC) released its Global Oil Depletion report which brought together a comprehensive review of previous studies, analysed industry databases and compared global supply forecasts[9]. This report reinforced many of the concerns raised in the IEA's World Energy Outlook, noting that the rate of decline of oil production is accelerating and that more than two thirds of existing capacity may need to be replaced by 2030 just to prevent production from falling. The report concluded that:

> *"A peak in conventional oil production before 2030 appears likely and there is a significant risk of a peak before 2020. Given the lead times required to both develop substitute fuels and improve energy efficiency, this risk needs to be given serious consideration".*

Oil price spikes, recession and decline in demand - The combination of the hike in oil prices along with the recessionary contraction of countries' economies caused oil demand to decline from a peak of 87.5mb/d in the first quarter of 2008 to 84.4mb/day in the first quarter of 2009[10]. Most of the supply reduction has been achieved by self-imposed supply cutbacks by OPEC[11] countries. OPEC has done this to reduce the margin between supply and demand, with the stated intention of stabilising oil prices at around $US70/b which they regard as necessary in order to maintain sufficient oil revenues, sustain new investment, and provide a stable base for economic recovery[12]. Since May 2009 oil prices have fluctuated in the range $US60-80/b but with an underlying upward trend.

Short-medium term outlook - In the short term the contraction of oil demand has taken the immediate pressure off oil supplies and has enabled there to be a more comfortable margin between supply capacity and demand (currently about 5mb/d). The IEA are updating the short term outlook on a monthly basis through the Oil Market Report. The October 2009 report predicted oil demand in 2009 to average 84.6mb/d, increasing by +1.0% in 2010 to 86.1mb/d which is close to oil demand in 2008[13]. In the four months to October the IEA's short term demand predictions have lifted substantially as the effects of the international recession have diminished.

From 2012 the IEA, through their Medium-Term Oil Market Report, has painted a picture of potentially diverging scenarios[14] – (a) a future with slower future oil demand growth rates

[8] http://www-static.shell.com/static/public/downloads/brochures/corporate_pkg/scenarios/shell_energy_scenarios_2050.pdf

[9] See: http://www.ukerc.ac.uk/support/tiki-index.php?page=Global+Oil+Depletion

[10] International Energy Agency. 2009. Oil Market Report July 2009. Note that gas liquids, biofuels and other direct oil substitute products are included in these totals. See: http://omrpublic.iea.org/omrarchive/10jul09full.pdf

[11] OPEC – Organisation of Petroleum Exporting Countries.

[12] http://news.lesswaiting.com/060209.html

[13] http://omrpublic.iea.org/currentissues/full.pdf

[14] See: http://www.iea.org/Textbase/press/pressdetail.asp?PRESS_REL_ID=285

and sufficient new investment to ensure a comfortable margin between supply and demand; while on the other hand (b) a future with higher growth in oil demand and insufficient investment, which could see a rapidly tightening oil market.

> *"Whether we end up facing a supply crunch again by mid-decade, or with a more comfortable buffer of supply flexibility, depends largely on the pace of economic recovery and government action on efficiency"[15].*

Investment in supply – In the immediate aftermath of the price crash oil industry analysts warned that the low price, combined with a decline in demand and consequential rise in spare capacity, may be sowing the seeds for another oil shock in a few years time because of the dampening effect on new supply investment. In May 2009, Cambridge Energy Research Associates (CERA) estimated that more than half of the expected growth in oil production capacity over the next five years was at risk of deferment or cancellation, and that this lack of investment could result in another adverse shock to global energy security. CERA termed it the "long aftershock"[16] – much the same as the IEA alludes to in its second scenario above.

However the current 'managed market', whereby OPEC are attempting to manage supply in order to maintain a price floor of about $US70/b may provide sufficient price surety to enable investments to occur[17]. New oil shale developments in Canada, for instance, require at least $US70/b for investment to be likely[18]. There is also a view that despite the current price uncertainties, the main oil industry players have not significantly lessened their commitment to investment in new supply infrastructure. Indeed, recent moves in NZ by two of the major oil suppliers to exit retailing mirrors what is happening in other mature markets around the world where oil majors are leaving fuel retailing to concentrate on exploration, refining and distribution[19]. It is also noteworthy that oil futures markets during August-September 2009 have been consistently pricing oil at $US90-95/b in 2017, suggesting a market belief in the likelihood of a rising price trajectory[20]. The prospects for new oil supplies becoming available to take over from some of the currently declining fields shouldn't be discounted either[21]. The volume of oil discovered each year on average has been higher since 2000 than in the 1990s, thanks to increased exploration activity and improvements in technology. New technology is also enabling greater extraction rates from existing fields.

Demand-side responses – One thing that the oil price spike (and subsequent price crash) of 2007/08 has done is to underline that demand is sensitive to a range of factors including price. At various price thresholds demand-side changes can be expected to reduce oil demand e.g. encouraging investment in more efficient technologies, investment in oil

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[15] Ibid (Nobuo Tanaka, Executive Director, IEA)

[16] Yergin, Daniel. 2009. The Long Aftershock: Oil and Energy Security after the Price Collapse. Testimony to the Joint Economic Committee of the US Congress. http://www2.cera.com/dy20090520.pdf

[17] This will depend on OPEC maintaining production quota discipline within the group.

[18] Yergin, ibid.

[19] http://www.nzherald.co.nz/business/news/article.cfm?_id=3&objectid=10586240

[20] See: http://www.nymex.com/lsco_fut_csf.aspx

[21] See for instance, a summary of new oil discoveries in Uganda, which while still relatively modest compared with middle east reserves, indicates that significant new oil fields are still being discovered and developed - see: http://www.economist.com/businessfinance/displayStory.cfm?story_id=14177583

alternatives, lifestyle and behavioural changes (through such things as transport demand reduction). The recession has heightened demand side responses, with oil demand being sensitive to levels of economic activity. There is also the effect of government policies on reducing greenhouse gas emissions, which while modest to date, are expected to accelerate over coming years as greater commitments are made. Indeed, the IEA surmised in the Medium-Term Oil Market Report (Ref 14) that there are indications that a structural downshift in oil use in countries such as the US might be underway. Demand in the US has reduced by some 2mb/day since early 2007 and new policies, consumer behaviour and new technologies may be permanently moving oil demand to a downward path. Some have speculated that a situation of 'peak demand' for oil may have been reached in some developed economies, in particular if policies to reduce greenhouse gases gain sufficient traction over the next decade.

In summary, the best that can be said is that it is a very uncertain outlook for oil supplies and prices in the short-medium term. In mature economies, with a relatively static population, and where more stringent climate change policies are likely to be adopted, there seems real prospects that oil use could decline over the next few years and might be on a downward trajectory. In emerging economies, especially large markets such as China and India, drivers of increased oil demand still appear to be very strong. While the current recession may be providing some breathing space in terms of the immediate pressure on oil prices, this might be short-lived. The longer term outlook is largely unchanged (i.e. tight margins between supply and demand, higher and more volatile oil prices) unless the combination of new technologies, government policies and consumer responses generates traction to change the overall trajectory of demand.

2.2 National context

Strategic Framework - The New Zealand Energy Strategy (NZES), prepared under the previous government in 2007, contains high level policies related to oil vulnerability. The NZES recognised that NZ relies on imported oil for around half of the country's energy needs, most of which is for transport. Two key issues identified were (1) the effect on the country's import bill when oil prices rise, and (2) that supply disruptions caused by international events beyond NZ's control are a reality that has to be managed.

With the change of government in late 2008 some of the policy directions mapped out in the NZES and associated documents have been changed or are under review (e.g. commitment to CO_2 emissions reductions is currently unclear). However, a number of policy positions, relevant to oil supply and demand, are in place including:

- Increasing oil reserves to act as a buffer and to meet treaty obligations as a member of the International Energy Agency (IEA), as well as updating emergency response planning
- Incentives for biofuels and the biofuel industry
- Information provision to improve energy efficiency in transport (e.g. fuel efficiency ratings).

- Proposals for time-period exemptions from road user charges for electric cars[22].

Planning assumptions - oil prices – While government does not adopt a formal position on future oil prices, various pricing positions are laid out in *Energy Outlook*, an energy futures scenario-based modelling approach produced by the government's energy policy agency the Ministry of Economic Development (MED). In the last decade Energy Outlook has been produced on a 3 yearly cycle with the latest version published in September 2009. In future Energy Outlook will be published as a series of annual updates.

The 'reference scenario' starts from business-as-usual assumptions in terms of broad trends in key economic drivers, policy setting, technology and fuel choices[23]. Oil price assumptions used in the reference scenario are based on mainstream sources - the 2009 Energy Outlook uses recent NYMEX[24] futures for the initial eight years, and IEA expectations after that[25]. In addition a range of alternative oil price scenarios have been constructed in order to test oil price sensitivity[26].

It is a reflection of the move in mainstream thinking over the last decade that in consecutive editions of Energy Outlook MED's price assumptions for oil in 2020 have increased more than threefold in real terms from 2000 (Table 1).

Table 1. Change in Energy Outlook's reference scenario assumption for oil prices in 2020

Source and base year	**Projected oil cost in 2020 expressed in current, real $US/b (2008)**
Energy Outlook (Feb 2000)	$US28
Energy Outlook (Oct 2003)	$US30
Energy Outlook (Sept 2006)	$US65
Energy Outlook (Sept 2009)	$US89

[22] The Minister for the Environment strongly endorsed the potential for electric cars in introducing the Road User Charges Amendment Bill in July 2009. See: http://www.parliament.nz/en-NZ/PB/Debates/Debates/Speeches/3/3/b/49HansS_20090702_00000703-Smith-Nick-Road-User-Charges-Amendment-Bill.htm

[23] New Zealand's Energy Outlook 2009 – Reference Scenario. See: http://www.med.govt.nz/upload/70162/a.%20Energy%20Outlook%20-%20Reference%20Scenario.pdf

[24] NYMEX – New York Mercantile Exchange

[25] Personal communication with Simon Lawrence, Mark Walkington, MED, Wellington. See also: http://www.med.govt.nz/upload/48668/EDAC.pdf

[26] New Zealand's Energy Outlook 2009 – Oil Price Sensitivity. See: http://www.med.govt.nz/upload/70162/c.%20Energy%20Outlook%20-%20Oil%20Price%20Sensitivity.pdf

Figure 4 shows the actual average oil price 1990-2008, Energy Outlook's projected price assumption through to 2030, and the current NYMEX price through to 2017[27]. The key messages are that:

- Over the last decade there has been a substantial and fundamental upward shift in mainstream international thinking about the future oil price
- This is being reflected in NZ's energy planning looking forward.

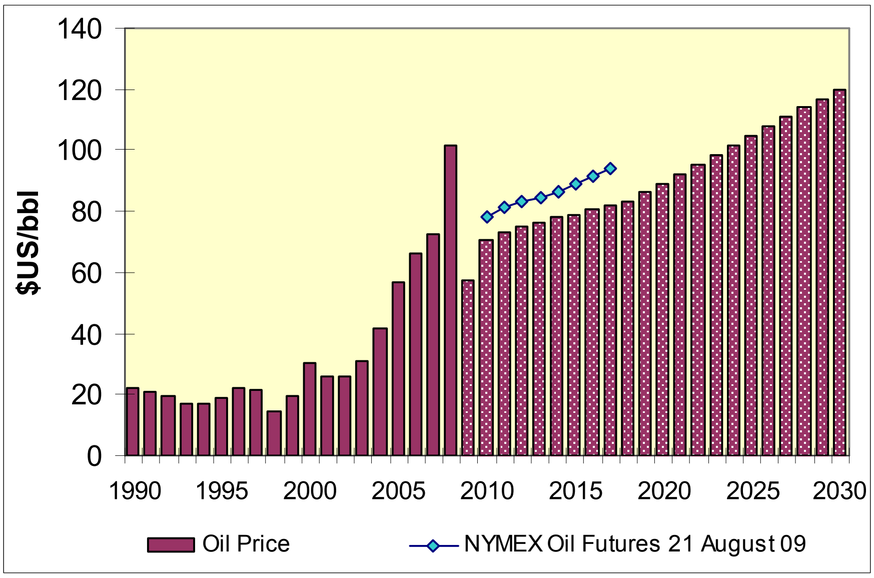

Figure 4. Crude oil prices 1990-2030 (current real based on average annual prices) - (1990-2008 actual; 2009-2030 - projected Reference Scenario; 2009-2017 NYMEX oil futures).

Oil Emergency Response Procedures – a concern emerging in the mid-2000s was that NZ did not comply with the IEA member requirement to hold at least 90 days of oil supply. The IEA regard this as a necessary risk management measure in the event of an international oil supply emergency (and a condition of IEA membership). Work was undertaken from 2004 to 2006 to explore options, with the overall result being that the country's 90 days obligation is now met by a combination of domestic oil storage and 'right to purchase' reserves held in other countries[28]. In 2008 these reserves were held in Japan,

[27] It is a reflection of the volatile environment for oil prices that whatever date the NYMEX price futures are locked in for Energy Outlook (or indeed any report, including this one) they are likely to seem dated by the time of publication. NYMEX prices as recorded on 21 August 2009 were $US8-12/bbl above Energy Outlook's price curve which had been established some weeks earlier.

[28] NZ's 'on-land' storage in 2008 was equivalent to about 55 days of forward demand. This was the fifth lowest level in 29 OECD countries (although higher than Australia). A number of countries (Japan, Finland, the Netherlands, and Switzerland) had over 120 days of on-land storage (from IEA Oil Market Report 14 May).

Australia, the Netherlands and the United Kingdom, whereby the government had the option to purchase oil in the event of an IEA declared emergency[29].

An Oil Emergency Response Strategy was prepared by Government in 2008, and elements of the strategy are being further developed. Ongoing work is focussed on establishing guidelines and processes for implementation, and meshing in with local level contingency plans deriving from a civil defence emergency management (CDEM) perspective. A National Contingency Plan for Fuel Supply[30] is currently under development and the current draft outlines a framework response based around:

1. Defining a list of CDEM critical customers (e.g. emergency services)

2. Invoking prioritisation by the CDEM controller if needed

3. Setting in place a response hierarchy that would be activated based on the magnitude, and the scope/breadth of the impacts (Fig 5). The core prioritisation methodology is based on minimal interference with fuel company operations, for as long as possible.

Of course, should there be an IEA declared emergency, that in itself would be sufficient to trigger a government response.

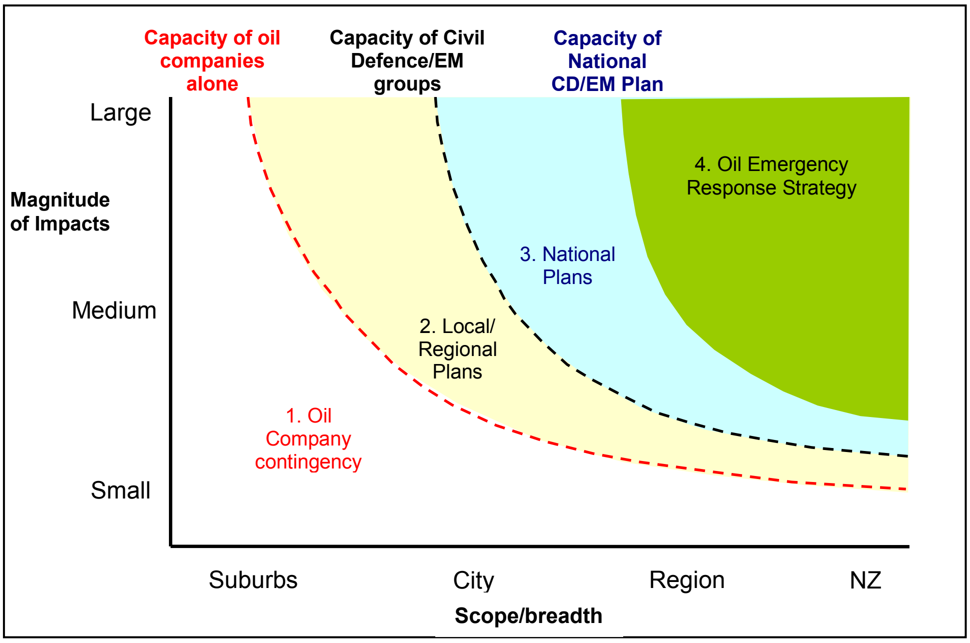

Figure 5. Contingency framework for responding to an oil supply situation

[29] Ministry of Economic Development. 2008. Oil Emergency Response Strategy – Government Response to an Oil Supply Disruption. July 2008.

[30] Based on the current draft version of the National Petroleum Contingency Plan – pers comm. Mark Gordon, AECOM.

2.3 Local preparedness

The Canterbury Engineering Lifelines Group has carried out considerable work at the regional level to assess preparedness in the event of a CDEM event. Between 2006-2008 a particular focus was petroleum storage, transport and supply in the region, and risks around logistics and delivery[31].

Most fuel delivery to the region is shipped into Lyttelton with smaller amounts shipped to Timaru (see Fig 6). Tankers typically call to Lyttelton on average every 7-10 days, although because of specialised fuel cargoes the gap between deliveries can be longer, while sometimes tankers with different fuel loads are in port within days of each other. Distribution occurs from there, most notably in Christchurch via the Woolston terminal, which provides a short term storage capability (i.e. the annual throughput suggests a stock turnover every 8 days).

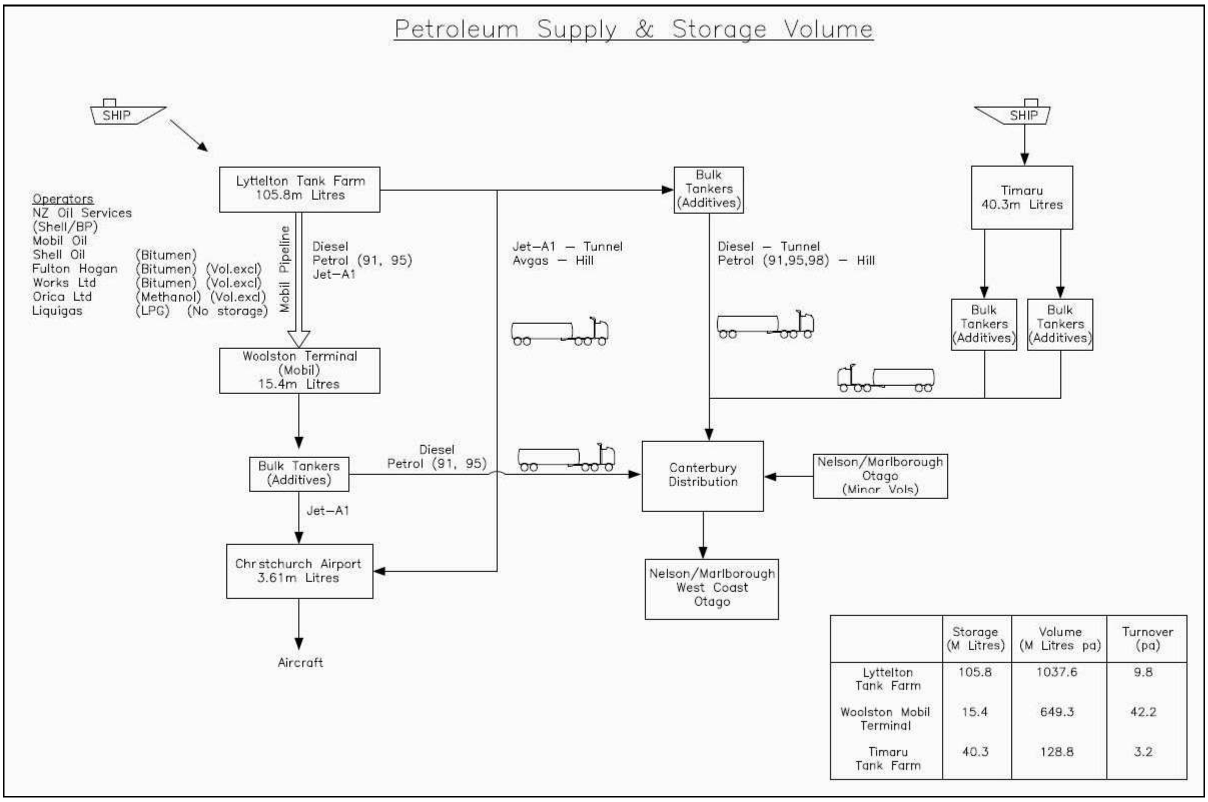

Figure 6. Canterbury petroleum supply and storage (Source Ref 31)

[31] Canterbury Lifelines Group. 2006. Hazard Assessment for Petroleum Storage, Transportation and Supply. Phase 1 Report. Canterbury Civil Defence Emergency Management Group (CDEMG) June 2006. (Maunsell/EACOM);

Canterbury Engineering Lifelines Group. 2008. Hazard Assessment for Petroleum Storage, Transportation and Supply. Phase 2 Report. ECan Report UO8/16. Canterbury Civil Defence Emergency Management Group.

Three issues of note are:

- Total fuel storage in the region comprises about 160m litres in bulk storage, and at least 50m litres in distributed storage (e.g. service stations, farm tanks) (Table 2), but currently there is no on-line system to show actual levels of storage at any particular point in time.

Table 2. Petroleum storage in region

Storage source	Million litres
Port storage (Lyttelton and Timaru)	146.1
Woolston terminal	15.4
Christchurch airport	3.6
Service stations (throughout region)	13.6*
Other regional storage (estimate)	33.6

* Note that only 3.9m litres (29%) is storage for diesel

- Because of fuel leakage from old underground tanks and concern about groundwater contamination oil companies have been moving to reduce storage and concentrate more in above ground supply tanks.

- Comparing total fuel usage in the region (just under 1,200m litres (Table 3)) with total storage implies that within the region there is storage capability of about 2 months. However, a typical supply disruption scenario is likely to occur when storage has already been depleted to some extent. Also, some fuel types have greater storage capability than others, fuel usage is seasonal, and some of the storage is private – again effectively reducing potential storage capability. Overall, for practical purposes local storage of 20-30 days maximum is more realistic, and may be less for some fuel types.

Table 3. Use of oil fuels in Canterbury 2006*

Fuel type	Million litres
Petrol	375
Diesel	370
Aviation fuels	202
Marine fuels	85
Rail	27
Non transport (mainly industrial)	125

* Source: Regional Energy Survey 2006. See:
http://www.ecan.govt.nz/Our+Environment/Energy/plansandreports/BiennialRegEnergySurvey82to06.htm

3 Interviewee responses and comment

3.1 Introduction

Responses from the interviews have been grouped into key themes:

- What was the specific impact of the oil price spike in 07/08?
- What relative importance do interviewees attach to future oil vulnerability, including their views on the future oil price?
- Technology and innovation.
- Views on the possibility of a short term disruption to oil supply.
- What role for Environment Canterbury on this issue?

3.2 Specific impacts of higher oil prices

A key issue in relation to the 2007/08 oil price spike cited by some interviewees was the unanticipated, sharp increase in price that occurred. This caused organisations to respond in a number of short-term and unplanned ways. If in the future there is a more predictable increase, some of the responses will also be more measured and longer term focused. Note also that the specific impacts of higher oil prices over the last three years have tended to become somewhat blurred because the recession and the flu pandemic have also had such a profound effect on the demand for some energy intensive goods and services (such as airline travel). Some of the key points made in relation to specific organisations or sectors were:

Export industries are vulnerable in these circumstances because they are ‘price takers’ and hence bear the brunt of unforeseen (or unplanned) increases in their costs. Oil price increases particularly impact on the profitability of products with a significant transport component. Ultimately this can lead to relocation of manufacturing in order to be closer to markets and reduce transport costs[32]. On the other hand some interviewees cited benefits gained under higher oil prices e.g. Solid Energy found that high oil prices transfer across to higher coal prices, thus improving the profitability of coal exports. Another example cited was the higher price obtained for NZ lamb in the Canadian market as a result of land being taken out of livestock production to grow biofuels.

Transport sector players in particular face immediate increases in costs from fuel price rises. In general they have no alternative but to pass these costs on – in the last three-four years airlines and some shipping lines and trucking companies used fuel surcharges as a way of transparently showing how increased fuel prices were adding to costs. However, it has been the second-order impacts as a result of customers’ response to price increases and the recession that have had the biggest impact on the sector. Road and sea goods volumes, and air transport passenger numbers were all cited as having reduced, thus reducing income while at the same time costs have increased.

[32] In these circumstances interviewees were reluctant to just cite oil costs as the main driver- invariably these are multi-variable decisions that also factor in relative labour costs, government policies, access to other resources etc.

Increasing fuel prices add to the pressure on operators to improve efficiency. For the trucking industry increased fuel costs have added to the arguments for allowing heavier/oversize truck loads in order to improve efficiency (which raises a set of further issues around safety, road user charging systems etc). For shipping, increased fuel costs have added to arguments for larger container vessels serving fewer NZ ports – with the implication that some ports (such as Primeport in Timaru) may be excluded from direct international trade links provided by some shipping companies. Airlines have had to be very adaptable to respond in ways that maintain profitability. Air New Zealand has reported that having flexible strategies to enable a number of efficiency gains to occur has been vital e.g. reducing capacity and services, replacing larger aircraft by smaller aircraft, fitting fuel saving wingtips[33]. Air New Zealand is one of the few airlines that has continued to report a profit over the last two years, but even then the combination of increased fuel prices (included hedge prices) and reduced passenger numbers has seen fuel costs increasing from 24% of revenue in 2008 to 37% in 2009, squeezing margins enormously.

Rural areas are particularly vulnerable because of a lack of alternative transport options. For example, last year, during the height of oil price increase, ECan experienced a big increase in requests for public transport services from areas outlying Christchurch city. In rural areas oil price increases can potentially have multiple negative effects – fuel costs increase because of 'tyranny of distance' and contribute to a downward spiral of reduced services, population decline and decline in skilled workforce etc.

Households – on average direct expenditure on fuel comprised about 5% of total household expenditure in 2006/07 (transport costs in total comprised 13%)[34]. For some households their exposure is much higher because of specific circumstances (e.g. they may choose to live in the country and face a long daily commute). Oil price rises exacerbate a cost-price squeeze on households faced with fixed incomes, and people's responses are invariably around reducing short term expenditure. A number of examples were cited:

- Trading down vehicles to more efficient models
- Some inter-fuel substitution e.g. petrol to diesel
- Renewed interest in trip sharing
- Economising in other areas – one example cited was when oil prices were at their height last year Foodstuffs noticed a trend towards people buying cheaper food in order to economise.

Government transport authorities – local government institutions, tied to 10 year LTCCPs and fixed one year budgets, experienced some difficulties during 2007/08 as the very large oil price increases placed considerable pressure on aspects of service delivery. For example, Timaru District Council, faced with a bitumen price increase of ~22% in their roading budget, delayed some aspects of their planned roads works programme.

ECan faced significant cost increases for their contracted bus services. which they met by a combination of additional funding from the New Zealand Transport Agency's (NZTA) price indexing adjustments, drawing down their passenger transport reserve fund, and raising

[33] See: http://www.airnewzealand.co.nz/resources/2009-annual-review.pdf

[34] From Household Economic Survey (Statistics NZ)

fares. ECan was about to reduce some low patronage, off-peak services if high oil prices had continued.

To a greater or lesser extent, this issue would have been faced by all road controlling authorities in the region, and also the New Zealand Transport Agency (NZTA) as the core government transport funder. In its 2008 Statement of Intent[35] the NZTA specifically outlined its risk from a reliance on income streams derived from oil-based road transport - higher oil prices lead to higher maintenance/construction and contractual costs, and potentially lower revenue streams because of reductions in transport demand.

3.3 Importance attached to oil vulnerability

Views on the future oil price - The majority of interviewees had a generally consistent view on the future oil price - a general belief that we are coming (or have come) to the end of cheap oil, rising oil prices in the medium-longer term future, and underlying market (and price) instability. These views tended to conform to the mainstream views coming through at the international and national level as outlined in the previous chapter. Where the discussion was couched in terms of the scenarios in Appendix 2, variations around scenario 3 was considered the most likely. In general though, there was not a sense of ‘crisis’, or indeed a sense that the world was ‘running out of oil’. A number of interviewees acknowledged the end of cheap oil but felt that there was not a shortage of oil (or oil alternatives) at higher prices. People expect rising oil prices to provide the signal for responses – combinations of new supply, alternatives to oil, efficiency improvements, fuel conservation, new technology, etc. Generally there was a positive attitude to this; a sense that people will find ways of adapting and coping with new situations – and it will present new opportunities as well. However there was also acknowledgement of the difficulty in relying on the price signal alone, given recent price volatility and short term focus of much of the responses.

A number of interviewees raised the issue of the component of costs associated with the price rise to $147/bbl last year – how much was due to oil scarcity, short-term physical constraints on supply infrastructure, or speculation? Certainly it was the view of several that the oil spike was greatly exacerbated by speculation, not by oil scarcity[36].

What priority is currently given to oil costs and supply? - Interviewees gave variable responses to this question. Not surprisingly, those whose businesses had a high direct oil dependency still regarded this as an important issue (e.g. road transport). Some central and local government interviewees also rated this as an important policy issue. But for most business sector interviewees the immediate threat posed by high oil prices/peak oil had faded and was now well down the list of priorities. A number of interviewees pointed out that they are confronted with multiple uncertainties and risk issues at the moment, and looking forward it is difficult to single out oil supply vulnerability as having any particular priority. The main current issues related to the impacts of the economic recession (securing buyers for products, dealing with the consequences of less volume of goods being transported etc), the high exchange rate, lack of availability of cash/investment funding, and

[35] From NZTA Statement of Intent 2008-2011.

[36] Note however that this kind of speculation is not necessarily a one-off. As a commodity, oil in the future will be prone to price speculation based on investors’ confidence in other investments and on perceptions of future scarcity and value.

lack of skilled labour[37]. For some there were also Canterbury-specific issues assuming higher strategic priority at present (e.g. water; reliability of electricity supply was considered a more important issue by a few). Solid Energy cited the risks of disruption to the Mainland Line rail link between the West Coast and the port of Lyttelton as being of far more immediate concern.

Ability to plan ahead - interviewees indicated major differences in the ability of their organisations to look ahead and strategically plan for this issue. A number of organisations referred to strategic studies being undertaken in their sector which included addressing how future oil supply issues might impact on their industry (e.g. Agriculture, Forestry, Tourism – and, in the case of land based sectors (agriculture and forestry) also the potential for energy production and oil substitution). Because of uncertainties as to the future oil price trajectory, and in particular the timing of possible increases (as alluded to in the previous chapter), it is a difficult issue for some organisations to strategically plan for.

It is interesting to observe the way in which various players within the tourism and airline travel industry, a critical sector for NZ's economic prosperity but one that is currently heavily oil-dependent, have addressed this issue. The oil price spike was clearly one of the factors contributing to a ~10% reduction in long haul inbound passenger numbers in 2008/09, but there is little to indicate now that the issue of oil vulnerability/peak oil is fundamentally changing growth prospects for the industry looking forward.

- The New Zealand Tourism Strategy was updated in September 2008[38], emphasising added-value from each tourist (i.e. an emphasis on quality rather than quantity) and the need to improve NZ's sustainability credentials through encouraging tourism sector players to adopt greater energy efficiency and reduce carbon footprint. The Strategy outlined 5 key global influences – climate change, the global economy, aviation capacity, international competition and fluctuations in the exchange rate. Security of oil supply/aviation fuel price was not among them.
- Key players in the sector are involved in a 3 year 'Tourism and Oil' research study aimed at identifying high-yielding adaptation measures for tourism to respond to global oil prices (Box 1). Several insights have been gained through the work so far, including input into the successful tourism promotion this winter to lure Australians to NZ which utilised a competitive trans-Tasman airline market, and lower oil costs through short haul travel distances compared to other markets.

> **BOX 1 Tourism and Oil study** – this study is a 3 year research programme (2007-2010) is FRST funded and involves a research team comprising Lincoln University, Covec and Landcare Research. It also has an Advisory Board comprising major players across the tourism industry. Several research papers have been produced and are downloadable (see below).
>
> Key results to date (based on analysis of results over the last few years) suggests consumer spending power in the main countries of origin, exchange rates, and the cost of tourism products and services in New Zealand are more important factors than oil prices on tourists' propensity to travel to NZ.
>
> See: http://www.leap.ac.nz/site/story.asp?bid=24&storyid=25248

[37] Also based on preliminary information from a survey of businesses conducted by the Canterbury Development Corporation.

[38] http://www.nztourismstrategy.com/files/NZTS2015%20final.pdf

- Christchurch International Airport (CIAL), the key 'gateway' infrastructure provider for the Canterbury region (and the South Island) outlined the challenges posed by oil costs in their 2008 Annual Report[39]. Actions they have taken include energy efficiency improvements and adopting carbon neutral branding by purchasing carbon credits. Fundamentally though their strategic outlook is based around continued sector growth, and positioning themselves as the main international tourism hub for the South Island. The CIAL is carrying on with an extensive terminal redevelopment, predicated on passenger throughput increasing from 5.9m currently to 6.4m in 2012 and 7.7m in 2018, a 30% increase.
- Air New Zealand, as the country's main international carrier, face the direct impacts of the oil market uncertainty, traveller decisions, and increased competition within market. In their latest Annual Review Air NZ highlight the uncertainty of planning in the current environment - they outline a range of scenarios within a +/-5% per annum band of wide body jet seating capacity in future years (i.e. within 5 years there is a 50% difference between low and high growth scenarios). Business survival in this environment requires the ability to move quickly and flexibly in terms of routes, schedules, markets served, eliminating inefficient aircraft etc. However, core major investment decisions to invest in more fuel efficient and flexible aircraft remain intact, indicating that within a very uncertain future, the running cost (and branding) benefits of more fuel efficient and 'greener' aircraft is an essential strategic priority.

Oil vulnerability or greenhouse gas emissions? - Often, 'peak oil'/oil vulnerability is lumped together with the need to reduce greenhouse gas (GHG) emissions because of the association between oil use and emissions/climate change. Interviews with tourism sector experts carried out under the Tourism and Oil study in January-March 2008 (i.e. during the lead-up to the oil price spike in July) suggested oil price concerns were a bigger threat and determinant of their business decisions than climate change policies[40]. But perceptions of the relative importance of this issue are likely to be sector specific and time dependent. In the interviews carried out for this study a number of interviewees considered that GHG issue was likely to be the more important as a policy driver, and that effective GHG policies would also have the positive effect of reducing oil supply vulnerability. Discussion of the tourism sector above also suggests that, fundamentally, GHG emission reductions are regarded as much more strategically important.

3.4 Technology/innovation

A recurring theme in the discussions with interviewees was the transformational role of new technology and innovation to steer us away from oil dependency. For some there were concrete technologies and options available that had come from significant research investment (i.e. wood/cellulose-based substitutes for oil). For others, technology options were cited, but the specific economics or feasibility were still uncertain. Biofuels were discussed as potential transport fuel options but were not necessarily seen as a long term sustainable solution.

[39] See CIAL 2008 Annual report and Statement of Intent for 2010: http://www.christchurchairport.co.nz/CorporateAndCommunity/AboutUs/FinancialReporting

[40] Susanne Becken (July 2008). The risk of higher oil prices - *Summary of interviews (published in Inside Tourism, IT697, page 7).* See: http://www.leap.ac.nz/site/story_images/4517_SummaryIntervie_s15147.doc

Electric propulsion for transport vehicles was raised by a number of interviewees – for both personal transport and public transport – and this has received further media prominence since the interviews were carried out[41]. There were discussions also around the local infrastructural implications of a significant shift to electric vehicles (EVs), in light of recent announcements on the imminent availability of battery electric cars and plug-in hybrid vehicles, and the re-charging networks that are being developed in the US and elsewhere[42]. Even although the current range of EVs is significantly less than petrol or diesel vehicles, in New Zealand's market where there is a high ownership of 2nd vehicles, shorter-range EV vehicles could still find significant market appeal. Energy use for EVs is being cited in the range of 0.15-0.25kWh per km[43], meaning that for a car covering 8,000km per year electricity use would be 1,200-2,000kWh per year.

For EVs to take hold in NZ (and specifically in Canterbury) a number of issues will need to be worked through around electricity supply, recharge points, time of day network demands etc. Based on the experience of California however, unlike oil supply which relies on global-national-local supply chains and networks, it is quite feasible for the infrastructure for EVs to be developed at a local level.

This issue, combined with other concerns raised about the security and quality of electricity supply in the region, suggests that enhancement of regional electricity grids, including integration of local, carbon neutral sources of generation should be a regional priority.

3.5 Short term disruption

A high proportion of interviewees (across a range of interests) considered there was a realistic risk of a short-term oil supply disruption. The cause would not necessarily be 'peak oil' related; quite a few mentioned things like a ship grounding, a CDEM issue (earthquake, flooding etc), or a close-down due to pandemic. Despite this expectation, however, there appeared to be little in the way of preparedness for such an event themselves. There was almost a resigned view that if such an event happened there would not be much that any individual organisation could do, and that national or local contingency plans would kick in and shortages/allocations would be dealt with in this way. Few organisations seemed clear on what those contingency plans would be, or how fuel might be allocated amongst competing needs. A number of interviewees offered the view that they considered the level of available fuel storage in the region to be marginal at best, and that there was a very thin margin between 'adequacy' and 'shortage'.

Transport operators (in general) appeared to have little in the way of contingencies planned themselves. They don't carry reserve stocks of fuel themselves so depend on regular top-ups of their own tanks (which typically would only provide a few days supply), or they rely for all their fuel from Truck Stops, which typically require regular fills from the bulk storage tanks at Woolston or ports.

[41] See: http://www.nzherald.co.nz/motoring/news/article.cfm?c_id=9&objectid=10593854 (accessed 29.8.09)

[42] See fact sheet issued by the California EPA Air Resources Board on EVs and charging networks: http://www.arb.ca.gov/msprog/zevprog/factsheets/evinformation.pdf. See also presentation from NZ's Electricity Commission: http://www.electricitycommission.govt.nz/pdfs/opdev/modelling/vehicles/PHEV.pdf

[43] The California Air Resources Board (Ibid) cites a current average of electric vehicles on the road in California as about 0.25kWh/km. Specifications for the Nissan Leaf, a specifically designed all electric car to be launched in 2010 cite a range of 160km on a full battery charge of 24kWh i.e. 0.15kWh/km (http://www.autoblog.com/2009/08/01/2010-nissan-leaf-electric-car-in-person-in-depth-and-u-s-b)

Supply disruptions would carry far more serious consequences depending on the time of year. For example for the dairy industry a fuel disruption in the middle of the milking season will be much more serious than in the middle of winter.

3.6 Role of Environment Canterbury

In general interviewees did not see a strong role for Environment Canterbury to play on this issue. Some considered that it should be more one for national policy i.e. policies needed to be focused on 'NZ Inc' rather than being regional. There was also a fairly consistent view that letting the market operate by having higher prices flowing through to consumers is a necessary part of any change process – in other words exposure to higher prices is not necessarily a bad thing and is part of what will generate change to greater efficiency, fuel alternatives etc. (these comments seemed to be partly made in response to a sense that ECan might have been suggesting that higher prices were a bad thing and should be avoided).

Some interviewees did see a constructive role that ECan could play. CIAL, for example, believed ECan could play a stronger role in the planning of strategic infrastructure related to fuel use – e.g. Lyttelton port and access, and possible access ways for fuel delivery by pipeline to the airport. Others felt ECan's role should be more around raising awareness of the issue.

In terms of mitigation strategies for coping with short term oil price volatility ECan's use of their passenger transport reserve fund during 2007/08 was instructive. The fund provided ECan with a degree of flexibility to manage short-term unplanned price increases. The use of such a mechanism may have wider applicability, in particular for organisations that work to annual fixed budgets (e.g. local govt), and where unbudgeted oil increases could result in unacceptable outcomes (such as curtailment of services, delays in expenditure etc). ECan could advise other bodies on setting up and managing a reserve.

For a number of years ECan has participated in the Canterbury Regional Energy Strategy Project (CRESP) which, amongst other things, is endeavouring to provide the region with a more secure, reliable and affordable energy supply system. There is an opportunity for ECan and CRESP to expand on the work done to date and to specifically factor in aspects of electricity supply and grid architecture that would be required to meet a growing market for EVs[44].

A final point relates to communication on this issue and use of the term 'peak oil', which for some interviewees in this study carried negative associations because 'peak oil' is often portrayed in 'end of civilisation as we know it' views of the future. There was also concern that use of the term risked overly simplifying a dynamic and complex international global oil supply picture. Use of terminology such as 'oil supply vulnerability' could be used instead.

[44] Note that the opportunity for EVs is likely to shape at least one recommendation of the draft Canterbury Regional Energy Strategy, under development in 2009 (pers comm. M O'Connell, ECan).

4 Recommendations

Preparedness for a short term fuel emergency – A significant proportion of interviewees considered there was a reasonable likelihood of some kind of fuel supply disruption in future years. Much work has been carried out recently to better equip NZ in the event of a fuel emergency, but there seemed to be little actual knowledge in the transport sector about how fuel would be allocated to sectors, protocols etc. There is an opportunity to better acquaint fuel users with the logistical arrangements around fuel supplies in Canterbury in the event of an emergency. Further clarity would be helpful because this would enable industry to better assess their risk, and be in a better position to judge whether they need to take additional risk management measures themselves. ECan could take the lead to organise this with the Road Transport Forum and involve speakers from the MED and CDEM group.

Arrange a stakeholder briefing around oil security and oil emergency response procedures.

Electricity – The issue of the quality and security of electricity supply was raised from a number of different perspectives - not just oil vulnerability related. It was raised in relation to the high dependence of local business and key export industries; as a key aspect of 'rural proofing'; and as an essential aspect of infrastructure development for electric vehicles and transport without oil. The findings from this work add weight to the priority given to regional electricity supply by the CRESP project, but an added dimension is to specifically factor in aspects of electricity supply and local grid architecture that would be required to meet a growing market for EVs in the future. Concepts such as a local 'smart grid' need to be further developed.

Develop EV considerations into planning for a secure and sustainable electricity supply and grid architecture in the region.

Risk management – Based on mainstream views of the future oil price, organisations should be planning for higher oil prices. In addition though there is core uncertainty around the timing and trajectory of increases – price volatility is a characteristic of the short-term oil market, while longer term price scenarios are characterised by a wide range of price possibilities. Organisations need to employ appropriate strategies to manage this risk. An example of a particular risk management strategy to help mitigate short term price volatility is Environment Canterbury's passenger transport reserve fund. Note that reserve funds are not suitable to accommodate longer term, expected increase in prices. These should be baseline budgeted. The reserve is there to manage the unpredictable overs and unders.

Encourage regional organisations to adopt appropriate risk management strategies to deal with various upward oil price pathways and volatility in prices, and the possibility of short term supply disruption.

Appendix 1 Interviewees

Interviewees were identified from a combination of having had previous contact with ECan on energy issues, and being recommended by others as being knowledgeable on the subject. There was no prior expectation about the views interviewees would have on the issue. Interviewees were drawn from a range of sectors – government, tourism, manufacturing and exporting, dairying/agriculture and horticulture, transport, infrastructure – but they were not necessarily interviewed as 'representatives' of either their sector or organisation they worked for. Sometimes the interviewees gave personal views on the issue.

Questions were focussed around 4 aspects:

(1) basic information on the oil dependency of the sector

(2) their assessment of the likelihood of each of the scenarios happening

(3) the implications of the scenarios on the sector

(4) what, if anything, should be done to better prepare for the future.

List of interviewees:

Susanne Becken (Associate Professor, LEAP), Lincoln University

Jeremy Boys (Chief Executive), Primeport Timaru

Jo Buckner, James Palmer (National Strategy Manager), Parnell Trost Ministry of Agriculture and Forestry (MAF)

Andrew Dixon, Timaru District Council

Stephen Esposito (Director Strategy and Risk), Solid Energy

Gavin Forrest, Office of the Minister of Agriculture

Stephen Godfrey (Business Analyst), Orion

Peter Goodwin (Area Manager Region 4), NZ Road Transport Association

Mark Gordon, AECom

Mike Graveson, Fonterra

Richard Hawke (Manager Energy and the Environment), Simon Lawrence, Andrew Robertson, Mark Walkington Ministry of Economic Development (MED)

Wayne Holton-Jeffreys (Passenger Services Manager), David Stenhouse, Environment Canterbury

Rob Lawrence (Business Analyst), Canterbury Employers Chamber of Commerce

Bill Luff (Chief Executive), Toni Brownie (General Manager Strategy and Services), Amy Marshall (Economic Analyst), Canterbury Development Corporation (CDC)

Ken McAnergney, (Manager Planning), Rhys Boswell (General Manager Planning and Environment), Christchurch International Airport Ltd (CIAL)

Chris Ward, Horticulture New Zealand

Steve Wilson (Managing Director), Talbot Plastics

Appendix 2 Oil supply 'Vulnerability Scenarios'

Four 'vulnerability scenarios' were developed to explore the implications of possible peak oil futures. The background for all scenarios is the likelihood of tightening margins between oil supply sources and demand, with old established supply sources diminishing and new sources struggling to keep up with new demand (as per IEA and others). However, differences in the nature of this supply-demand relationship, and in responses in the marketplace, are explored.

Scenario 1. Interruption of supply. A physical supply interruption <u>of various length</u>(s) and at some indeterminate time in the future. This scenario most likely represents a period of international chaos in oil supply chains cause by a number of possibilities e.g.:

- a major climatic catastrophe taking out production in an area for a period, or
- political turmoil resulting in loss of supply from a major source, tanker diverted/not arriving, major refinery outage etc., or
- ongoing consequences of a rapidly dwindling oil supply from existing sources, raising tensions and making existing supply chain vulnerable to disruptions.

Scenario 2. High and increasing fuel price. This would most likely come about through the combination of demand at least holding firm under higher prices (because of expanding economic activity, particularly in China and India), and supply becoming increasingly tight. Increasingly tight, or even reducing supplies could come about through combinations of the following:

- accelerating decline in non-OPEC existing supplies (as noted by IEA)
- combinations of OPEC managing the balance of supply to create very tight supply margins (as per current OPEC policy), or OPEC themselves experiencing a physical decline in their oil supply capability.

By 'high and increasing fuel price' we are looking at oil prices being sustained at price levels over $100/bbl.

Scenario 3. 'Undulating plateau'. This is based on the CERA scenario whereby general instability in oil supply-demand produces instability in oil prices - i.e. periods of perceived (or fear of) over and under-supply, lags between investments and production, impact of extreme weather events etc., followed by periods of economic decline, demand fall-off, oil price slumps etc. It is based on the market working, but rather imperfectly. The underlying conditions are ones of a general tightening of oil supply as existing fields decline, so there is most likely to be a general upward trend to the oil price floor.

Scenario 4. 'No crisis'. This scenario accepts that there will be 'peak oil' but that as oil production peaks new sources/technologies take over and there is a more or less seamless shift to alternatives to oil over the long term. Oil prices would rise and fall periodically, but not in ways that produce major instability. The supply-demand market for oil will be relatively stable, and the progression away from dependence on oil will be relatively smooth. New technologies such as electric cars will be introduced in a fairly orderly manner over time, with markets and institutional responses being reasonably aligned.