The Senate

Standing Committee on Rural and Regional Affairs and Transport

Australia's future oil supply and alternative transport fuels

Final report

February 2007

ISBN 0 642 71726 5

This document was prepared by the Standing Committee on Rural and Regional Affairs and Transport, and printed by the Senate Printing Unit, Department of the Senate, Parliament House, Canberra.

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CHAPTER 1 – Introduction

This inquiry was prompted by the question of whether Australia should be concerned about 'peak oil'. This term refers to the theory that, for fundamental geological reasons, global conventional oil production will reach a peak and then start an irreversible decline soon enough to be of concern. [1.3]

CHAPTER 2 – Future oil demand and supply

Projections of world oil production and consumption

The International Energy Agency (IEA), in its *World Energy Outlook 2005*, predicts that in a 'reference scenario' world demand for oil will grow from 82 million barrels per day in 2004 to 92 millions barrels per day in 2010 and 115 million barrels per day in 2030 – an average growth rate of 1.3 per cent per year over the period. [2.30]

It assumes that most of the increased demand for oil to 2030 will be supplied by a large increase in OPEC production, particularly in the Middle East. [2.32]

The IEA argued that resources are adequate to meet projected demand, although 'reserves will need to be "proved up" in order to avoid a peak in production before the end of the projection period [2030].' However it noted that financing the investment needed to find and exploit the resources is a serious challenge. [2.31]

The core document used to support the assumption that oil supply will not be constrained before 2030 appears to be the US Geological Survey's *World Petroleum Assessment 2000* (USGS 2000). This estimated that the world's total conventional oil and natural gas liquids produced to 1995, or with potential to be added to reserves between 1995 and 2025, is about 3,345 billion barrels. Of this about 1,000 billion barrels has already been produced. [2.35]

Oil production and consumption in Australia

Australia's demand for petroleum is over 750,000 barrels per day. This is projected to rise to over 800,000 barrels per day by 2009-10, and over 1,200,000 barrels per day by 2029-2030. [2.43]

Australia's net self-sufficiency in oil is expected to decline significantly as future discoveries are not expected to make up for the growth in demand and the decline in reserves as oil is produced. [2.48]

CHAPTER 3 – ‘Peak oil’ concerns about future oil supply

‘Peak oil’ commentators commonly predict a peak of conventional oil production somewhere between now and 2030. They fear that declining production after the peak will cause serious hardship if mitigating action is not started soon enough. [3.3]

‘Peak oil’ commentators mostly estimate an ultimately recoverable resource (total production past and future) of conventional oil much lower than official agencies such as the US Geological Survey. This affects the timing of the peak as the rate of production should be expected to peak when about half the ultimately recoverable resource has been produced. [3.17, 3.73]

The main areas of disagreement are:

- Estimates of current reserves: Peak oil commentators argue that estimates of remaining reserves are unreliable and probably overstated, particularly in the Middle East. [3.19]
- Estimates of future reserve growth: ‘Reserve growth’ is the commonly seen increase in the estimated reserves of already discovered oilfields over time. USGS 2000 estimated future world reserve growth by analogy with past reserve growth in the United States. Peak oil commentators argue that this is unsound, since US reserve growth has been enlarged by factors which do not apply worldwide or will not apply as much in future. [3.25, 3.27, 3.31]
- Estimates of future oil discoveries: New field oil discoveries have declined greatly since the 1960s. USGS 2000 estimates of future discoveries, to be realised, would require a drastic turnaround of this declining trend. Peak oil commentators argue that the declining trend of oil discovery reflects geological fundamentals and should be expected to continue. [3.38, 3.40, 3.52]

Estimating the timing of peak oil

The timing of peak oil is debated. However the concept appears to be well accepted including by official agencies. [3.88]

The US Energy Information Administration in 2000 estimated a peak between 2020 and 2050 depending on assumptions about demand growth and the size of the ultimately recoverable resource. In a similar exercise the International Energy Agency (IEA) in 2004 estimated a peak of conventional oil production between 2013 and 2037 depending on assumptions. Many commentators predict an earlier peak. [3.79, 3.82, 3.86]

The US Energy Information Administration study found that widely differing estimates of the ultimately recoverable resource (URR) make surprisingly little difference to the timing of the peak. The exponential growth of demand is the dominating factor. [3.83]

From this it follows that an optimistic view of long term oil supply cannot rely only on a high estimate of the URR. It must rely on an optimistic view of the ability of market forces and technological progress to bring alternative fuels on stream in a timely way in sufficient quantity to serve the post (conventional) oil age. [3.90]

Investment needed to maintain production

The upstream developments needed to offset depletion of existing oilfields and to supply demand growth will require very significant investment. The IEA's recent World Energy Outlooks have stressed that there is no guarantee that this will be forthcoming. [3.94]

The prospects of nonconventional oil

All scenarios for future oil production assume increased exploitation of nonconventional oil (heavy oil, tar sands, shale oil) to offset declining conventional oil. Peak oil commentators argue that large scale exploitation of these resources will be too difficult and costly to make much difference to the peak oil problems which they predict. [3.99, 3.105]

The IEA notes that 'producing such a massive amount of resources can only be done over long periods of time… simply mobilising the capital… is likely to take several decades.' [3.107]

Implications for the price of oil

Demand for oil is relatively inelastic, because for its major use – transport – there are no easy substitutes. This means that a relatively small shortfall in supply can cause a large increase in price. This will increase the volatility of the price in response to small changes in supply when there is little spare capacity. [3.114]

The IEA now expects that the price of crude oil will ease to about US$47 per barrel by 2012, theìn increase to US$55 by 2030 (2005 dollars). Prices are likely to remain volatile. Some commentators believe that much higher prices are possible. [3.112, 3.117]

New warnings in the World Energy Outlook 2006

The IEA's *World Energy Outlook 2006* (WEO 2006) gives serious new warnings about the energy future. It regards current trends as 'neither secure nor sustainable'. It stresses the need for energy policy to be consistent with environmental goals – chiefly, the need to reduce greenhouse gas emissions. [3.121, 3.122]

The WEO 2006 proposes an 'alternative policy scenario' to reduce the growth of energy use and greenhouse gas emissions. A key finding is that energy saving measures reduce the total investment required to meet the demand for energy services. [3.125, 3.128]

Committee comment on peak oil concerns

The essence of the peak oil problem is risk management. The risks involved are high if peak oil comes earlier than expected, or if economies cannot adapt quickly enough to the post peak decline. Australian governments need better information from which to decide a prudent response to the risk. [3.135]

Recommendation 1 (paragraph 3.136)

The committee recommends that Geoscience Australia and ABARE reassess both the official estimates of future oil supply and the 'early peak' arguments and report to the Government on the probabilities and risks involved.

The committee considers that more needs to be done to reduce Australia's oil dependency in the long term. This is desirable not only because of peak oil concerns, but also for other reasons – to mitigate greenhouse gas emissions; to mitigate the costs of the expected long term decline in Australia's net oil self-sufficiency; and to mitigate the risks of supply disruptions as oil production becomes concentrated in a declining number of major oil-producing countries, some of which are politically unstable. [3.144]

Recommendation 2 (paragraph 3.145)

The committee recommends that in considering a less oil dependent policy scenario, the Government take into account the concerns expressed in the *World Energy Outlook 2006*, namely -

• current trends in energy consumption are neither secure nor sustainable;

• energy policy needs to be consistent with environmental goals, particularly the need to do more to reduce fossil fuel carbon dioxide emissions.

CHAPTER 4 – Economic and social impacts of possible higher fuel prices

The general impact of a long term higher oil price would be reduced economic growth. A price increase transfers income from oil-consuming to oil-producing nations, and the net economic effect is negative. [4.11]

Industries in which fuel is a higher proportion of input costs will be relatively more affected. These include transport (particularly aviation), mining and agriculture. [4.30-4.35]

Among consumers, higher fuel prices are likely to have most effect on those who are highly reliant on car transport and lack alternatives. These people tend to be outer suburban residents and rural and regional communities. [4.36]

The expected future concentration of oil production in fewer countries increases the risk of disruptions to supply. [4.46]

CHAPTER 5 – Supply side responses: overview and exploration

Oil exploration in Australia

Australia's self-sufficiency in oil is expected to decline into the long term as reserves are depleted and because of rising demand. It appears prudent to encourage oil exploration. [5.5, 5.7]

By world standards Australia's sedimentary basins have been only lightly explored. However opinions differ about the prospects of finding significant quantities of new oil. [5.8, 5.12, 5.13]

Current exploration activity is not high by historical standards, because of exploration costs and risks; uncertainty about the longer term price of oil; and policy settings including taxation regimes and incentives. On 14 August 2006 the Prime Minister announced a number of initiatives to stimulate exploration. [5.18, 5.19, 5.30]

There are reasonable grounds to believe that there are good prospects for discovering further reserves. However a multifaceted approach to reduce dependence on imported oil is still necessary. [5.33]

CHAPTER 6 – Alternative fuels from gas, coal and shale

Gaseous fuels: natural gas, LPG and hydrogen

Natural gas as a vehicle fuel has advantages and disadvantages. Advantages include its ready availability and claimed lower emissions. Disadvantages include the size and weight of storage tanks, the limited range of vehicles; the energy cost of compressing or liquefying the gas; the lack of refuelling infrastructure; and doubt about the long term gas price. [6.28, 6.29, 6.36]

The claimed environmental advantages of natural gas are not completely clear. Greenhouse gas emissions in use are lower than petrol or diesel; however on a 'well to wheels' basis the advantage may be reduced or neutralised by the energy cost of compressing or liquefying the gas; the unintended leakage of methane (which is a powerful greenhouse gas); and by release of carbon dioxide which is found in natural gas reservoirs. [6.65-6.67]

Australia is the world's largest per capita user of automotive LPG, and the number of LPG vehicles is increasing, encouraged by recently established government subsidies. LPG is superior to regular petrol in greenhouse terms. However there are some doubts about the long term adequacy of supply, depending on what proportion of the vehicle fleet is converted. [6.76, 6.83, 6.90]

Hydrogen has been put forward as a transport fuel, however there are formidable technical challenges before it could be widely used. In the committee's view it might be considered for the distant future, but it is not a useful option for the current or medium term. [6.93-6.95]

Synthetic fuels from gas or coal

Processes to produce liquid fuels from gas or coal are well proven. [6.96]

Gas-to-liquids (GTL) diesel is compatible with existing refuelling infrastructure and can be blended with conventional diesel. Plants have tended to be built where gas prices are low. Uncertainty about the longer term oil price seems to be holding back investment in Australia and elsewhere. [6.102-6.106]

The well to wheels greenhouse gas performance of the output liquid is debated. One study shows greenhouse emissions higher than conventional diesel, though lower than conventional petrol. [6.110-6.111]

Coal-to-liquids (CTL) is seen by some as a viable method of producing liquid fuel on a large scale in the near future. Capital costs per barrel of daily capacity are somewhat higher than for a gas-to-liquids plant. A plant currently proposed for the Latrobe Valley is estimated to cost $5 billion to produce 60,000 barrels per day, 80 per cent of which would be diesel. [6.116, 6.120, 6.123]

The output liquid has high well to wheels greenhouse gas emissions. If a charge was made for carbon dioxide emissions in future this would affect its viability. [6.121]

The CTL plant proposed for the Latrobe Valley would include carbon capture and storage. Carbon capture and storage has been demonstrated on a relatively small scale in several parts of the world, and the committee was told it is 'well on the path of being proven.' [6.126, 6.129]

It appears that there are grounds for cautious optimism that carbon capture and storage technology has good prospects for success. However, the committee also notes the comments in the recently released IEA *World Energy Outlook 2006* that carbon capture and storage has not yet been demonstrated on a commercial basis. [6.138]

Significant production of gas-to-liquids or coal-to-liquids fuel will require large capital investment and long lead times, and involve risks that are hard to manage, such as the longer term price of oil and gas. [6.135-6.136]

Oil from shale could theoretically make a significant contribution to Australia's transport fuel requirements, however there serious economic, technical and environmental obstacles to commercialising it. It is suggested that oil from shale is only viable when the long term crude oil prices reaches $US70-95 per barrel. [6.148, 6.149]

CHAPTER 7 - Supply side responses: biofuels

The government has a target of 350 million litres of biofuels production by 2010. The two most commonly discussed biofuels are ethanol and biodiesel. [7.1, 7.7]

Ethanol

Ethanol blended with petrol is widely used as a vehicle fuel in some countries. In Australia it is currently produced from sugarcane (generally using molasses), grain and grain residues. [7.15]

Some submissions argued that the availability of affordable feedstocks is a major factor limiting greater ethanol production. Production of ethanol from lignocellulose, though not yet proven on a large commercial scale, offers potential to greatly increase production and improve the energy return on energy invested. [7.17, 7.25]

E10 has fewer greenhouse gas emissions than neat petrol. The net effect on other emissions is less clear. [7.35]

The 2005 Biofuels Taskforce found that the long term oil price would need to average US$42-47 per barrel (2004 dollars) for new ethanol producers to be viable after 2015 without assistance (depending on the feedstock used). [7.44]

The main barrier to growth is the commercial risk for investors considering the uncertainty of the future price of petrol and ethanol, and current consumer resistance to ethanol. [7.51, 7.54]

The committee supports the development of a fuel ethanol industry, but notes the significant barriers that need to be overcome before it becomes a mainstream fuel. It appears that production from lignocellulose is the only realistic way to make ethanol a mainstream fuel. [7.56, 7.57]

The committee considers that there is a need to increase transparency in relation to whether biofuels targets are being met. [7.62]

Recommendation 3 (paragraph 7.63)

The Committee recommends that the Government publish the results of its review of progress made towards meeting the biofuels target of 350ML per year, including which companies are meeting the target.

Recommendation 4 (paragraph 7.64)

The committee recommends that the Government examine the adequacy of funding for lignocellulose ethanol research and demonstration facilities in Australia, and increase funding where appropriate.

Biodiesel

Biodiesel is a diesel-like fuel made by chemically modifying vegetable oils or animal fats. A limited amount of biodiesel is already produced in Australia, but it is available at only a few locations. A major challenge for increasing production is obtaining affordable feedstocks. [7.66, 7.68, 7.89]

Biodiesel has lower emissions of pollutants and greenhouse gases than conventional diesel. [7.86 - 7.88]

Recent changes to the fuel taxation system have reportedly had an adverse impact on the prospects of the industry. The Biofuels Taskforce considered that between 2010 and 2015 biodiesel is likely to become commercially unviable. [7.72]

The committee considers that biodiesel can make a small but worthwhile contribution to Australia's fuel mix. However the economics of the industry are precarious, particularly if government assistance is reduced, as is the current policy. [7.89]

Committee comments on alternative fuels in general

In relation to alternative fuels in general, the committee acknowledges that massive investment in large scale production will be essential if they are to replace conventional fuels to any significant degree. Corporations see this investment as risky. Some alternative fuels face consumer acceptance barriers. There are also long lead times associated with many of these projects. Unless risk can be quantified or controlled, investment will not be forthcoming. [7.90 – 7.93]

Recommendation 5 (paragraph 7.96)

The committee recommends that the Government commission a research group within the Department of the Treasury to identify options for addressing the financial risks faced by prospective investments in alternative fuels projects that are currently preventing such projects from proceeding. This group should determine how these risks might be best addressed in order to create a favourable investment climate for the timely development of alternative fuel industries, consistent with the principles of sustainability and security of supply.

CHAPTER 8 – Demand side responses

Increasing the fuel efficiency of vehicles

Since 1979 the fuel efficiency of light vehicle engines has improved significantly. However the efficiency of the light vehicle fleet has improved more slowly, as consumers have moved to larger, more powerful vehicles. [8.4]

A current voluntary code agreed in 2003 between government and the Federal Chamber of Automotive Industries calls on FCAI members to improve the national average fuel consumption of new passenger cars to a target of 6.8 litres per 100km by 2010 (the actual figure in 2001 was 8.28 litres/100km). This would require a significant improvement on the trend of the decade before 2001. [8.9]

It is unclear what progress has been made to achieve this target. The committee recommends that this should be investigated. [8.12, 8.13]

Recommendation 6 (paragraph 8.21)

The committee recommends that the Government, in consultation with the car industry, investigate and report on trends in the fuel efficiency of the light vehicle fleet and progress towards the 2010 target for the fuel efficiency of new passenger cars. If progress under the present voluntary code seems unlikely to meet the target, other measures should be considered, including incentives to favour more fuel efficient cars; or a mandatory code.

Other suggestions in submissions to improve the fuel efficiency of cars include:

- measures to encourage smaller and hybrid cars, for example by adjusting registration fees to favour them;
- measures to encourage diesel cars; and
- increasing the fuel excise to encourage use of more efficient vehicles (this could be coupled with lower registration charges to be tax-neutral overall). [8.16]

Congestion charges

A congestion charge is a road use charge tailored to target the most congested times or places – for example, a cordon charge to enter a Central Business District, or a toll that varies according to the time of day. [8.29]

A congestion charge, by discouraging some users, reduces congestion. This improves fuel efficiency, as vehicles use more fuel in congested conditions. [8.29]

While the economic case for congestion charging is strong, politically is has been difficult to implement because of the perception that it is 'yet another tax on motorists'. To win public support it is important to hypothecate the revenue for transport improvements, including public transport improvements so more motorists have alternatives to their cars. [8.31]

The committee suggests that Australian governments should take a more active role in educating the public about the benefits of congestion charges. [8.34]

Recommendation 7 (paragraph 8.35)

The Committee recommends that Australian governments investigate the advantages and disadvantages of congestion charges, noting that the idea may be

more politically acceptable if revenue is hypothecated to public transport improvements (as has been done in London, for example).

Encouraging walking, cycling and public transport in cities

Many submissions argued for increased use of walking, cycling and public transport as a way of reducing transport fuel use. Ambitious goals for increasing the public transport mode share are commonly seen in official plans. [8.36, 8.39]

Many submissions urged the Commonwealth to be more involved in improving urban public transport infrastructure, as happens in many other federal countries. The Commonwealth's policy is that public transport is the responsibility of the states. [8.39, 8.41]

However the Commonwealth has supported 'Travelsmart' projects through the Greenhouse Gas Abatement Programme. Travelsmart aims to reduce car use by direct approach to targeted households (for example, to give information about public transport services). This can be a very cost effective, and the committee recommends that Commonwealth support should continue. [8.42, 8.55]

Recommendation 8 (paragraph 8.56)

The committee recommends that Commonwealth support for Travelsmart projects be maintained beyond the currently planned termination date.

The committee does not suggest that the Commonwealth should take over the States' basic responsibility to operate public transport services. However there may be a case for Commonwealth assistance to major projects such as rail extensions which are unlikely to happen, or unlikely to happen soon enough, without the involvement of the bigger budget which the Commonwealth commands. [8.53]

Integrating transport planning and land use planning

Car-dominated transport habits reflect patterns of urban development which make high car use necessary. Submissions stressed that turning around this situation requires better public transport and planning policies to shape urban development so that public transport networks can work efficiently and attract more 'choice' customers. [8.57, 8.61]

Urban strategic planning is the responsibility of State and Territory governments. The needed initiatives involve state and local governments. The right institutional arrangements and powers are needed to ensure that the planning and the execution are coherent. [8.67]

More use of rail for long distance freight

Many submissions argued for more use of railways for long distance freight. Trains use about one third the fuel of trucks per net tonne/kilometre. [8.71]

Commonwealth policy recognises that the rail system has been under funded in the past and has the potential to increase its share of the freight task if there are improvements to infrastructure and modernisation of operating practices. The Commonwealth has committed $2.4 billion to rail improvements over the five years to 2008-2009, mostly for the Melbourne-Sydney-Brisbane corridor. [8.75]

If there is a long term rise in the price of fuel, this will favour rail, because fuel is a greater proportion of total costs for road transport. This may suggest a need to increase the pace of catch-up investment in rail infrastructure. Auslink corridor strategies should allow for this. [8.77]

Recommendation 9 (paragraph 8.78)

The committee recommends that corridor strategy planning take into account the goal of reducing oil dependence as noted in recommendation 2. Existing Auslink corridor strategies should be reviewed accordingly.

Fringe benefits taxation of employer-provided cars

Many submissions argued that the concessionary tax treatment of cars as a fringe benefit should be abolished, on the grounds that

- it encourages car use and undesirably distorts economic behaviour;
- as a way of assisting the Australian car industry it is poorly targeted, as now only 29 per cent of new cars are Australian made. [8.82, 8.87]

The concession arises because the statutory formula which most people use to calculate the tax obligation overestimates the amount of business use of the cars in question – thus, some private use is untaxed. [8.84]

The committee notes that the Council of Australian Governments (COAG) is now considering options for managing urban traffic congestion. The committee suggests that this should include the Commonwealth reconsidering the policy behind the concessionary fringe benefits taxation of cars. [8.91]

Recommendation 10 (paragraph 8.94)

The Committee recommends that the government review the statutory formula in relation to fringe benefits taxation of employer-provided cars to address perverse incentives for more car use.

It should be stressed that the question of whether the tax should be concessionary is different from the question of minimising compliance costs. A statutory formula method can be retained for the sake of easy compliance, while the concessionary aspect can be removed by adjusting the rates. [8.95]

RECOMMENDATIONS

Recommendation 1

3.136 The committee recommends that Geoscience Australia, ABARE and Treasury reassess both the official estimates of future oil supply and the 'early peak' arguments and report to the Government on the probabilities and risks involved, comparing early mitigation scenarios with business as usual.

Recommendation 2

3.145 The committee recommends that in considering a less oil dependent policy scenario, the Government take into account the concerns expressed in the World Energy Outlook 2006, namely -

• current trends in energy consumption are neither secure nor sustainable;

• energy policy needs to be consistent with environmental goals, particularly the need to do more to reduce fossil fuel carbon dioxide emissions.

Recommendation 3

7.63 The Committee recommends that the Government publish the results of its review of progress made towards meeting the biofuels target of 350ML per year, including which companies are meeting the target.

Recommendation 4

7.64 The committee recommends that the Government examine the adequacy of funding for lignocellulose ethanol research and demonstration facilities in Australia, and increase funding, where appropriate.

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8.21 The committee recommends that the Government, in consultation with the car industry, investigate and report on trends in the fuel efficiency of the light vehicle fleet and progress towards the 2010 target for the fuel efficiency of new passenger cars. If progress under the present voluntary code seems unlikely to meet the target, other measures should be considered, including incentives to favour more fuel efficient cars; or a mandatory code.

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8.56 The committee recommends that Commonwealth support for Travelsmart projects be maintained beyond the currently planned termination date.

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8.78 The committee recommends that corridor strategy planning take into account the goal of reducing oil dependence as noted in recommendation 2. Existing Auslink corridor strategies should be reviewed accordingly.

Recommendation 10

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Chapter One

Introduction

1.1 The Senate referred the inquiry to the committee on 29 November 2005. The terms of reference are:

> Australia's future oil supply and alternative transport fuels, with particular reference to:
>
> a) projections of oil production and demand in Australia and globally and the implications for availability and pricing of transport fuels in Australia;
>
> b) potential of new sources of oil and alternative transport fuels to meet a significant share of Australia's fuel demands, taking into account technological developments and environmental and economic costs;
>
> c) flow-on economic and social impacts in Australia from continuing rises in the price of transport fuel and potential reductions in oil supply; and
>
> d) options for reducing Australia's transport fuel demands.

1.2 The committee advertised the inquiry in *The Australian* and wrote to many peak bodies inviting submissions. The committee received 194 submissions and held nine hearings. The committee thanks submitters and witnesses for their contribution.

1.3 The inquiry was prompted by the question whether Australia should be concerned about 'peak oil'. This refers to the theory that, for fundamental geological reasons, global conventional oil production will reach a peak and then start an irreversible decline soon enough to be of concern. Proponents of peak oil arguments commonly predict a peak somewhere between now and 2030. They suggest that this could cause serious economic hardship if mitigating action is not started soon enough.

1.4 There are additional concerns about recent rises in the price of oil, and concerns about the possible longer term effect as Australia's need for imported oil increases.

1.5 The inquiry was informed by the knowledge that there is a convergence of concern about increasing atmospheric concentrations of greenhouse gases and declining global oil supplies. It was understood that solving the transport fuel challenge without reference to reducing greenhouse gas emissions would be a flawed response. The Committee determined to identify transport fuel solutions that were also consistent with the objective of reducing emissions.

1.6 The committee made an interim report on 7 September 2006. This report replaces the interim report.

Structure of the report

1.7 Chapter 2 summarises predictions of Australian and world oil production and consumption.

1.8 Chapter 3 notes the arguments of the peak oil proponents and responses by their critics. It concludes that the possibility of peak oil before 2030 should be a matter of concern.

1.9 Chapter 4 describes the possible social and economic impacts of sustained high oil prices.

1.10 Chapters 5, 6 and 7 discuss possible supply side responses to long term high oil prices, including more exploration for oil in Australia; alternative fuels from gas, coal and oil shale; and biofuels.

1.11 Chapter 8 discusses possible demand side responses to reduce dependence on oil-fuelled transport. The items most mentioned in evidence were encouraging more fuel efficient vehicles, reducing reliance on cars for transport in cities, and encouraging more use of railways for long distance freight.

Chapter Two

Future oil demand and supply

Oil and gas basics

2.1 Petroleum hydrocarbons, principally crude oil and natural gas, form from the remains of marine organisms and algae which are buried by sediments and subjected to conditions of high temperature and pressure over hundreds of millions of years. Gas forms when the temperature and pressure are higher; oil when they are lower. The oil and gas, being lighter than water, then migrate towards the surface through pores or fissures in the rock. They may reach the surface and be lost; or a recoverable reservoir may form if it accumulates in a layer of rock which is capped by an impermeable layer that prevents it from rising further. A petroleum reservoir may accumulate a variety of gaseous and liquid hydrocarbon compounds, natural carbon dioxide and water at depths varying between some tens of metres to thousands of metres.

2.2 The oil-forming process is still at work, but it is so slow that the current oil and gas resource is effectively non-renewable.

2.3 Simple hydrocarbon molecules are comprised of a chain of carbon atoms with hydrogen atoms attached. The properties of different hydrocarbons depend largely on the length of the carbon chain. Short chain molecules form gases at standard temperature and pressure while longer chains form liquids (and eventually solids), becoming denser and more viscous as the chain lengthens. Crude oil is a blend of up to 300 different hydrocarbons, as well as sulphur, nitrogen and metal compounds, depending on source conditions. Refining separates the different hydrocarbons into groups with properties that are uniform enough to be useful as petroleum products and as feedstocks for petrochemical plants.[1]

2.4 When burnt, hydrocarbon molecules combine with oxygen to form carbon dioxide and water, releasing heat energy. Carbon dioxide released from burning oil, gas and coal is the main cause of human-induced global warming.[2]

Resources, reserves and related terms

2.5 The **resource** is the total amount of oil in the ground, including oil which will never be discovered or, if discovered, will never be produced.[3]

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1 Thus methane CH_4 and ethane C_2H_6 are 'natural gas'; propane C_3H_8 and butane C_4H_{10} may be present in natural gas mixtures and are used to make liquefied petroleum gas; the C5-12 fractions make automotive gasoline; the C14-16 fractions make diesel oil, etc.

2 Other gases also contribute. Methane, the principal component of natural gas, is a powerful greenhouse gas in its own right.

2.6 **Reserves** are quantities of oil in known reservoirs which can be recovered commercially with today's prices and technology. Reserves are divided into:

- **Proved reserves:** quantities which are estimated 'with reasonable certainty' to be recoverable reserves by the definition above; or if probabilistic methods of estimation are used, there is a 90 per cent probability (P90) that the amount recovered will be more than this, and a 10 per cent probability that it will be less. 'In this sense, proved reserves are a conservative estimate of future cumulative production from a field.'[4]
- **Probable and possible reserves**: additional quantities which are estimated to be commercially recoverable reserves with less certainty. Proved plus probable reserves are an 'as likely as not' estimate of future production; proved plus probable plus possible reserves are a more optimistic, less likely estimate. In general, a portion of a field's probable and possible reserves tend to get converted into proved reserves over time as operating history reduces the uncertainty around remaining recoverable reserves.[5]

2.7 Reserves are depleted by production, and enlarged by discovery of new oilfields and by 'reserve growth'.

2.8 **Reserve growth** refers to the commonly observed increase in reported reserves in previously discovered fields over time. This results from 'a combination of several factors, including conservative initial estimates, improvements in exploration and drilling technology, improved production technology, and various political and economic forces'.[6] Future reserve growth is an important element in official estimates

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3 'The entire resource base (Total petroleum initially in place) is generally accepted to be all those quantities of petroleum contained in the subsurface…' Society of Petroleum Engineers, *Glossary of Terms Used*, at www.spe.org/spe/jsp/basic_pf/0,,1104_3306579,00.html
An alternative definition is that resources are reserves plus all the petroleum *that may eventually become available:* 'In practice resource estimates are made only for those accumulations that are seen as potentially economic at some time in the future.' This is a narrower definition of the resource. McCabe P.J., 'Energy Resources - Cornucopia or Empty Barrel' *AAPG Bulletin*, vol. 82 no. 12 November 1998, p. 2115.

4 'Oil reserves': notes to *BP Statistical Review of World Energy 2006,* at http://www.bp.com/sectiongenericarticle.do?categoryId=9011008&contentId=7021601

5 'Oil reserves': notes to *BP Statistical Review of World Energy 2006.*

Society of Petroleum Engineers: *Petroleum Reserves Definitions* at http://www.spe.org/spe/jsp/basic/0,2396,1104_12169_0,00.html
'Probable' and 'possible' are commonly defined as - taking proved and probable reserves together: there is a 50 per cent probability that the true figure is more, and a 50 per cent probability that it is less. Taking proved, probable and possible reserves together: there is a 10 per cent probability that the true figure is more, and a 90 per cent probability that it is less. According to the SPE, 'the effect of possible future improvements in economic conditions and technological development can be expressed by allocating appropriate quantities of reserves to the probable and possible classifications'.

6 T.R.Klett, D.L. Gautier & T.S. Ahlbrandt, 'An Evaluation of the US Geological Survey World Petroleum Assessment 2000', *AAPG Bulletin*, vol. 89 no. 8 August 2005, p. 1036.

of future oil supply. How valid these estimates are is a major part of the 'peak oil' debate, considered in chapter 3.

2.9 **The ultimately recoverable resource (URR),** according to BP, is an estimate of the total amount of oil that will ever be recovered. This includes production to date, future production from discovered reserves, and future production from not yet discovered fields.[7] According to the International Energy Agency (IEA), 'ultimately recoverable resources include cumulative production to date, identified remaining reserves, undiscovered recoverable resources and estimates of "reserves growth" in existing fields.'[8] This amounts to the same thing if one assumes that all reserves will eventually be produced.[9] An alternative definition of the URR is 'the amount of oil which is thought recoverable given existing technology and economics [including] estimates of undiscovered oil.'[10]

2.10 **Conventional oil** is, in the IEA's definition, 'oil that is produced from underground reservoirs by means of wells'. This leaves as **nonconventional oil** that which 'is produced in other ways or requires additional processing to produce synthetic crude…[including] shale oil, synthetic crude and products derived from oil or tar sands and extra-heavy oil, coal- and biomass-based liquids and the output of natural gas to liquids (GTL) plants.'[11]

2.11 'Conventional' and 'non-conventional oil' are sometimes defined in other ways, and this can be a source of confusion in comparing figures from different sources. For example, by the definition above polar and deepwater oil is conventional; but some include it with non-conventional because of the difficulty of reaching it.[12]

2.12 The natural nonconventional resource is mostly located in Canadian tar sands, Venezuelan heavy oil, and oil shale. The nonconventional resource is very large, though the proportion that is a recoverable reserve is relatively small because of the difficulty of extracting it.[13] There will be greater use of it in future as conventional oil

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7 'Oil reserves': notes to *BP Statistical Review of World Energy 2006,* at http://www.bp.com/sectiongenericarticle.do?categoryId=9009529&contentId=7017933

8 International Energy Agency, *World Energy Outlook 2005*, p. 126.

9 This would be expected given the definition of 'reserves' as 'known *commercially viable* accumulations.'

10 Lynch M.C., *The New Pessimism about Petroleum Resources: Debunking the Hubbert Model (and Hubbert Modelers),* n.d..

11 International Energy Agency, *World Energy Outlook 2005*, p. 124.

12 Eg ASPO Ireland, *Submission 10*, p. 2. Definitions are discussed in IEA, *Resources to Reserves - Oil and Gas Technologies for the Energy Markets of the Future*, 2005, p. 26.

13 It is suggested that the nonconventional oil originally in place is up to 7,000 billion barrels, of which economically recoverable reserves are about 600 billion barrels. International Energy Agency, *World Energy Outlook 2004,* p. 95. Hirsch R. & others, *Peaking of World Oil Production: Impacts, Mitigation and Risk Management*, 2005, p. 40. ABARE, *Australian Commodities* June 2006, p. 305.

is depleted. It is sometimes said that this means that what is now non-conventional will become conventional in future. This form of words unfortunately obscures the fact that what is now called conventional is effectively the 'easy oil', and what is now called non-conventional is more difficult and expensive to produce; and that relativity is unlikely to change. Greater exploitation of harder to get oil will become more normal as easier oil is depleted, but it will come at an extra economic cost that economies will have to cope with.

Rate of production and recovery factor

2.13 Oil reserves are stock; production is a flow. The immediate concern in a market is whether the rate of production satisfies demand. Reserves are only of interest for what they imply about future production and resource security.

2.14 As oil is produced the natural reservoir pressure which drives it to the surface through a well bore declines. It becomes gradually harder and eventually impossible to recover what is left. Thus an oil reservoir is not like a tank of water, in which the last drop can be tapped almost as easily as the first. It is more like a tank of waterlogged sand: how fast the water can be tapped depends not only on the size of the tap, but also on how fast the water drains through the sand to reach it. This becomes slower over time. There is still some water in the sand when flow stops.

2.15 **The rate of production** over time from an oilfield will tend to grow as the infrastructure is built up to exploit the reserve, reach a peak, then decline as the reserve is depleted and it becomes progressively harder to produce what is left.[14] The same tends to apply to larger regions or nations: for example, oil production in the US lower 48 states peaked in 1970.[15] Non-OPEC conventional oil production is expected to peak in 2010-2015.[16] Oil production is in decline in 33 of the 48 largest oil producing countries.[17] What this implies for world production is part of the peak oil debate.

2.16 **The recovery factor** is the percentage of the oil originally in place in a field that can be recovered. The recovery factor varies enormously from one field to another depending on the geological conditions, but averages about 35 per cent world-

14 As gas flows more easily than oil, a gas field can be produced at a high level for longer, but will then decline much more suddenly when the reserve is exhausted.

15 This phenomenon for an individual oilfield does not *necessarily* imply the same for a larger region. In theory a certain rate of production from a larger region could be maintained indefinitely, **providing** new oilfields of the needed size could be discovered at a constant rate indefinitely. But this is not the case: the rate of discovery of new oil has been declining for many years: see paragraph 3.38. Many nations are past their peak of oil production as noted.

16 International Energy Agency, *World Energy Outlook 2005*, p. 140.

17 Chevron, quoting Worldwatch Institute, *Vital Signs,* 2005, p. 30: http://www.willyoujoinus.com/issues/alternatives/

wide.[18] The recovery factor may be increased by techniques such as injecting water or carbon dioxide to maintain pressure. The cost-effectiveness of these techniques also varies greatly from place to place. A small increase in the average recovery factor through technological advances can create a large increase in reserves.[19] What should be expected in this regard in future is another part of the peak oil debate.

2.17 **The reserves to production ratio** (R/P ratio) is the ratio of proved reserves to production in the year. World wide it is now about 40:1 for oil and 65:1 for gas.[20] This prompts statements such as 'reserves are sufficient to maintain production at present rates for X years.' Such statements are not helpful - firstly, because demand will not be static; secondly, because the R/P ratio says little about the future rate of production. Given the nature of oil depletion as described above, it will not be possible to maintain production at a constant rate until reserves are exhausted, as implied.[21]

Oil and gas in context of total energy use

World energy use and projections

2.18 Energy use tracks economic growth closely. Worldwide, since 1971 each 1 per cent increase in global gross domestic product (GDP) has been accompanied by a 0.6 per cent increase in primary energy consumption. The difference between the 1 per cent and 0.6 per cent reflects the fact that the energy use for each unit of GDP is in long term decline. This is expected to continue as reliance on heavy industry declines and energy efficiency improves.[22]

2.19 In the International Energy Agency's *World Energy Outlook 2005* 'reference scenario' (which assumes no policies to curb energy use or greenhouse gas emissions beyond what governments have committed to already), energy use is expected to increase by 1.6 per cent on average per year to 2030. Oil, gas and coal will retain their dominant position, with about 80 per cent of total energy supply. Renewables will

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18 International Energy Agency, *Resources to Reserves - Oil and Gas Technologies for the Energy Markets of the Future*, 2005, p. 14.

19 For gas, which flows more easily, the recovery factor is naturally higher - about 70% - so future improvements to the recovery factor are less significant. International Energy Agency, *Resources to Reserves - Oil and Gas Technologies for the Energy Markets of the Future*, 2005, p. 14.

20 *BP Statistical Review of World Energy, 2006.*

21 In a period of declining production a constant R/P ratio can be maintained by matching production to reserves correctly as both approach zero. In the USA in the late 20th century the R/P ratio was stable at about 10 over 20 years of mostly declining production. McCabe P.J., 'Energy Resources - Cornucopia or Empty Barrel' *AAPG Bulletin*, vol. 82 no. 12 November 1998, p. 2115.

22 International Energy Agency, *World Energy Outlook 2004,* pp 31 and 41. Primary energy consumption is the sum of end-use energy consumption and energy lost in transmission or conversion processes.

increase significantly in percentage terms, but because they are coming from an extremely small base, they will remain small in absolute terms:

Figure 2.1 – World primary energy demand, IEA Reference Scenario, 2003-2030
million tonnes of oil equivalent

	2003		2030		average annual growth, per cent	total growth in annual demand, per cent
	no.	per cent	no.	per cent		
coal	2,582	24%	3,724	23%	1.4%	44%
oil	3,785	35%	5,546	34%	1.4%	46%
gas	2,244	21%	3,942	24%	2.1%	75%
nuclear	687	6.5%	767	5%	0.4%	12%
hydro	227	2%	368	2%	1.8%	62%
biomass and waste	1,143	11%	1,653	10%	1.4%	45%
other renewable	54	0.5%	272	2%	6.2%	218%
total	10,723	100%	16,271	100%	1.6%	52%

International Energy Agency, *World Energy Outlook 2005,* p.82

2.20 Oil as a proportion of total energy use has declined from 44% in 1971 to the present 35% as users have moved to other energy sources, particularly in response to the 1973 and 1979 oil crises. However it is more difficult to use other fuels for transport, and 95 per cent of transport is fuelled by oil. Thus the trend to prefer other fuels for non-transport purposes means that oil use is becoming increasingly concentrated in transport. The IEA expects that in 2030 transport will use 54 per cent of the world's oil compared to 33 per cent in 1971 and 47 per cent now. In OECD countries, the use of oil for other purposes is expected to decline sharply. However in many developing countries oil products will remain the leading source of modern commercial energy for cooking and heating, especially in rural areas.[23]

2.21 The predictions above derive energy demand from predictions of future population growth, economic growth and energy prices. In the IEA's *World Energy Outlook 2005*, the predicted price trend is for a slight increase in real oil prices from $US36 per barrel in 2004 to $US39 per barrel in 2030 (2004 dollars). This assumes there is no constraint on supply before 2030.[24] (The *World Energy Outlook 2006* appeared at the time of writing. It contains updated, higher price projections. Comments on it are gathered in Chapter 3 - see paragraph 3.121).

23 International Energy Agency, *World Energy Outlook 2004*, pp 58 and 84.

24 International Energy Agency, *World Energy Outlook 2005*, pp 63-4 and 140.

Australian energy use and projections

2.22 In Australia, compared with the world, coal is a bigger proportion of total energy supply (42 per cent of the total); oil and gas are about the same, and renewables are a smaller proportion. Energy consumption is projected to increase by 63 per cent by 2029-30, an average rate of 1.9 per cent per year. The most important driver of this is economic growth. As natural gas becomes more important coal is expected to become relatively less important, though it still increases greatly in absolute terms. Renewables are expected to increase greatly in percentage terms, but because they are starting from an extremely small base, they are still insignificant in absolute terms.[25]

Figure 2.2 – Projection of Australian primary energy consumption by fuel
Petajoules

	2003-4		2029-30		average annual growth, per cent	total growth, per cent
	no.	per cent	no.	per cent		
black coal	1,570	29%	2,248	26%	1.4%	43%
brown coal	679	13%	857	10%	0.9%	26%
oil	1,792	34%	2,981	34%	1.7%	66%
natural gas	1,048	20%	2,136	24%	2.8%	104%
hydro	58	1%	65	1%	0.4%	12%
biomass	183	3%	370	4%	2.8%	102%
other renewables	16	0.3%	71	1%	5.9%	344%
total	5,345	100%	8,728	100%	1.9%	63%

ABARE, *Australian Energy: national and state projections to 2029-2030*, 2005, p. 26
1 petajoule = 23,880 tonnes of oil equivalent. 1 million tonnes of oil equivalent = about 42 petajoules. 1 petajoule = 169,900 barrels oil @ 5883MJ/barrel (Geoscience Australia, submission 127, p. 17.)

2.23 This scenario assumes that crude oil prices fall to below $US30 per barrel by the early 2010s, 'reflecting an assumed easing of geopolitical concerns and an expansion in oil production infrastructure.'[26]

2.24 Worldwide 47 per cent of oil is used for transport; in Australia, 77 per cent. This is because in Australia oil is used much less in other areas such as home heating

25 ABARE, *Australian Energy: national and state projections to 2029-2030*, 2005, p. 23ff.

26 ABARE, *Australian Energy: national and state projections to 2029-2030*, 2005, p. 24.

or electricity generation.[27] Thus for Australia an oil supply problem is to a large extent a transport fuel problem.

World oil production and consumption

2.25 According to BP's *Statistical Review of World Energy*, world oil production in 2005 was 29.5 billion barrels (81 million barrels per day), and proved reserves of oil and natural gas liquids at the end of 2005 were 1,200 billion barrels. Year on year production grew in the OPEC countries and the Former Soviet Union, and declined in the OECD and other non-OPEC countries in total.[28]

2.26 Natural gas production in 2005 was 2,703 billion cubic metres, and proved reserves were 180,000 billion cubic metres.[29]

2.27 On BP's figures proved reserves of oil and natural gas liquids continue to grow: annual additions to reserves through new discoveries and reserve growth are greater than annual production.[30] 62 per cent of reserves are in the Middle East.

2.28 This raises the question: why then have oil prices been high over the last two years?[31] Most analysts answer that demand has grown because of strong economic growth, particularly in China, while supply has lagged because of insufficient investment in new capacity since the period of low prices in the late 1990s. As well, commentators point to the weather in 2005, including hurricanes in the USA which disrupted production; and geopolitical instability, which has caused the market to want 'precautionary inventories'.[32]

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27 Bureau of Transport and Regional Economics, *Is the World Running Out of Oil? A review of the debate.* BTRE working paper 61, 2005.

28 BP, *Statistical Review of World Energy*, 2006, pp 6 and 8. 'Production includes crude oil, shale oil, oil sands and natural gas liquids.' The OPEC countries are Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates and Venezuela.

29 1 cubic metre = 35.515 cubic feet. 6,000 cubic feet of gas = 1 barrel of oil equivalent (US Geological Survey, *World Petroleum Assessment 2000*, table AR-1). By these figures natural gas production is 16 billion barrels of oil equivalent, and proven natural gas reserves are 1,065 billions barrels of oil equivalent, which is slightly less than proven oil reserves.

30 Year on year change in reserves is found by subtracting production and adding new discoveries and reserve growth. On BP's figures world oil reserves were 770 billion barrels in 1985, 1,027 billion barrels in 1995, 1,194 billion barrels in 2004 and 1,200 billion barrels in 2005.

31 The price of West Texas Intermediate crude oil rose steadily (with some fluctuations) from about $US35 per barrel in early 2004 to $US78 in July 2006. It then declined to $US63 in September 2006 and $US59 in early November. ABARE, *Australian Commodities*, vol. 13 no. 3, September 2006, p. 499. S. Kinsella (ABARE), personal communication, November 2006.

32 For example, P. Davies (BP), *Quantifying Energy - BP Statistical Review of World Energy 2006,* speech 14 June 2006. International Energy Agency, *World Energy Outlook 2005*, p. 5.

2.29 In this view there is no fundamental geological constraint on the supply of oil, and prices may be expected to fall again in the medium term as higher prices stimulate exploration and investment, and supply catches up with demand. ABARE predicts that oil prices 'could remain relatively high for a number of years, but should fall towards the end of the decade 'in response to higher global oil production and a substantial increase in oil stocks by that time.'[33] Contrary views by peak oil proponents are considered in chapter 3.

Projections of world oil production and consumption

2.30 The International Energy Agency (IEA), in its *World Energy Outlook 2005*, predicts that in a 'reference scenario' world demand for oil will grow from 82 million barrels per day in 2004 to 92 million barrels per day in 2010 and 115 million barrels per day in 2030 - an average growth rate of 1.3 per cent per year over the period. The growth rate will be above average in the developing countries, and below average in OECD countries.

2.31 The *World Energy Outlook 2005* argues that resources are adequate to meet the demand, but 'reserves will need to be "proved up" in order to avoid a peak in production before the end of the projection period [2030].'[34] It comments that 'the exact cost of finding and exploiting those resources over the coming decades is uncertain, but will certainly be substantial…financing the required investments in non-OECD countries is one of the biggest challenges posed by our energy-supply projections.'[35] It makes no significant comment on the future after 2030.[36]

2.32 The *World Energy Outlook 2005* assumes that most of the increased demand for oil to 2030 will be supplied by a large increase in OPEC production, particularly in

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33 ABARE, *Australian Commodities,* June 2006, p. 303ff.

34 In the market of economics textbooks, supply is the amount brought to market, and demand is the amount sold. Demand in this sense cannot exceed supply. In the future oil supply debate, discussion of whether supply will be adequate to meet demand implicitly means 'demand as it would be if supply was unconstrained'.

35 International Energy Agency, *World Energy Outlook 2005*, pp 45, 83 and 140. The reference scenario assumes no policies to curb energy demand or greenhouse gas emissions beyond what governments have committed to already: p. 59.

36 In the *World Energy Outlook 2005* a brief relevant comment on the longer term future is: 'Using a more optimistic assumption of 3,200 billion barrels [of ultimately recoverable oil] pushes the production peak out to around 2035…non-conventional sources, including tar sands in Canada, extra-heavy oil in Venezuela and gas-to-liquids output, fill the growing gap between conventional oil production and global oil demand.' p. 140.

A 2003 IEA report considered energy scenarios to 2050. The scenarios describe different responses to environmental concerns. All scenarios assume that 'there are sufficient fossil energy resources to meet demand in the next 50 years; whether they will actually be extracted depends on the pace and direction of technological change and on the level of environmental concern.' International Energy Agency, *Energy to 2050 - scenarios for a sustainable future*, 2003.

the Middle East, 'because their resources are greater and their production costs lower' (peak oil concerns about whether this will be possible are considered in chapter 3).[37] OPEC production is expected to increase from 39 per cent to 50 per cent of world production.

Figure 2.3 – World oil production and demand projections, IEA Reference Scenario million barrels per day. Includes natural gas liquids and condensates					
	2004	2010	2030	average annual growth, per cent	total growth 2004 - 2030, per cent
Oil production					
OPEC[38]	32.3	36.9	57.2	2.2%	77%
of which OPEC Middle East	*22.8*	*26.6*	*44.0*	*2.6%*	*93%*
OECD[39]	20.2	19.2	13.5	-1.5%	-32%
transition economies[40]	11.4	14.5	16.4	1.4%	44%
other countries	15.2	17.7	16.3	0.3%	7%
non-conventional oil[41]	2.2	3.1	10.2	6.1%	364%
total	**82.1**	**92.5**	**115.4**	**1.3%**	**41%**
Oil demand					
OECD	47.6	50.5	55.1	0.6%	16%
transition economies	4.4	4.9	6.2	1.3%	41%
other countries	27.0	33.9	50.9	2.5%	86%
international marine bunkers	3.1	3.1	3.3	0.3%	6%
total	**82.1**	**92.5**	**115.4**	**1.3%**	**41%**
OPEC production as percentage of world demand	*39%*	*40%*	*50%*		
OPEC Middle East production as percentage of world demand	*28%*	*29%*	*38%*		
International Energy Agency, *World Energy Outlook 2005,* pp 83, 90, and 124.					

37 International Energy Agency, *World Energy Outlook 2005*, p. 46.

38 OPEC: Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates and Venezuela.

39 OECD: 23 European countries plus USA, Canada, Mexico, Australia, New Zealand, Korea and Japan.

40 Transition economies: 23 nations of eastern Europe and former Soviet Union.

41 Conventional oil: produced from underground reservoirs by wells. Non-conventional oil includes shale oil, synthetic crude and products derived from oil or tar sands and extra-heavy oil, coal- and biomass-based liquids and the output of natural gas to liquids (GTL) plants.

2.33 The *World Energy Outlook 2005* assumes a crude oil price of about $US35 per barrel in 2010, increasing to $US39 by 2030 (2004 dollars). It notes that 'the near term outlook for oil prices remains unusually uncertain'; and 'the assumed slowly rising trend in real prices after 2010 reflects an expected increase in marginal production costs outside OPEC, an increase in the market share of a small number of major producing countries, and lower spare capacity.' Most of the new production capacity needed to satisfy the predicted demand is expected to come from OPEC countries, particularly in the Middle East. The slowly rising price trend is not intended to mean a stable market: 'indeed, oil prices may become more volatile in future'.[42]

2.34 The IEA's *World Energy Outlook 2006* was released at the time of writing with updated, higher price projections. Comment on it is at paragraphs 3.121–3.124.

Official estimates of the ultimately recoverable resource of conventional oil

2.35 The core document used to support the assumption that oil supply will not be constrained before 2030 appears to be the US Geological Survey's *World Petroleum Assessment 2000* (USGS 2000). This estimated that the world's total conventional oil and natural gas liquids produced to 1995, or with potential to be added to reserves from 1995 to 2025, is about 3,345 billion barrels.[43] This is the mean estimate.[44] Future additions to reserves are composed of future discoveries and future 'reserve growth' in already discovered fields as explained above (paragraph 2.8):

42 International Energy Agency, *World Energy Outlook 2005*, pp 63-5.

43 US Geological Survey: *World Petroleum Assessment 2000*, table AR-1, p. ES-1. New work for USGS 2000 considered the world except the United States. Figures for the United States were imported from previous work to give world totals.

Note that 'with potential to be added to reserves by 2025' is not an estimate of the *ultimately* recoverable resource (URR). A corresponding estimate of the URR, since it would include post-2025 additions, would be higher. USGS 2000 disavowed any attempt to estimate the URR (p. IN-5). However this proviso is commonly overlooked, and its figures are quoted as though they are an estimate of the URR - including by the International Energy Agency (for example, *World Energy Outlook 2005*, p. 126).

44 USGS 2000 estimates relating to future events are the output of a mathematical procedure whose inputs were the authors' expert opinions on many detailed matters, such as the likely number of undiscovered fields in a region, the likely size of undiscovered fields, etc. The mean estimate is derived from a probability distribution and is slightly greater than the P50 (50 per cent probable) estimate.

Figure 2.4 – USGS 2000 estimate of conventional petroleum with potential to be added to reserves 1995 to 2025. Mean estimate billion barrels (for gas, billion barrels of oil equivalent @ 6,000 cubic feet = 1boe)				
	oil	natural gas liquids	oil and NGLs	gas
World except United States				
undiscovered conventional	649	207	856	778
reserve growth (conventional)	612	42	654	551
remaining reserves	859	68	927	770
cumulative production	539	7	546	150
total	2,659	324	2,983	2,249
United States				
undiscovered conventional	83	with oil	83	88
reserve growth (conventional)	76	with oil	76	59
remaining reserves	32	with oil	32	29
cumulative production	171	with oil	171	142
total	362	with oil	362	318
Total				
undiscovered conventional	732	207	**939**	866
reserve growth (conventional)	688	42	**730**	610
remaining reserves	891	68	**959**	799
cumulative production	710	7	**717**	292
total	**3,021**	**324**	**3,345**	**2567**

source: US Geological Survey, *World Petroleum Assessment 2000*, table AR-1.
Note: reserve and cumulative production figures date from 1995. Proved reserves of oil at the end of 2005 were 1,200 billion barrels. Cumulative production of oil and natural gas liquids to 2005 was 1,048 billion barrels. *BP Statistical Review of World Energy*, 2006. IEA, *World Energy Outlook 2005*, p. 126.

2.36 USGS 2000 published 5 per cent probable and 95 per cent probable estimates only for the world except the United States:

Figure 2.5 – USGS 2000 estimate of conventional petroleum with potential to be added to reserves 1995 to 2025. billion barrels (for gas, billion barrels of oil equivalent @ 6,000 cubic feet = 1boe)		
	undiscovered conventional	reserve growth (conventional)
Oil		
P95 estimate	334	192
mean estimate	649	612
P5 estimate	1,107	1,031

Natural gas liquids		
P95 estimate	95	13
mean estimate	207	42
P5 estimate	378	71
Oil and NGLs		
P95 estimate	429	205
mean estimate	856	654
P5 estimate	1,485	1,102
Gas		
P95 estimate	383	175
mean estimate	778	551
P5 estimate	1,362	924
Source: US Geological Survey, *World Petroleum Assessment 2000*, table AR-1.		

2.37 The USGS 2000 mean estimate of future reserve additions is much higher than previous estimates. Most of the increase in USGS 2000 resulted from including an estimate of future reserve growth, which the USGS had not done previously.[45] For example, the USGS 2000 mean estimate of future oil reserve additions (not including natural gas liquids) outside the USA is 1,261 billion barrels (649+612 in figure 2.4 above). The corresponding figure from the USGS's previous survey in 1994 was 539 billion barrels.[46]

2.38 The IEA's *World Energy Outlook 2005* gives an updated estimate of the ultimately recoverable resource, based on USGS 2000:

Figure 2.6 – Estimate of ultimately recoverable oil and natural gas liquids. IEA 2005. Mean estimate. Billion barrels				USGS 2000 mean estimate, conventional oil/ NGLs/ total
	Middle East/ North Africa	rest of world	total	total
future discoveries	313	570	883	732/ 207/ 939[1]
future reserve growth in existing fields	109	199	308[3]	688/ 42/ 730[1]
reserves	784	322	1,106	891/ 68/ 959[2]
cumulative production	334	714	1,048	710/ 7/ 717[2]
total: ultimately recoverable resource	**1,541**	**1,804**	**3,345**	**3,021/ 324/ 3,345**
source: International Energy Agency, *World Energy Outlook 2005*, p. 126. The figures				

45 US Geological Survey: *World Petroleum Assessment 2000*, p. ES-3 & figure ES-2.

46 US Geological Survey: *World Petroleum Assessment 2000*, figure ES-2.

appear to be for conventional oil, although the accompanying text is not explicit.
US Geological Survey, *World Petroleum Assessment 2000*, table AR-1.

1. USGS 2000 figures were estimates of amounts with potential to be added to reserves from 1995 to 2025: p. IN-2.
2. USGS 2000 figures for reserves and cumulative production date from 1995.
3. The IEA figure for reserve growth is said to be based on 'IEA analysis based on USGS'. The accompanying text does not explain the large difference from the USGS 2000 estimate of reserve growth.

2.39 On these figures, about a third of the ultimately recoverable resource of conventional oil has already been produced. 'Peak oil' arguments about the reliability of these figures are considered in chapter 3.

2.40 It should be noted that USGS 2000 was a geologists' estimate of possible future additions to reserves. It was not concerned with whether the resource will be brought to market in a timely way to meet demand.

Oil production and consumption in Australia and projections

2.41 Commercial crude oil production in Australia started at Moonie in 1964, and grew dramatically after the discovery of the offshore Gippsland oilfields in the 1960s. It has mostly been between 400,000 and 500,000 barrels per day since then. As gas production on the North West Shelf has increased, production of associated condensate has also increased, to around 150,000 barrels per day. Over the last decade production of crude oil and condensate has mostly been between 500,000 and 600,000 barrels per day.[47]

2.42 The rate of new discoveries has declined significantly since the discovery of the supergiant Gippsland fields in the late 1960s. More recent smaller discoveries have slowed but not reversed the overall decline in reserves as oil is produced.[48] Geoscience Australia (GA) predicts that Australian production of crude oil plus condensate will hold at current levels of about 550,000 barrels per day until about 2009 then decline to about 224,000 barrels per day by 2025 (mid-range estimate).[49]

2.43 Australia's demand for petroleum (including crude oil and condensate) is over 750,000 barrels per day, and is projected to rise to over 800,000 barrels per day by 2009-10, and over 1,200,000 barrels per day by 2029-30 – an increase of almost 2 per cent per year over the period.[50]

47 Geoscience Australia, *Submission 127*, pp 13-16. Condensate is a light oil-like liquid produced from gas fields. 1 barrel = 158.987 litres.

48 Dr C. Foster, Geoscience Australia, *Proof Committee Hansard,* 12 May 2005, p. 4.

49 Geoscience Australia, *Submission 127*, p. 13.

50 Geoscience Australia, *Submission 127*, based on ABARE, *Australian Energy - National and State Projections to 2029-30*, 2005, p. 63.

2.44 In Australia 77 per cent of oil is used for transport, and 97 per cent of transport is fuelled by oil. Transport accounts for 14 per cent of Australia's greenhouse gas emissions.[51]

2.45 On Geoscience Australia's figures, it appears that over the next 20 years Australia's net self-sufficiency in oil and petroleum products will decline from 84 per cent to 20 per cent (using a mid-range estimate of future production), or from 98 per cent to 31 per cent (using an optimistic estimate of future production):[52]

Figure 2.7 – Forecast Australian production of crude oil and condensate. Forecast Australian consumption of petroleum products excluding LPG

Thousand barrels per day

	production			consumption[1]	production as percentage of consumption		
	P90	P50	P10		P90	P50	P10
2006	544	635	741	756.8	72%	84%	98%
2010	400	510	654	817.0	49%	62%	80%
2015	225	349	541	902.9	25%	39%	60%
2020	177	269	409	998.3	18%	27%	41%
2025	148	224	342	1099.9	13%	20%	31%

P90: 90 per cent probability that the true figure will be at least this much (most cautious estimate). P50: 50 per cent probability that the true figure will be at least this much. P10: 10 per cent probability that the true figure will be at least this much (most optimistic estimate). See text for qualifications.

1. 2006 figure is that shown in the source as '2005-06' etc.

Geoscience Australia, *Submission 127*, p. 13ff.

2.46 The production forecasts listed above include production expected from already identified fields, and production expected from not yet discovered resources in known petroleum provinces. They include future reserve growth only in the P10 estimate. The figures do not include enhanced oil recovery in fields nearing depletion, but GA estimates that under certain conditions this could add up to 155,000 barrels

51 Bureau of Transport and Regional Economics, *Is the World Running Out of Oil? A review of the debate.* BTRE working paper 61, 2005. Australian Government, *Securing Australia's Energy Future*, Dept of the Prime Minister and Cabinet, 2004, pp 82 and 137.

52 *net* self-sufficiency: the concept of self-sufficiency is somewhat artificial in any case, as Australia both imports and exports crude oil. This is because Australian crude oil is relatively light, and cannot provide the full range of petroleum products. Australian production of crude oil, condensate and LPG is about 95% of Australian consumption of liquid petroleum products; however over half of Australian production is exported, and over half of Australian refinery inputs is imported. ABARE, *Australian Commodities*, vol. 13 no. 13, September 2006, pp 507-8. Australian Institute of Petroleum, *Crude Oil Pricing*, at www.aip.com.au/pricing/crude.htm

per day. The figures do not include future discoveries in provinces which have not been explored or have no discoveries to date, as these cannot be estimated.[53]

2.47 ABARE expects that Australia's crude oil and condensate production will remain steady at over 1,000 petajoules per year (about 466,000 barrels per day[54]) to 2029-30. This would means Australia's net self-sufficiency in petroleum products falls to about 50 per cent by 2029-30. This is rather more than Geoscience Australia's estimate.[55] This is because ABARE, unlike GA, makes an estimate of prospective production from resources that have not yet been discovered in basins that have not yet been fully explored, based on the resource estimates of USGS 2000. This includes modelling economic variables which are not within GA's brief.[56]

2.48 In either case Australia's oil self-sufficiency is predicted to decline significantly. The predicted demand growth is a much more important cause that the exact level of future Australian production.

2.49 The Australian Petroleum Production and Exploration Association (APPEA) noted that Australia has historically been a net exporter of oil, gas and petroleum products; however this situation has turned around in the last two years because of rising prices and a fall in domestic crude oil production. In 2005 imports exceeded exports by $4.7 billion. APPEA suggested that by 2015 this figure could be in the range of $12 billion to $25 billion, depending on assumptions about Australian production and price.[57]

2.50 How serious the effects of this reversal are will depend in part on the long term price of oil.[58] That will reflect the long term supply-demand balance. That brings into play peak oil concerns about future oil supply, which are considered in the next chapter.

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53 Geoscience Australia, *Additional information,* 13 September 2006.

54 At 5883MJ per barrel: Geoscience Australia, *Submission 12*, p. 17.

55 ABARE, *Australian Energy - national and state projections to 2029-30*, report 05.9, October 2005, pp 38 and 45. ABARE, *Submission 166*, p. 2.

56 ABARE, *Additional information,* 27 November 2006.

57 Australian Petroleum Production and Exploration Association, *Submission 176*, p. 8.

58 Treasury pointed out that as Australia is a net energy exporter, there may be compensation for a rising oil price if the price of substitutes which Australia exports also rises. Dr S. Kennedy, Department of the Treasury, *Committee Hansard*, 18 August 2006, p. 22.

Chapter Three

'Peak oil' concerns about future oil supply

3.1 Proponents of peak oil views argue that official estimates of future oil production are overly-optimistic, and that supply will be constrained by a shortage of resources soon enough to be a concern.

3.2 Peak oil commentators include a number of prominent oil industry experts including oil industry veterans Colin Campbell and Jean Laherrere; Kenneth Deffeyes (formerly of Shell Oil and Princeton University); Ali Samsam Bakhtiari (formerly of Iranian National Oil Company); Matthew Simmons (leading energy industry financier and a former energy adviser to US Vice-President Dick Cheney), and Chris Skrebowski (editor, *Petroleum Review*).[1] Peak oil views are expressed by the Association for the Study of Peak Oil and Gas (ASPO) among other groups.

Peak oil views and responses in summary

3.3 Peak oil commentators commonly predict a peak of conventional oil production somewhere between now and 2030. They fear that declining production after the peak will cause serious hardship if mitigating action is not started soon enough. In summary, their arguments are:

- Official estimates of world reserves, future reserve growth and future discoveries are over-optimistic. In particular:
  - Reported reserves in the Middle East are untrustworthy. We should not be confident that the Middle East will be able to increase production to the extent required by International Energy Agency (IEA) projections to satisfy predicted demand.
  - The US Geological Survey's (USGS) 2000 report (which is the key source for optimistic estimates of the ultimately recoverable resource) is flawed in various ways.
- Discovery of oil peaked in the 1960s and has generally declined since then. This trend should be expected to continue.
- World production should be expected to peak when about half the ultimately recoverable resource has been produced. Production in many major oil-producing countries is already declining.

1 Bureau of Transport and Regional Economics, *Is the world running out of oil - a review of the debate*, working paper 61, 2005, p. 4.

- There are very large resources of non-conventional oil (such as Canadian tar sands and Venezuelan heavy oil).[2] However the difficulty, cost and environmental problems of exploiting them means it is unlikely that they can be brought on stream in time or in enough quantity to make up for the predicted decline of conventional oil.

3.4 ASPO suggests that the total past and future production of conventional oil will be about 1,900 billion barrels. This is much less than the USGS mean estimate of at least 3,345 billion barrels.[3]

3.5 Other commentators who reject peak oil concerns commonly argue that pessimistic views of future oil supply do not allow for the likely increase in oil exploration and technological advances in oil recovery that would be spurred by rising prices. They also argue that as conventional oil is depleted market forces will bring nonconventional oil and alternative fuels on stream to fill the breach when the price is right. For example, ABARE's long term projections of oil demand assume an oil price of $US40 per barrel, on the grounds that oil prices will be held to that level by competition from substitutes, such as oil from coal, which become viable at about that price.[4]

3.6 'Peak oil' arguments are enlarged below with responses from their critics interleaved. Committee comments are partly in place and partly at the end of the chapter.

Is 'ultimately recoverable resource' a useful concept?

3.7 The core logic of the most common peak oil argument is shown in the following table. The reasoning is:

- the ultimately recoverable resource (total production past and future) is X;
- past production is Y;
- annual production is increasing at rate Z (this allows future production during the growth period to be estimated);

2 Estimated recoverable reserves are 315 billion barrels of tar sands in Canada and 270 billion barrels of heavy oil in Venezuela. ABARE, *Australian Commodities*, June 2006, p. 305. This may be compared with current proved reserves of conventional oil of 1,200 billion barrels.

3 Campbell C.J., *The Availability of Non-conventional Oil and Gas*, n.d. [2006], p. 4. 'At least 3,345 barrels': see chapter 2, footnote 43.

4 ABARE, *Australian Commodities,* June 2006, p. 303ff. Dr J. Penm (ABARE), *Committee Hansard,* 18 August 2006, p. 59.

- the rate of production will peak when about half the ultimately recoverable resource has been produced.[5] [6]

3.8 Knowing X,Y and Z, the peak year can easily be calculated. But the result depends crucially on the estimate of the ultimately recoverable resource (URR): the total amount that will ever be produced. This is very uncertain. For example, taking expected demand growth as 1.5 per cent per year (which is close to official predictions), different estimates of the URR give peak years as follows:

Figure 3.1 – Simplified peak oil calculation

Assumptions: • Past production is 1,000 billion barrels. • Present production is 30 billion barrels per year. • Pre-peak production grows at 1.5% per year.[1] • Peak production occurs when half of total production (URR) has been produced.
Billion barrels.

A. total production (URR)	B. future production (A-1,000)	C. total production before peak (A/2)	C. future production before peak: C-1,000	at 1.5% annual growth, peak is -	annual production at peak	annual production at peak: million barrels per day
2,000[2]	1,000	1,000	0	now	30	82
3,000[3]	2,000	1,500	500	in 15 yrs	37	101
4,000[4]	3,000	2,000	1,000	in 28 yrs	45	123
5,000[5]	4,000	2,500	1,500	in 38 yrs	52	142

1. The growth rate would be expected to fall to zero as the peak is approached, causing a gradual transition rather than a sudden peak. This would make a lower, earlier peak than shown.[7] How gradual the transition would be is a matter of debate.
2. 'Early peakers', eg ASPO Australia, *Submission 135C*, (approximately).
3. For example, USGS 2000 mean estimate (approximately).
4. For example, ExxonMobil, *Tomorrow's Energy*, 2006, p. 5: including non-conventional.
5. For example, International Energy Agency, *Resources to Reserves*, 2005, p. 17: including nonconventional, shale oil, enhanced oil recovery.

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5 For example, Campbell C.J. & Laherrere J.H, 'The End of Cheap Oil', *Scientific American*, March 1998, p 78. Estimates by ASPO use detailed country-specific data and assumptions (eg, extrapolating the production trend of countries already in decline) to calculate country peaks, and sum these to estimate a global peak. Campbell C.J., *The Availability of Non-conventional Oil and Gas*, n.d. [2006].

6 Another line of argument is that oil discovery peaked in the 1960s, and production may be expected to mirror discovery after a time lag. For example Laherrere J., *Forecasting Production From Discovery,* May 2005, at http://www.mnforsustain.org/oil_forecasting_production_using_discovery_laherrere505.htm

7 US Energy Information Administration, *Long Term World Oil Supply (A Resource Base/ Production Path Analysis)*, July 2000, slide 18, at http://www.eia.doe.gov/pub/oil_gas/petroleum/presentations/2000/long_term_supply/index.htm

3.9 Some critics of peak oil views argue that the very concept of 'ultimately recoverable resource' (URR) is not useful. Firstly, it is argued that the URR cannot be usefully estimated as it will change in future (for example, as technological advances make more oil economically recoverable). Past estimates have always been too pessimistic:

> The primary flaw in Hubbert-type models is a reliance on URR as a static number rather than a dynamic variable, changing with technology, knowledge, infrastructure and other factors, but primarily growing.[8]

3.10 Secondly, critics argue that the size of the resource is not of interest in any case, because market forces will ensure that there is no need to recover it all: as depletion increases prices and technological progress facilitates alternatives, other fuels will take over:

> The world will never run out of oil. For reasons of economics if not politics, humanity will quit using oil long before nature exhausts its supply.[9]

3.11 Examples of this are said to be coal replacing wood in 17th century England (driven by the increasing scarcity of wood), and kerosene replacing whale oil in 19th century America (made possible by the discovery of petroleum).[10]

Comment

3.12 The view that the ultimately recoverable resource of oil is irrelevant seems to be mostly based on an optimistic view of future technological progress.[11] However there is no guarantee that the advances of the past will be repeated indefinitely in future. For example, the discovery of petroleum at the time that whale oil was becoming scarce was fortuitous. There is no guarantee that the same thing will happen again at a needed time - and today the stakes are much higher.

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8 Lynch M.C., *The New Pessimism about Petroleum Resources: Debunking the Hubbert Model (and Hubbert Modellers),* n.d.. Similarly: 'Estimates of declining reserves and production are incurably wrong because they treat as a quantity what is actually a dynamic process driven by growing knowledge…Because the concept of a fixed limit is wrong, the predicted famine always fails.' Adelman M.A. & Lynch M.C., 'Fixed View of Resource Limits Creates Undue Pessimism', *Oil and Gas Journal*, vol. 95 no. 14, 7 April 1997, p. 56.

9 *Oil and Gas Journal,* vol. 101 no. 32, 18 August 2003, editorial. Similarly: 'The total mineral in the earth is an irrelevant non-binding constraint. If expected finding-development costs exceed the expected net revenues, investment dries up and the industry disappears. Whatever is left in the ground is unknown, probably unknowable, but surely unimportant: a geological fact of no economic interest.' Adelman M.A., 'Mineral depletion with special reference to petroleum, *The Review of Economics and Statistics*, vol. 72 no. 1, February 1990, p. 1.

10 McCabe P.J., 'Energy Resources - Cornucopia or Empty Barrel', *AAPG Bulletin*, vol. 82 no. 11, November 1998, p. 2122.

11 'Oil is, after all, a finite resource. The larger message in OGJ's series is that human ingenuity is not.' *Oil and Gas Journal,* vol. 101 no. 32, 18 August 2003, editorial.

3.13 A key feature of conventional oil is its very high Energy Return on Energy Invested (EROI). Alternative fuels now in prospect (such as nonconventional oil or oil from coal) are less advantageous in this regard. Moving to other fuels will have an economic cost that should be anticipated, even allowing that it will not be necessary to use the last conventional oil.

3.14 Estimating the ultimately recoverable resource of conventional oil is of interest because it gives an indication of when supply might peak and how soon those costs might start to bite. Given the fundamental importance of this to the future world economy, even an uncertain estimate is better than none.

3.15 Note also that statements like 'humanity will quit using oil long before nature exhausts its supply' accept that oil production will reach a peak and decline. This now seems to be accepted in the industry and official peak agencies such as the IEA (as shown, for example, by the scenarios described from paragraph 3.79 below).[12] In that case the key difference of opinion is not whether there will be a peak of oil production, but whether the decline of oil will be driven by resource scarcity with harmful effects (as peak oil commentators fear), or whether it will be driven by market forces developing alternative fuels in a timely way to offset the depletion of oil, presumably with benign effects (as 'economic optimists' seem to expect).

3.16 In *either* case, estimating the time of the peak is arguably a matter of interest for prudent public policy. Official predictions which deal only with the growth period are not telling the full story.[13]

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12 For example: 'How rapidly will production decline after the peak?... For conventional oil, important horizons of finiteness are indeed coming into view.' *Oil and Gas Journal*, 18 August 2003, editorial. 'Of course, oil production must peak one day.' IEA, *World Energy Outlook 2005,* p. 140. The US Energy Information Administration has estimated dates for the peak of conventional oil for various scenarios, broadly following the 'Hubbert curve' methodology. A similar exercise by the IEA estimated a peak of conventional oil production between 2013 and 2037 depending on assumptions. See paragraph 3.79.

13 Calling the URR 'a dynamic variable' (Lynch) depends on defining URR as 'the amount of oil which *is thought recoverable* given existing technology and economics….' (emphasis added. See paragraph 2.9). In this scheme the URR is *nothing more than* a number, calculated today by a certain methodology, which may be different when calculated tomorrow by the same methodology (given updated data).

The more common definition of URR seems to be 'the amount of oil *which will ever be recovered'* (BP). Peak oil arguments concerning the 'Hubbert curve' must define the URR in this way. This URR is a definite number which does not change over time. However it cannot be known exactly until production has ended, and there is great uncertainty in estimating it before then.

Much of the 'economic optimist' critique of peak oil concerns probably comes down to a view that estimates of the URR (in the second sense) are so uncertain that they are not useful for planning purposes.

Estimating the ultimately recoverable resource: issues

3.17 Peak oil commentators commonly estimate a URR of conventional oil considerably lower than official agencies such as the US Geological Survey. For example, ASPO suggests a URR of about 1,900 billion barrels. This is much less than the mean estimate of at least 3,345 billion barrels in the US Geological Survey's *World Petroleum Assessment 2000* (USGS 2000).[14]

3.18 The main points which cause peak oil commentators to make lower estimates are their views that:

- estimates of reserves in the Middle East are uncertain and probably overstated;
- USGS 2000 estimates of future reserve growth and future new field oil discoveries are overstated because of unsound methodology.

Arguments about reserve estimates

3.19 Peak oil commentators argue that reported reserves figures are unreliable as they are 'clouded by ambiguous definitions and lax reporting practices.'[15] In particular, they argue that reserves figures for the Middle East are untrustworthy, since:

- state owned oil companies do not release field by field figures to allow independent auditing;
- in many Middle East countries reported reserves were increased enormously for political reasons, absent any significant discoveries, during the ‘quota wars’ of the 1980s; and
- in some countries reported reserves have been unchanged for years, implying that new discoveries and reserve growth exactly match production, which is implausible.[16]

3.20 The inference is that reported reserves in the Middle East are implausibly high. ASPO suggests that as much as 300 billion barrels may be in question.[17] This is important because 62 per cent of worldwide reported proved oil reserves - 742 billion barrels - are in the Middle East. 22 per cent - 264 billion barrels - are in Saudi Arabia

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14 Campbell C.J., *The Availability of Non-conventional Oil and Gas*, n.d. [2006], p. 4. US Geological Survey, *World Petroleum Assessment 2000. 'At least* 3,345 billion barrels': see chapter 2, footnote 43.

15 K.Aleklett & C.J.Campbell, *The Peak and Decline of World Oil and Gas Production*, n.d. [2003], p. 1.

16 K.Aleklett & C.J.Campbell, *The Peak and Decline of World Oil and Gas Production*, n.d. [2003], p. 6.

17 Campbell C.J., *The Availability of Non-conventional Oil and Gas*, n.d. [2006], p. 3.

alone.[18] The world's reliance on Middle Eastern oil is expected to increase as production in other areas declines.

3.21 Concerning the consistency and reliability of reserves reporting generally, USGS 2000 noted that 'criteria for the estimation of remaining reserves differ widely from country to country.' The IEA notes that 'there is no internationally agreed benchmark or legal standard on how much proof is needed to demonstrate the existence of a discovery [or] about the assumptions to be used to determine whether discovered oil can be produced economically.' Further, 'a lack of independent auditing makes it impossible to verify the data, even on reported proved reserves in many countries.' The IEA is working with relevant organisations to improve the definition and classification of energy reserves and resources. The United Nations Economic Commission for Europe has developed a United Nations Framework Classification for Energy and Mineral Resources.[19]

3.22 Concerning Middle East reserves, comments by the IEA support peak oil concerns up to a point. According to the IEA, 'there are doubts about the reliability of official MENA [Middle East and North Africa] reserves estimates, which have not been audited by independent auditors…'. On the matter of reserve revisions, the IEA agrees that sharp increases in reported Middle East reserves in the 1980s and 90s 'had little to do with the actual discovery of new reserves':

> MENA proven oil reserves increased sharply in the 1980s and, after a period during which they hardly increased, rose further around the turn of the century…. As a result, world oil reserves increased by more than 40%.
>
> This dramatic and sudden revision in MENA reserves has been much debated. It reflected partly the shift in ownership of reserves away from international oil companies, some of which were obliged to report reserves under strict US Securities and Exchange Commission rules. The revision was also prompted by discussions among OPEC countries over setting production quotas based, at least partly, on reserves. What is clear is that the revisions in official data had little to do with the actual discovery of new reserves….[20]

3.23 On the other hand, the IEA argues that:

- 'a substantial rise in oil prices would lead to higher reserves estimates, as more oil reserves become economically viable…';

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18 *BP Statistical Review of World Energy 2006*, p. 6.

19 US Geological Survey, *World Petroleum Assessment 2000,* p. RG-2. IEA, *World Energy Outlook 2004,* p. 87. *World Energy Outlook 2005,* p. 128.
For UNECE work see http://www.unece.org/ie/se/reserves.html
A resume of the project is in *UNECE Weekly*, no.76, 12-16 July 2004, at http://www.unece.org/highlights/unece_weekly/weekly_2004/UNECE_weekly_2004-76.pdf

20 International Energy Agency, *World Energy Outlook 2005*, pp 123-126.

- the region has been 'far from fully explored', since current high reserves to production ratios mean there has been little motive for exploration - as a result 'there is tremendous potential for adding to proven reserves';
- because recovery factors are generally lower in the Middle East than in the rest of the world, 'there is a large potential for improving these [recovery] factors by introducing more advanced technology and modern production practices'.[21]

3.24 Saudi Arabian authorities argue that they are 'very confident' of their reserves figures - including 'another 100 billion barrels [beyond currently proved reserves] that we feel very confident will be recovered with current technologies and upcoming technologies'.[22]

Arguments about future reserve growth

3.25 'Reserve growth' is the commonly seen increase in the estimated reserves of already discovered oilfields over time. Three main factors contribute to this:

- Operators generally only report reserves that are known with high probability. As knowledge of the field improves with development more accurate estimates become available.
- As an oilfield is developed, drilling tends to extend its initial boundaries.
- A reserve is defined as that part of an accumulation of oil which is *commercially viable* to produce with today's prices and technology. As technological improvements make recovery cheaper at the margin or increase the recovery factor, the reserve increases.[23]

3.26 In the US lower 48 states from 1966 to 1979, over half of the reserve growth was attributed to improved recovery rates (as opposed to better delineation of field boundaries).[24]

3.27 USGS 2000 estimated future world reserve growth by analogy with the history of reserve growth in the USA. This procedure was admittedly not ideal: it would have been better to use a history of *world* reserve growth, but the data needed was not available. USGS 2000 discussed reasons why the analogy of US reserve growth could under- or over-estimate world reserve growth:

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21 International Energy Agency, *World Energy Outlook 2005,* pp 128-131.

22 Dr Nansen G. Saleri, 'Future of Global Oil Supply: Saudi Arabia', conference presentation 24 February 2004, Saudi-US Relations Information Service, at www.saudi-us-relations.org/energy/saudi-energy-saleri.html

23 ABARE, *Australian Commodities*, vol. 13 no. 3, September 2006, pp 502-3.

24 Porter E.D., *Are We Running Out of Oil?* American Petroleum Institute Policy Analysis and Strategic Planning Department, discussion paper 81, December 1995, p. 37.

- world oil and gas fields might in effect be 'younger' than US fields of similar calendar age, because of longer delays from discovery to full development (younger fields tend to have more reserve growth);
- future world reserve growth might benefit from better technology than that which created the historical record of US reserve growth;
- a world oil shortage might accelerate activities designed to generate reserve growth;
- criteria for reporting reserves might be less restrictive in the world as a whole than in the USA;
- reported reserves might be deliberately overstated in some countries; and
- large fields around the world might have more development than US fields before the release of initial field-size estimates.

3.28 The first three points would cause the USGS 2000 methodology to under-estimate future reserve growth; the last three points would cause an over-estimate. The report commented that 'the balance that will ultimately emerge from these and other influences upon world reserve growth relative to US reserve growth is unclear.' The estimate of future world reserve growth 'carries much uncertainty', but it was considered to be more useful than making no estimate at all.[25]

3.29 Since part of recent US reserve growth has been caused by technological improvements, estimating future world reserve growth by analogy appears to incorporate an assumption that improved recovery because of technological improvements will continue at a similar rate.

3.30 In the result, potential reserve growth outside the USA from 1995-2025 was predicted to be almost as important as potential future discoveries (mean estimate 612 billion barrels of reserve growth versus 649 billion barrels of new discoveries: see Chapter 2, Figure 2.4).

3.31 'Peak oil' commentators argue that estimating future world reserve growth by analogy with past US reserve growth is unsound, since US reserve growth has been enlarged by factors which do not apply world wide or will not apply as much in future:

- historically, US reserve reporting has been driven by US prudential standards which encourage conservative bookings in the first instance and larger later additions;
- company balance sheets benefited from gradual booking of reserves; and
- in the US, initial field development tended to use primary oil recovery only, with enhanced oil recovery applied late in field life.

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25 US Geological Survey, *World Petroleum Assessment 2000*, p. RG-10ff.

3.32 It is argued by contrast that today, worldwide:

- most reserves do not meet US prudential standards (that is, they are estimated more liberally in the first place, giving less potential for later increases);
- companies no longer have the luxury of spreading reserves bookings over time; and
- enhanced oil recovery is now applied extensively and early in field development; thus not so much should be expected by way of later reserve growth from this source.[26]

3.33 Further, it is argued that the USGS 2000 approach 'failed to understand that reserve growth is mainly confined to large fields with several phases of development, and will not be matched in the smaller fields of the future.'[27]

3.34 These points would be expected to make future worldwide reserve growth less than past US reserve growth. USGS 2000 acknowledges some of them, as noted above.[28]

3.35 In 2005 some USGS 2000 authors compared reserve growth from 1996 to 2003 against the UGGS 2000 estimates. They found that in these years - 27 per cent of the USGS 2000 forecast period - 28 per cent of the expected reserve growth of conventional oil had materialised. Thus reserve growth pro-rata has been as expected.[29]

3.36 This is not necessarily a complete vindication of USGS 2000 on this point, because reserve growth is related to new discoveries, and new discoveries have been tracking well below expectations, as discussed below (paragraphs 3.38-3.49).

Arguments about future new field oil discoveries

3.37 The rate of discovery of oil should be expected to rise to a peak, then fall, as explained in the IEA's 2005 report *Resources to Reserves*:

> In the initial stage of exploration for a resource such as oil, the success rate for discoveries is small because geologists do not know where it is best to explore. But as more oil is found, we learn more about places where it is likely to be found, and the success rate increases. However, because the amount of oil in the ground is finite, there eventually comes a time when

26 ASPO Australia, *Submission 135C*, pp 6-7.

27 K. Aleklett & C.J. Campbell, *The Peak and Decline of World Oil and Gas Production*, n.d., p. 9.

28 US Geological Survey, *World Petroleum Assessment 2000,* pp RG-12-13.

29 Klett T.R. & others, 'An evaluation of the US Geological Survey *World Petroleum Assessment 2000*', *AAPG Bulletin*, vol. 59 no. 8, August 2005, p. 1033ff. Canadian tar sands - the greatest single addition to reserves in the last decade - were excluded from this assessment.

> most of it has been found, and it becomes more and more difficult to find additional reservoirs: the exploration success rate decreases again.[30]

3.38 It appears that the world has passed the peak rate of oil discovery. According to the IEA's *World Energy Outlook 2004* new field oil discoveries have declined sharply since the 1960s. In the last decade discoveries have replaced only half the oil produced.[31] The average size of discoveries per wildcat (new field exploration) well - about 10 million barrels - is barely half that of the period 1965-79.[32]

3.39 According to Mr Longwell (former executive vice-president of ExxonMobil), 'It's getting harder and harder to find oil and gas…'

> Industry has made significant new discoveries in the last few years. But they are increasingly being made at greater depths on land, in deeper water at sea, and at more substantial distances from consuming markets.[33]

3.40 ASPO argues that the declining trend in discovery should be expected to continue:

> World discovery has evidently been in decline since 1964, despite a worldwide search always aimed at the biggest and best prospects; despite all the many advances in technology and geological knowledge; and despite a favourable economic regime whereby most of the cost of exploration was offset against taxable income. It means that there is no good reason to expect the downward trend to change direction.[34]

3.41 The following figure, based on information from Exxonmobil, shows the declining trend in discovery. Expected future discovery appears to be an extrapolation of the trend, added by ASPO (who supplied the graphic). This suggests future

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30 International Energy Agency, *Resources to Reserves - Oil & Gas Technologies for the Energy Markets of the Future*, 2005, p. 38.

31 Oil reserves have continued to increase, but this includes reserve growth, as discussed above.

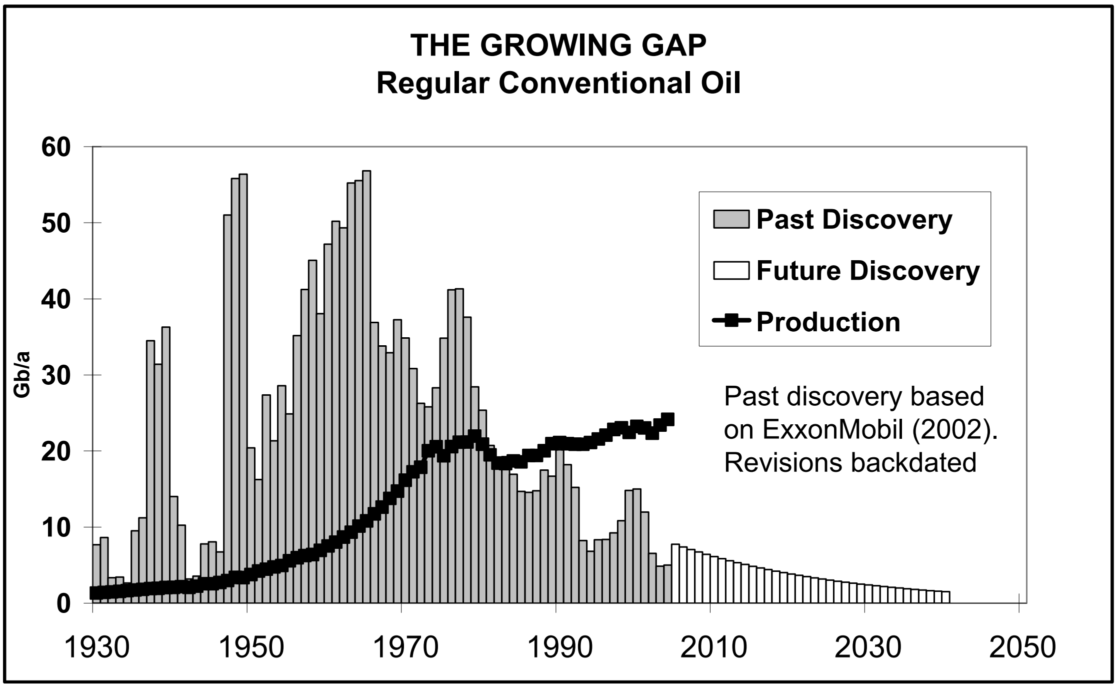
32 International Energy Agency, *World Energy Outlook 2006*, p. 90.

33 Longwell H. (ExxonMobil), 'The Future of the Oil and Gas Industry: past approaches, new challenges', *World Energy* vol. 5 no. 3, 2002, p. 103. Similarly, F. Harper (BP exploration consultant): 'Whilst some corners of the planet still remain to be explored, sufficient exploration has been carried out globally to indicate there won't be another discovery on the scale of the fields in the Middle East…[technology] will do something to defer the peak, but it's not a magic bullet.' remarks at an ASPO workshop, May 2004, at http://www.gasandoil.com/goc/features/fex42409.htm

34 ASPO Ireland, *Submission 10,* p. 3.

discovery of conventional oil (which in this figure does not include natural gas liquids) of something less than 10 billion barrels per year.[35]

Figure 3.2 – Discovery versus production of conventional oil
source: ASPO Ireland, Submission 10
'ExxonMobil (2002)' refers to Longwell H., 'The Future of the Oil and Gas Industry: past approaches, new challenges', *World Energy* vol. 5 no. 3, 2002, p. 100ff.



3.42 It may seem that the recent record of increasing reserves contradicts this picture. However reported reserve additions include reserve growth as discussed above. ASPO argues that when discussing the trend in discovery, reserve additions by reserve growth should be backdated to the original discovery of the field. ASPO argues that the discovery trend is relevant not only because of its implications for the ultimately recoverable resource, but also because 'oil has to be found before it can be

35 ASPO Ireland, *Submission 10,* p. 3. Longwell H. (ExxonMobil), 'The Future of the Oil and Gas Industry: past approaches, new challenges', *World Energy* vol. 5 no. 3, 2002, p. 100ff. A similar picture emerges in Francis Harper (exploration consultant, BP), *Ultimate Hydrocarbon Resources in the 21st Century.* AAPG conference 'Oil and Gas in the 21st Century', September 1999, UK. Quoted in Illum K., *Oil Based Technology and Economy - prospects for the future*, Danish Board of Technology and Society of Danish Engineers, 2004, p. 62.

produced, which means that production in any country, region, and eventually the World as a whole, has to mirror discovery after a time-lapse.'[36]

3.43 Political and market factors can disrupt the predicted discovery curve. According to the IEA the fall in discovery is largely the result of reduced exploration activity in the regions with the biggest reserves.[37] The declining average size of new field discoveries is said to be caused by the fact that the industry has had difficulty getting access to prospective acreage; and also by the virtual cessation of exploration in the Middle East, where discoveries have been largest. The IEA thinks that the Middle East/North Africa has some of the greatest potential for finding new fields, and expects there will be a rebound in exploration in the Middle East as the decline of existing fields speeds up and the number of undeveloped fields drops.[38]

3.44 The long term discovery trend may be compared with USGS 2000 estimates and the recent record of discovery.

3.45 USGS 2000 estimated potential new field discoveries outside the USA in the forecast period 1995-2025.[39] The results are described as quantities 'that have the potential to be added to reserves'. It is not particularly clear what assumptions this involves (if any) about future technological improvements. A 2005 review by some USGS 2000 authors says that USGS 2000 was 'an estimate of that part of the geologic resource endowment that could be considered accessible *using existing technology* in the foreseeable future.' (emphasis added).[40]

3.46 USGS 2000 estimated potential conventional oil discovery (excluding natural gas liquids) over 30 years as 649 billion barrels, or about 22 billion barrels per year on average (see Chapter 2, Figure 2.4). This implies a drastic turnaround of the 40 year declining trend in the rate of discovery.

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36 ASPO Ireland, *Submission 10*, p. 3. This assumes that reserves, once found, will be produced in a timely way: see IEA, *Resources to Reserves - Oil & Gas Technologies for the Energy Markets of the Future*, 2005, p. 39. This seems a reasonable assumption: 'There is a ready market for additional oil flows. The days of large oil companies having substantial reserves banks are largely over. This means that any substantial finds will become development projects in a very limited time, unless actively inhibited by politics or access.' *Petroleum Review,* January 2004, editorial.

37 This would be explained as rational market behaviour: there is no point spending money prematurely on exploration to add to reserves which are already ample.

38 International Energy Agency, *World Energy Outlook 2004,* pp 97-8. *World Energy Outlook 2006*, pp 89-90.

39 This was done by a bottom-up expert assessment in which geologists made judgments about the likely number and size of undiscovered fields in 246 assessment units. US Geological Survey, *World Petroleum Assessment 2000,* p. AR -1ff.

40 Klett T.R. & others, 'An Evaluation of the US Geological Survey World Petroleum Assessment 2000', *AAPG Bulletin*, vol. 89 no. 8, August 2005, p. 1034.

3.47 Conventional oil discoveries outside the USA from 1996 to 2003 (not including natural gas liquids) have been 69 billion barrels, or about 8.6 billion barrels per year on average - about 40 per cent of the suggested rate, and much closer to the ASPO prediction. According to ASPO 'this is doubly damning because the larger fields are found first.'[41]

3.48 Some also argue that the exploration behaviour of the oil majors suggests that they think USGS 2000 'discoverable' estimates are over-optimistic. For example:

> Dr Jeffrey Johnson from ExxonMobil [at an ASPO conference in May 2004] declined to answer a question of why his company was not vigorously drilling for oil in the United States, given that the USGS predicts that more than 80 billion barrels are there to be found before year 2025.[42]

3.49 USGS 2000 authors stress that USGS 2000 was an estimate of amounts *with potential* to be added to reserves, not an attempt to predict amounts that would actually be found - as that would depend also on market conditions. They argue that the result could be explained as follows:

- Most of the undiscovered resources are in 'environmentally, economically or politically difficult locations'. In contrast, previously discovered fields 'have consistently presented a stable, known opportunity for oil and gas investment.'
- In most of the period 1996-2003 the price of oil has been relatively low. Rates of exploratory drilling have been very low. It appears that in this period explorers have preferred developing existing fields with a view to reserve growth, in preference to exploring for new fields, as a 'low cost, minimal risk strategy.'[43]

Comment

3.50 On the face of it the shortfall of oil discovery since 1996, compared with that implied by USGS 2000, supports the ASPO position. However it is hard to say how much of the difference is validly explained by reasons suggested above. Certainly

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41 Klett T.R. & others, 'An Evaluation of the US Geological Survey World Petroleum Assessment 2000', *AAPG Bulletin*, vol. 89 no. 8, August 2005, p. 1038. K. Aleklett & C.J. Campbell, *The Peak and Decline of World Oil and Gas Production*, n.d., p. 9.

42 Aleklett K., *International Energy Agency Accepts Peak Oil*, n.d., at www.peakoil.net/uhdsg/weo2004/theuppsalacode.html

43 Klett T.R. & others, 'An Evaluation of the US Geological Survey World Petroleum Assessment 2000', *AAPG Bulletin*, vol. 89 no. 8, August 2005, p. 1039.

exploration effort will be influenced by the price of oil.[44] On the other hand, it appears that in the long term there has been little correlation between the oil price and oil discovery. According to Mr Longwell of ExxonMobil, 'most of our discoveries were made in a much lower price environment than today [2002], and cycles of discovery show little correlation with price over the long term…'

> Discovered volumes, over a long period of time, have not been closely related to price fluctuations.[45]

3.51 ASPO argues that 'oil companies work in advantageous tax regimes… exploration is not therefore much affected by economic constraints…'

> Prime prospects are viable under most economic conditions, but high-risk speculative prospects are drilled at times of high oil price with tax dollars.'[46]

3.52 This seems to support the view that the long term trend decline in discovery should be expected to continue - the argument being that the trend primarily reflects the fact that most of the world has been well explored, and the best prospects tend to be found first. However the committee notes the IEA's view that this might be changed by more exploration in the Middle East, which is said to be still very prospective but relatively little explored.

3.53 The suggestion by USGS 2000 authors that explorers have preferred developing existing fields to new field exploration in recent years implies that reserve growth and new field discovery are negatively correlated: one will relatively decrease if exploration investment flows preferentially to the other.

3.54 In that case one might expect that if discoveries have been lower than expected, reserve growth would have been higher. This has not been the case: discoveries have been below expectation, but reserve growth has not been above it.

3.55 It should also be noted that about half the officially expected future conventional oil discovery outside OPEC Middle East is arctic and deepwater.[47] There is probably more uncertainty about achieving the suggested discovery rate in these areas, than in other areas.

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44 According to the IEA, over the last 15 years the elasticity of exploration and production expenditures to the crude oil price has averaged 0.5 - in other words, a 10% increase in the price has led to a 5% increase in exploration and production expenditure, 'boosting new discoveries.' *World Energy Outlook 2004,* p. 90. ABARE reports that 'capital investment and exploration activity have been rising over the past few years in response to higher oil prices.' *Australian Commodities*, vol. 13 no. 3, September 2006, p. 500.

45 Longwell H. (ExxonMobil), 'The Future of the Oil and Gas Industry: past approaches, new challenges', *World Energy* vol. 5 no. 3, 2002, p. 102.

46 ASPO, *Presentation on Oil Depletion, Part 1*, n.d., at http://www.oildepletion.org/roger/ASPO_info/ASPO_tutorial/tutorial_pdf-files/ASPO-1_notes.pdf

47 International Energy Agency, *Resources to Reserves - Oil & Gas Technologies for the Energy Markets of the Future*, 2005, p. 65.

The role of technological progress in increasing reserves

3.56 Optimistic views of future oil supply tend to assume continued technological progress. This includes advances that make it easier to discover oil, or to produce it in more difficult locations, or those that increase the recovery factor - that is, make it possible to produce more of the oil originally in place in a field.

3.57 For example, ExxonMobil argues that 'continued technology advances will be needed to increase supplies… these advances evolve over time and are expected to continue…'[48] The USGS 2000 calculation of future reserve growth, by using the analogy of past US reserve growth, seems to assume that technological improvements which have enlarged reserves in the past will continue at the same rate.[49]

3.58 On the other hand, a recent IEA report notes the risks of relying on future technological improvements:

> Most projections assume various levels of sustained improvement in technologies… Projections are based heavily on extrapolating past industry trends. There are three reasons, however, why such assumptions may need to be re-examined.
>
> • As the industry moves on to more and more "difficult" oil and gas deposits, the pace of technological progress will need to accelerate significantly if past production trends are to be maintained.
>
> • Although technological advances appear to be continuous when averaged over time, such advances actually come in discrete steps as successive new techniques are deployed. There is no guarantee that the required key technologies will actually emerge in time to make new supplies available in the way that the models project.
>
> • Technological progress also needs investment; and long lead times are often involved.

3.59 The report notes that upstream research and development expenditure declined during the period of low oil prices in the 1990s, and comments that 'this could be a worrying sign that technological progress might be slower over coming years than in the past.'[50]

3.60 The prospect of significantly increasing the recovery factor is often held out as a way of increasing the ultimately recoverable resource. The recovery factor - the

48 ExxonMobil, *Tomorrow's Energy*, 2004, p. 6.

49 'This process [the USGS 2000 methodology] clearly assumes some enhanced oil recovery (EOR), since enhanced oil recovery may already be assumed in the figures for proven reserves, also because the reserve growth curve, calibrated on United States data, contains the amount of EOR historically performed in that country.' International Energy Agency, *Resources to Reserves - Oil & Gas Technologies for the Energy Markets of the Future*, 2005, p. 63.

50 International Energy Agency, *Resources to Reserves - Oil & Gas Technologies for the Energy Markets of the Future*, 2005, pp 19 and 33-34.

proportion of the oil originally in place in a field that can be recovered - varies enormously depending on the geological conditions. On average it is about 35 per cent. A small percentage increase could lead to a large increase in reserves. According to the IEA:

> Some fields are now reaching 50% recovery rates. Norway, for example, has been particularly active in bringing up the recovery levels…. Increasing the worldwide average recovery rate to 45% in existing fields would usher in "new" oil reserves larger than those of Saudi Arabia.[51]

3.61 Others argue that the prospect of greatly increasing reserves through enhanced recovery techniques in future is over-rated, on the grounds that most modern fields are developed efficiently from the start:

> Of course it is possible to go back to an old field developed long ago with poor technology and extract a little more oil from it by a range of well known methods, such as steam injection. But this is a phenomenon of the dying days of old onshore fields of the United States, Soviet Union and Venezuela. Most modern fields are developed efficiently from the beginning.[52]
>
> The annual growth in average oil recovery is a small fraction of 1 per cent. A 10 per cent gain is certainly achievable but it may take a lot of time or a significant increase in technological capability to realize the prize.'[53]

Comment

3.62 How much faith to place in future technological progress is one of the key uncertainties of managing the risks of the oil future. There is no guarantee that the advances of the past will continue at the same rate indefinitely. As technology improves, it is possible that there will come a time of declining marginal returns to investment in yet further improvement.

Estimates of the ultimately recoverable resource

3.63 Estimates of the ultimately recoverable oil resource (URR) vary widely. Part of the variation may depend on what categories are included, particularly in relation to nonconventional oil.

3.64 ASPO suggests a URR of 'regular conventional oil' of 1,900 billion barrels. This is based on detailed country by country data and assumptions (eg extrapolating

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51 International Energy Agency, *Resources to Reserves - Oil & Gas Technologies for the Energy Markets of the Future*, 2005, pp 51-2.

52 Campbell C.J., *The Imminent Peak of World Oil Production*, presentation to a House of Commons All-Party Committee 7 July 1999.

53 F. Harper (BP exploration consultant), quoted in Quoted in Illum K., *Oil Based Technology and Economy - prospects for the future*, Danish Board of Technology and Society of Danish Engineers, 2004, p. 61.

the production trend of countries already in decline). It excludes deepwater and polar oil and natural gas liquids.[54]

3.65 USGS 2000 suggests a URR of at least 3,345 billion barrels of conventional oil (mean estimate: see Chapter 2, Figure 2.4). This includes natural gas liquids - for crude oil alone the figure is 3,021 billion barrels. This appears to be the basis of most official agency reporting.

3.66 Much higher figures are sometimes seen. These are speculative, and include nonconventional oil. For example ExxonMobil suggests a recoverable total of 4-5,000 billion barrels. The assumptions behind this are not stated.[55]

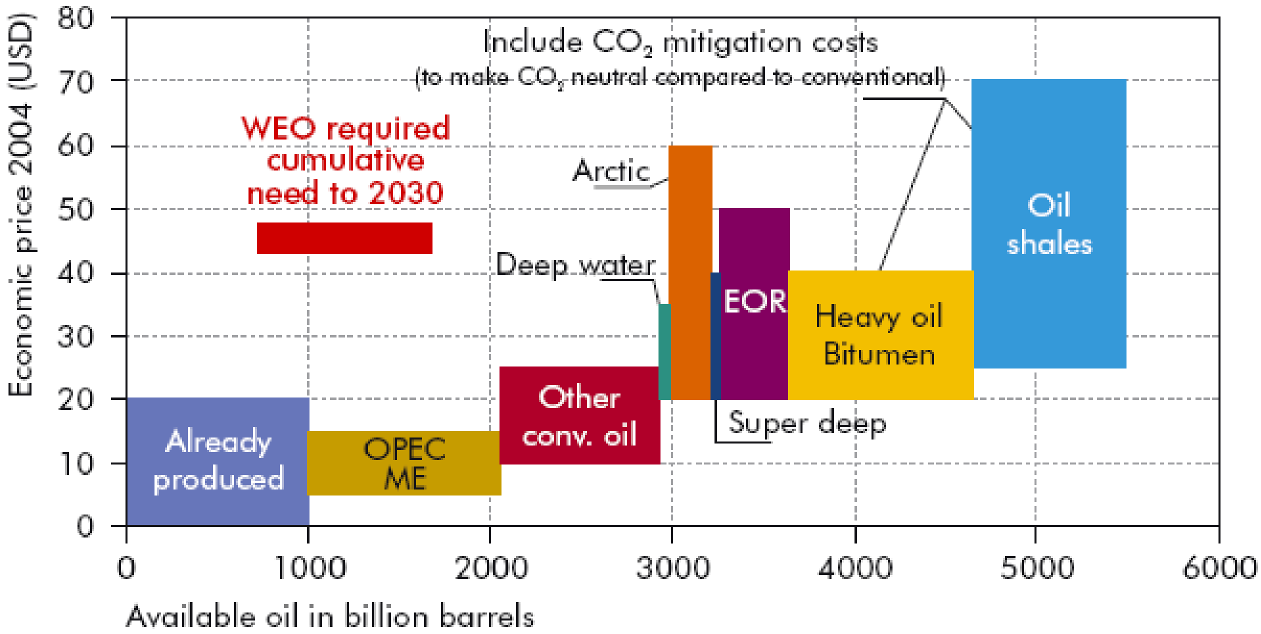
3.67 A 2005 IEA report suggested an ultimately recoverable total of up to 5,500 billion barrels, depending on the price of oil. In addition to conventional oil this includes estimates for deepwater and arctic oil, enhanced oil recovery, heavy oil and bitumen, and shale oil. It would require the oil price to reach $US70 per barrel in the long term to make all of the shale oil component viable:

54 Campbell C.J., *The Availability of Non-conventional Oil and Gas*, n.d. [2006], p. 4.

55 ExxonMobil, *Tomorrow's Energy*, 2006, p. 5.

Figure 3.3 – Oil cost curve including technological progress: availability of oil resources as a function of economic price

source: IEA, *Resources to Reserves - Oil and Gas Technologies for the Energy Markets of the Future*, 2005, p. 17.



The x axis represents cumulative accessible oil. The y axis represents the price at which each type of resource becomes economical.

Source: IEA.

3.68 This figure appears to be based on the following textual comments estimating the nonconventional recoverable resource:

- undiscovered deepwater 120 billion barrels; undiscovered Arctic 200 billion; 'additional enhanced oil recovery potential' 300 billion;
- heavy oil and bitumen: 800 billion barrels based on 20 per cent recovery of 4,000 billion barrels of oil in place in Canada and Venezuela;[56] and
- oil from shale: 1,060 billion barrels based on estimated 2,600 billion barrels of hydrocarbons in place.[57]

56 ABARE in 2006 reported recoverable reserves of 315 billion barrels of tar sands in Canada and 270 billion barrels of heavy oil in Venezuela: *Australian Commodities*, June 2006, p. 305.

3.69 It is not clear what the degree of confidence is in these figures. It is not clear what justifies the suggested recovery factors for nonconventional oil.

3.70 It should be remembered that figures for the ultimately recoverable resource include oil produced to date: about 1,000 billion barrels.

Comment

3.71 It is unclear whether high end estimates of the ultimately recoverable resource are intended to be optimistic, mean or conservative estimates. It is unclear what they assume about future technological improvements.

3.72 In any case, it is noted below that large differences in the estimated URR make surprisingly little difference to the timing of peak oil. The exponential growth in demand is the dominating factor. See paragraph 3.83.

Relating the ultimately recoverable resource to peak: the Hubbert curve

3.73 Peak oil proponents commonly predict that world oil production will peak when about half the ultimately recoverable resource has been produced. This is based on the work of geologist M. K. Hubbert, who in 1956 correctly predicted that US lower 48 states oil production would peak around 1970. This combined his estimate of the ultimately recoverable resource with the assumption that total production would follow a roughly bell-shaped curve, with a long period of rising production followed by a long period of falling production (as explained at paragraph 2.15).[58]

3.74 If the rate of decline mirrors the rate of growth, the graph of annual production over time will be a symmetrical bell shape, and the year of highest production will be when half the ultimate production has occurred. The arithmetic involved is shown in the simplified peak oil calculation in Figure 3.1, (paragraph 3.8).

3.75 There is no inherent reason why the curve should be symmetrical: production growth depends on factors such the growth of the market for the product; while decline reflects other factors such as the increasing difficulty of producing the

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57 International Energy Agency, *Resources to Reserves - Oil & Gas Technologies for the Energy Markets of the Future*, 2005, pp 63, 65, 73, 75, and 82. Estimated resources in place: heavy oil and bitumen 6,000 billion barrels (of which Canada 2,500 billion, Venezuela 1,500 billion); oil shale 2,600 billion (of which USA 1,600 billion). Reason for discrepancies between the numbers and the graphic is unclear. The report also says 'super-deep reservoirs… could easily reach 300 billion barrels oil equivalent': p. 73. This does not appear to be included in the graphic. 'Additional enhanced oil recovery potential' of 300 billion barrels assumes a 'conservative recovery rate increase of 5 per cent of oil in place' above that implied by the USGS 2000 methodology: p. 63.

58 Hubbert gave two scenarios based on higher or lower estimates of remaining resources in 1955. Production history has been reasonably close to the high estimate. McCabe P.J., 'Energy Resources - Cornucopia or Empty Barrel', *AAPG Bulletin*, vol. 82 no. 11, November 1998, p. 2122.

depleting resource, or competition from substitutes. An earlier peak is associated with a slower decline after the peak. A later peak is associated with a sharper decline. [59]

3.76 Critics of the Hubbert approach argue that:

- the calculation depends on the size of the URR. If the estimate of URR is constantly changing, the calculation has no predictive value;
- there is no reason to assume that the decline profile will mirror the growth profile at world level. Many regions have not shown the suggested symmetrical profile. For example, Unites States post-peak decline has been slower than pre-peak growth; and[60]
- production histories of fossil fuels are driven more by demand than by the abundance of the resource. Post peak decline is driven by competition from substitutes, not by scarcity. For example: 'The decline in US supply after 1970 did not indicate that the US was "running out" of oil, but rather that the cost associated with much of remaining Lower 48 resources was no longer competitive with imports from lower cost sources worldwide. …the decline in US supply from 1970 represented not a signal of growing global resource scarcity, but rather a signal of growing global resource abundance.'[61]

Comment

3.77 The committee comments on the bullet points above:

- The uncertainty of estimating the ultimately recoverable resource is discussed above (paragraph 3.9). Given the importance of the issue, an uncertain estimate is better than none.
- It is true that there is no inherent reason why the peak should be at the half way point of production. However it appears that in fact it commonly is. One analysis found that of the over 50 oil-producing nations whose production has peaked, the peak occurred in the vast majority of cases when 40-60 per cent of URR had been extracted. It appears that within this range the exact figure is not very important: in another analysis, assuming that the peak production of nations occurred when 60 per cent (versus 50 per cent) of their extractable ultimate

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59 International Energy Agency, *World Energy Outlook 2004*, p. 101.

60 Porter E.D., *Are We Running Out of Oil?* American Petroleum Institute Policy Analysis and Strategic Planning Department, discussion paper 81, December 1995, p. 17.

61 The implication is that Hubbert's reasoning concerning resource scarcity was completely wrong, but purely by chance market forces later created an outcome for the USA that looked the same as his prediction. McCabe P.J., 'Energy Resources - Cornucopia or Empty Barrel', *AAPG Bulletin*, vol. 82 no. 11, November 1998, p. 2110. Porter E.D., *Are We Running Out of Oil?* American Petroleum Institute Policy Analysis and Strategic Planning Department, discussion paper 81, December 1995, p. 19.

resource had been extracted added only 3-9 years to the timing of peak production.[62] According to the IEA 'oilfields will tend to enter a decline phase, other things being equal, when over 50 per cent of reserves have been produced'. [63]

- Production histories of fossil fuels may well have been driven more by changing demand than by the abundance of the resource. There is no guarantee that the same will apply to future demand for oil at the global scale.

Estimating the timing of peak oil

3.78 There are many estimates of the timing of peak oil. The more nonconventional oil is included, the later the peak will be; but at the same time, the more serious are the questions about what happens after the peak, since the nonconventional oil which has already been included is no longer available to buffer the decline.

3.79 The International Energy Agency in 2004, based on USGS 2000 figures for the ultimately recoverable resource, estimated a peak of conventional oil between 2013 and 2037 depending on assumptions. The 'reference scenario' assumes the USGS 2000 mean resource estimate (3,345 billion barrels: see Chapter 2, Figure 2.4). The 'low resource' and 'high resource' cases are a more cautious (90 per cent probable) figure and a more optimistic (10 per cent probable) figure. Demand is assumed to grow at slightly different rates in each case, on the assumption that prices change in response to different production levels.[64]

3.80 In the low resource case, production peaks in about 2015, and nonconventional oil meets just under a third of demand. In the high resource case conventional production peaks in 2033. In the reference case (mid-range resource estimate) the peak is around 2030. The scenarios do not claim that *total* oil production (as opposed to *conventional* oil production) would peak at those times. That would depend on whether non-conventional growth is greater than conventional decline after the conventional oil peak.

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62 Duncan R., 'Three world oil forecasts predict peak oil production', *Oil and Gas Journal* vol. 101 no. 14, 2003, pp 18-21. Hallock J.L. & others, 'Forecasting the limits to the availability and diversity of global conventional oil supply', *Energy* 29 (2004), pp 1679 and 1685.

63 International Energy Agency, *Medium Term Oil Market Report*, July 2006, p. 23.

64 The source does not say what the modelled demand growth rates were.

Figure 3.4 – IEA peak oil scenarios billion barrels			
	low resource case	reference scenario	high resource case
remaining ultimately recoverable resource of conventional oil at 1/1/1996	1,700	2,626	3,200
peak period of conventional production	2013-2017	2028-2032	2033-2037
demand at peak of conventional oil (million barrels per day)	96	121	142
non-conventional oil production in 2030 (million barrels per day)	37	10	8
source: International Energy Agency, *World Energy Outlook 2004,* p. 102.			

3.81 However the situation differs greatly across regions. Some regions have already reached their production peak, and non-OPEC conventional oil production is expected to peak between 2010 and 2015. According to the IEA, 'the biggest increase is expected to occur in the Middle East. Consequently, the rate of expansion of installed production capacity in this region and the Middle East and North African (MENA) region as a whole will determine when global production peaks.'[65]

3.82 In a similar exercise, the US Energy Information Administration in 2000 estimated the peak of conventional oil for various scenarios resource limits and demand growth. The modelling assumed a decline path after the peak which maintains a reserves to production ratio of 10 to 1, based on US experience. Most of the scenarios lead to a peak between 2020 and 2050. For example, using the USGS 2000 mean estimate of the recoverable resource, and assuming 2 per cent annual growth in demand, leads to a peak in 2037:

Figure 3.5 – World conventional oil production scenarios Post-peak decline assumed to maintain a reserves to production ratio of 10 to 1.					
probability	ultimate recovery billion barrels	annual growth rate of production	estimated peak year	peak production billion barrels per year	peak production million barrels per day
95 per cent	2,248	1.0%	2033	34.8	95
	2,248	2.0%	2026	42.8	117
	2,248	3.0%	2021	48.5	133
mean (expected value)	3,003	1.0%	2050	41.2	113
	3,003	**2.0%**	**2037**	**53.2**	**146**
	3,003	3.0%	2030	63.3	173

65 International Energy Agency, *World Energy Outlook 2005,* p. 140.

5 per cent	3,896	1.0%	2067	48.8	134
	3,896	2.0%	2047	64.9	178
	3,896	3.0%	2037	77.8	213
Source: US Energy Information Administration, *Long Term World Oil Supply (A Resource Base/Production Path Analysis)*, 2000					

3.83 The authors comment that the outcome depends crucially on the assumed rate of demand growth, and by contrast is 'remarkably insensitive to the assumption of alternative resource base estimates…'

> For example, adding 900 billion barrels - more oil than had been produced at the time the estimates were made - to the mean USGS resource estimate in the 2 per cent growth case only delays the estimated production peak by 10 years.[66]

3.84 This study has been criticised for assuming that post-peak decline maintains a reserves to production (R/P) ratio of 10 to 1. This implies a decline which is very steep at first (between 6.7 per cent and 8.3 per cent per year depending on resource assumptions), and slows later (a steeper decline is associated with a later peak). By contrast, existing oilfields are said to be declining at an average rate of 4-6 per cent (see paragraph 3.92); so net decline post-peak will presumably be something less than that (since there will still be new developments offsetting part of the decline from existing fields). The IEA has noted that the assumptions used for decline rates in mature fields are the most uncertain part of any supply forecast.[67]

3.85 Critics argue that decline maintaining a reserves to production ratio of 10 to 1 is implausibly steep, and a more symmetrical profile is more usual.[68] Assuming 2 per cent growth and 2 per cent decline, in the USGS 2000 mean resource case, brings forward the peak from 2037 to 2016:

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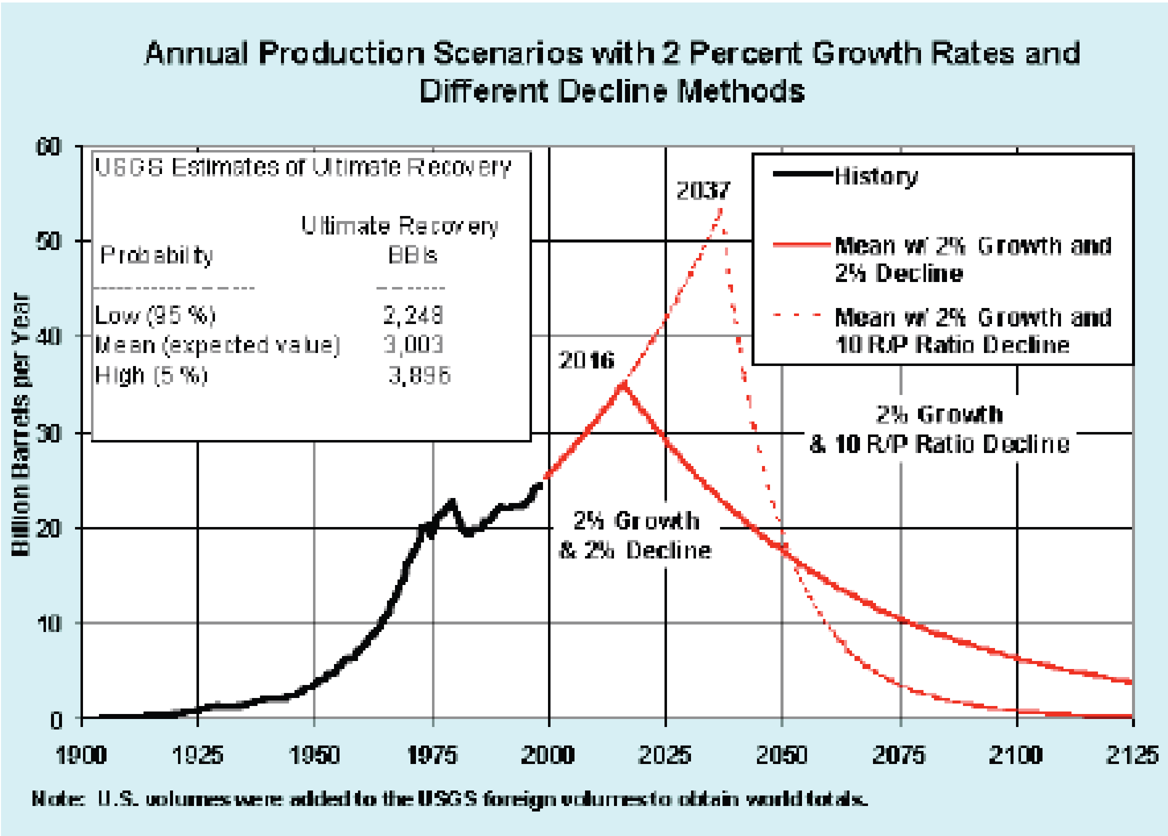
66 J.H.Wood, G.R.Long & D.F.Morehouse, *Long Term World Oil Supply Scenarios - the future is neither as bleak or as rosy as some assert*, US Energy Information Administration, 2004, pp 5-7.

67 International Energy Agency, *Medium Term Oil Market Report*, July 2006, p. 23.

68 R.L. Hirsch, R. Bezdek & R. Wendling, *Peaking of World Oil Production - impacts, mitigation and risk management,* 2005, p. 69. Hallock J.L. & others, 'Forecasting the limits to the availability and diversity of global conventional oil supply', *Energy* 29 (2004), p. 1683. Cavallo A., 'Predicting the peak in world oil production', *Natural Resources Research* vol. 11 no. 3, 2002, pp 187-195.

Figure 3.6 – EIA peak oil scenarios. Based on 2% annual demand growth and mean (expected) ultimate recovery of 3,003 billion barrels. Comparison of decline at 2 per cent per year (peak year 2016) and decline with reserves to production ratio 10 to 1 (peak year 2037)
Source: US Energy Information Administration, Long Term World Oil Supply (A Resource Base/Production Path Analysis), 2000



3.86 Many other commentators predict an earlier peak, apparently based on lower estimates of the ultimately recoverable resource. ASPO predicts a peak of conventional oil around 2010, with significant uncertainty on either side of that time.[69] Other opinions are gathered by Robert Hirsch, author of a 2005 report on peak oil for the US Department of Energy:

2005 - T. Boone Pickens (oil and gas investor)
2005 - K. Deffeyes (retired Princeton professor and Shell geologist)
at hand - E.T. Westervelt et al (US Army Corps of Engineers)
now - S. Bakhtiari (Iranian National Oil Company planner)
close or past - R. Herrera (retired BP Geologist)
very soon - H. Groppe (oil/gas expert and businessman)
by 2010 - S. Wrobel (investment fund manager)

69 ASPO Australia, *Submission 132*, p. 2.

around 2010 - R. Bentley (university energy analyst)
2010 - C. Campbell (retired oil company geologist)
2010+/- a year - C. Skrebowski (editor of Petroleum Review)
around 2012 - R.H.E.M Koppelaar (Dutch oil analyst)
a challenge around 2011 - L.M. Meling (Statoil oil company geologist)
within a decade - Volvo Trucks
within a decade - C. de Margerie (oil company executive)
2015 - S. al Husseini (retired executive vice-president of Saudi Aramco)
around 2015 - Merrill Lynch (brokerage/financial)
2015-2020 - J.R. West, PFC Energy
around 2020 or earlier - C.T. Maxwell, Weeden & Co., brokerage
within 15 years - Wood Mackenzie, energy consulting
around 2020 - Total, French oil company
mid to late 2020s - UBS (brokerage/financial
well after 2020 - CERA (energy consulting)
no sign of peaking - ExxonMobil (oil company)
impossible to predict - J. Browne (BP CEO)
deny peak oil theory - OPEC [70]

3.87 ASPO emphasises that 'these dates are of no particular significance. They are not high or isolated peaks, but simply the maximum values on a gentle curve…'

> Minor changes in the input or modelling could shift them by a few years, as could a collapse in demand from economic recession. That said, the overall pattern of growth being followed by decline is beyond doubt and immensely important.[71]

Comment

3.88 The timing of peak oil is debated. However the concept appears to be widely accepted, including by official agencies such as the IEA and the US Energy Information Administration, and some major oil companies.

3.89 The scenarios above by the IEA and US Energy Information Administration should be compared with the simplified peak oil calculation at Figure 3.1. Figure 3.1 is reasonably consistent with the official scenarios (after allowing that the Energy Information Administration scenarios at Figure 3.6 postpone the peak by assuming a steep decline). In Figure 3.1, even the most generous assumption of the ultimately recoverable resource - 5,000 billion barrels including nonconventional oil - still leads to a peak in 38 years - well within the maturity of today's children. The exponential growth of demand is the dominating force.

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70 Hirsch R., *Peaking of World Oil Production - an overview*, Atlantic Council workshop on Transatlantic Energy Issues*, 23 October 2006*, p. 11ff.

71 Campbell C.J., *The Availability of Non-conventional Oil and Gas*, n.d. [2006], p. 4.

3.90 Clearly, an optimistic view of **long term** oil supply cannot be sustained merely by saying, 'our estimate of the ultimately recoverable resource is bigger than yours'. It must rely on an optimistic view of the ability of market forces and technological progress to bring alternative fuels on stream in a timely way in sufficient quantity to serve the post-oil age.

Investment needed to maintain production

3.91 Reserves are stock; production is a flow. The rate of production is the matter of immediate concern: reserves are only of interest for what they imply about the future rate of production or future security of supply. New oil developments must make up for the declining production rate of existing fields before they can begin to satisfy any increase in demand. According to the IEA the assumptions used for decline rates in mature fields are the most uncertain part of any supply forecast.[72]

3.92 Various estimates exist of the average decline rate of existing oilfields.[73] ExxonMobil estimates 4-6 per cent per year. The IEA suggests that the global rate is 'closer to 5 per cent than 10 per cent'. Many countries are in overall decline. Decline rates are highest in mature OECD producing areas, and lowest in regions with the best production prospects, such as the Middle East.[74]

3.93 At current rates of depletion and demand growth, over two thirds of new production is needed to offset depletion, and this proportion is expected to increase.[75] According to the IEA, 'by 2030 most oil production worldwide will come from capacity that is yet to be built.'[76]

3.94 The upstream developments needed to offset decline and satisfy predicted demand growth will require very significant investment. Recent World Energy Outlooks have stressed with increasing urgency that there is no guarantee this will be forthcoming:

> Meeting the world's growing hunger for energy requires massive investment in energy-supply infrastructure… [In the reference scenario] Oil investment – three-quarters of which goes to the upstream – amounts to

72 International Energy Agency, *Medium Term Oil Market Report*, July 2006, p. 23.

73 Gas declines differently because of its different properties.

74 ExxonMobil, *The Lamp*, 2003 no. 1. International Energy Agency, *World Energy Outlook 2005*, p. 103. International Energy Agency, *Medium Term Oil Market Report*, July 2006, p. 23. ASPO Australia, *Submission 135*, p. 2. Chevron, quoting Worldwatch Institute, *Vital Signs,* 2005, p. 30: http://www.willyoujoinus.com/issues/alternatives/

75 International Energy Agency, *World Energy Outlook 2004*, p. 121. Rehaag K. (IEA), *Is the World Facing a Third Oil Shock?* Presentation to FVG & IBP workshop, Rio de Janeiro, 12 July 2004, p. 27.

76 International Energy Agency, *World Energy Outlook 2004,* p. 103. Similarly: 'By 2015, we will need to find, develop and produce a volume of new oil and gas that is equal to eight out of every 10 barrels being produced today.' ExxonMobil, *The Lamp*, 2003 no. 1.

> over $4 trillion in total over 2005-2030. Upstream investment needs are more sensitive to changes in decline rates at producing fields than to the rate of growth of demand for oil…
>
> There is no guarantee that all of the investment needed will be forthcoming… The ability and willingness of major oil and gas producers to step up investment in order to meet rising global demand are particularly uncertain.[77]

3.95 The level of investment affects the timing of peak oil:

> The rate of expansion of installed production capacity in [the Middle East] and the MENA [Middle East North Africa] region as a whole will determine when global production peaks… MENA production will most likely peak some time after global production. How soon after will depend on investment.[78]

3.96 IEA projections require a very high growth of production in Middle East countries to offset depletion in other areas. Middle East production is expected to nearly double to 2030 (see Chapter 2, Figure 2.3). Some 'peak oil' commentators doubt that this will be physically possible. For example, Matthew Simmons in *Twilight in the Desert* (2004) suggested that Saudi Arabian oil production is on the brink of decline. Critics of this view have made detailed responses arguing that in fact Saudi oilfields enjoy a 'gradual and well-managed depletion' and Saudi Arabia has good prospects for new discoveries. Saudi authorities claim that Saudi Arabia could produce up to 15 millions barrels per day to 2054 and beyond.[79]

3.97 For major oil projects there is a typical lead time of up to five years between decision and production. Chris Skrebowski, editor, *Petroleum Review,* has tabulated known major projects under development to predict supply expansion to 2010. His latest outlook for future supply (April 2006) is 'somewhat brighter than even six months ago… possibly as a result of high prices being sustained and triggering investment decisions.' It predicts gross new capacity from major projects (over 50,000 barrels per day peak flows) of over 3 million barrels per day per year from 2006 to 2010. This must offset depletion of existing fields and satisfy demand increases. Supply could fall short of expectations for several reasons, including increasing depletion:

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77 International Energy Agency, *World Energy Outlook 2006*, p. 40.

78 International Energy Agency, *World Energy Outlook 2005*, p. 140.

79 Simmons M.R., *Twilight in the Desert: the Coming Saudi Oil Shock and the World Economy*, c2005. Jarrell J., 'Another Day in the Desert: A Response to the Book "Twilight in the Desert"', *Geopolitics of Energy,* vol. 17 no. 10, October 2005. Saudi-US Relations Information Service newsletter, 25 August 2004. Saudi Arabian oil production is currently about 11 million barrels per day: BP Statistical Review of World Energy 2006, p.8

> Capacity erosion or depletion will increase as more countries reach the point where their production declines year on year… all the evidence shows that depletion tends to speed up rather than slow down.[80]

3.98 Skrebowski concludes that 'oil production has the potential to expand for the rest of the decade but shortly thereafter production is more likely to decrease than to increase.'[81] This is consistent with comments in the *World Energy Outlook 2006*: 'Increased capital spending on refining is expected to raise throughput capacity by almost 8 million barrels per day by 2010. Beyond the current decade, higher investment in real terms will be needed to maintain growth in upstream and downstream capacity.'[82]

The prospects of nonconventional oil

3.99 All scenarios for future oil production assume increasing nonconventional production to offset declining conventional oil. The main elements of this are usually defined as tar sands (mostly from Canada), heavy oil (mostly from Venezuela) and oil from shale. Some include as 'nonconventional oil' the output of gas to liquids (GTL) and coal to liquids (CTL) processes - these are considered in Chapter 6.

3.100 The nonconventional resource originally in place is very large - perhaps up to 7,000 billion barrels.[83] 80 per cent of this is in Canadian tars sands, Venezuelan heavy oil in Venezuela, and oil shale in the United States. However the proportion of it which is an economic reserve is relatively small, because of the difficulty of extracting it. IHS Energy estimated that there were 333 billion barrels of remaining recoverable bitumen reserves worldwide in 2003.[84] ABARE in 2006 reports recoverable reserves of 315 billion barrels of tar sands in Canada and 270 billion barrels of heavy oil in Venezuela. The shale oil resource is very large, but it requires a high oil price to be commercially viable.[85]

3.101 Production costs are typically much higher than for conventional oil. Energy intensive conversion processes are needed to make usable products, so their viability

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80 *Petroleum Review*, April 2006, editorial. It is unclear how important untabulated smaller projects are expected to be compared with the tabulated 'megaprojects'.

81 Skrebowski C., *Megaprojects analysis explained*, June 2006, at www.odac-info.org/bulletin/documents/megaprojects_explained.htm

82 International Energy Agency, *World Energy Outlook 2006*, p. 40.

83 International Energy Agency, *World Energy Outlook 2004*, p. 95. Another IEA report estimates the nonconventional resource as 2,500 billion barrels in Canada, 1,500 billion in Venezuela, and 2,600 billion in oil shale (of which 1,600 billion is in the USA): *Resources to Reserves - Oil & Gas Technologies for the Energy Markets of the Future*, 2005, pp 75 and 82. ABARE reports an estimate of shale oil resource in place of 2,900 billion barrels: *Australian Commodities*, June 2006, p. 305.

84 International Energy Agency, *World Energy Outlook 2004*, p. 95.

85 ABARE, *Australian Commodities*, June 2006, p. 305.

is very sensitive to input energy prices. This also means that on a 'well to wheels' basis the product has higher greenhouse gas emissions than conventional oil if the operation does not include carbon capture and storage.

3.102 A 2005 IEA report estimated the oil prices that would be needed to make various forms of nonconventional oil viable: It estimated up to $US40 per barrel for tar sands and heavy oil, and up to $US70 per barrel for shale oil: see Figure 3.3 above. ABARE reports an estimate of $US70-95 per barrel for an initial shale oil project, declining later.[86]

3.103 According to the *World Energy Outlook 2006,* production of oil from Canadian tar sands was 1 million barrels per day in 2005, and is projected to rise to 3 million barrels per day by 2015, and 5 million barrels per day by 2030. This is a significant increase on the previous projection 'in response to higher oil prices and to growing interest in developing such resources'. This assumes that no financial penalty for carbon dioxide emissions is introduced - as production is very carbon intensive, a charge could have a major impact on the prospects for new investment.[87]

3.104 Production of Venezuelan heavy oil is about 650,000 barrels per day and according to the 2004 *World Energy Outlook*, added capacity of 180,000 barrels per day by 2010 is planned.[88]

3.105 Peak oil commentators are concerned that exploitation of these nonconventional resources will be too difficult and costly to make much difference to the peak oil scenarios they predict:

> The Canadian operations are constrained by the mammoth nature of the task, the shrinking supplies of cheap gas to fuel the plants, water supply limits and the need to excavate ever greater thicknesses of overburden… it is important to remember that so far only the more favourable locations have been exploited.[89]

3.106 An IEA report notes the difficulty of supplying the gas and water needed for processing: 'In Canada more particularly this is expected to hamper heavy oil

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86 International Energy Agency, *World Energy Outlook 2006,* p. 98. International Energy Agency, *Resources to Reserves - Oil & Gas Technologies for the Energy Markets of the Future*, 2005, p. 17. ABARE, *Australian Commodities*, June 2006, p. 305.

87 International Energy Agency, *World Energy Outlook 2006,* pp 98-9.

88 Esser R., *The Oil Industry Growth Challenge - expanding production capacity*, testimony to US House of Representatives Energy and Air Quality Subcommittee, 7 December 2005, p. 6. International Energy Agency, *World Energy Outlook 2004,* p. 115. There is no comparable discussion in *World Energy Outlook 2006* and it is unclear how Venezuelan heavy oil is accounted for in the 2006 supply projection tables (pp 92-3). It is noted that 'Most of the production of extra-heavy bituminous crude oil in Venezuela is now classified as conventional oil.' p. 97.

89 Aleklett K.& Campbell C.J., *The Peak and Decline of World Oil and Gas Production*, n.d., p. 14.

production as early as 2015.' [90] As well, it notes that processing consumes 20-25 per cent of the energy content of the product, with associated greenhouse emissions. Nuclear power is being discussed to provide the needed energy. Alternatively, carbon capture and storage in underground formations would be possible, but would cost about $US5-7 per barrel of product.

3.107 In general the IEA notes that 'producing such a massive amount of resources can only be done over long periods of time… simply mobilising the capital for exploitation of a significant fraction of the resources is likely to take several decades.'[91]

Implications for the price of oil

3.108 The effect of these scenarios on long term oil prices is of course much harder to predict, as it also depends on other factors such as economic growth, the trend in energy consumption per unit of economic output, and the development of alternative fuels.

3.109 ABARE sees 'a distinct possibility that world oil prices could remain relatively high for a number of years', but projects that prices will fall towards the end of the decade 'in response to higher global oil production and a substantial increase in oil stocks by that time.' In the short term, significant volatility in world oil prices is likely to continue as oil production capacity is expected to increase only gradually.[92]

3.110 ABARE's long term projections of demand for oil assume an oil price of $US40 per barrel, on the grounds that oil prices will be held to that level by competition from substitutes, such as oil from coal, which become viable at about that level.[93]

3.111 The *World Energy Outlook 2005* assumed a crude oil price easing from the current high to $US35 per barrel in 2010 as new crude oil production and refining capacity comes on stream; then increasing gradually to $US39 by 2030 (2004 dollars). It notes that 'the assumed slowly rising trend in real prices after 2010 reflects an expected increase in marginal production costs outside OPEC, an increase in the market share of a small number of major producing countries, and lower spare capacity.' Most of the new production capacity needed to satisfy the predicted demand is expected to come from OPEC countries, particularly in the Middle East. The slowly

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90 International Energy Agency, *Resources to Reserves - Oil & Gas Technologies for the Energy Markets of the Future*, 2005, p. 78.

91 International Energy Agency, *Resources to Reserves - Oil & Gas Technologies for the Energy Markets of the Future*, 2005, p. 81.

92 ABARE, *Australian Commodities,* June 2006, p. 303ff. *Australian Commodities,* September 2006, p. 501.

93 Dr J. Penm (ABARE), *Proof Committee Hansard,* 18 August 2006, p. 59.

rising price trend is not intended to mean a stable market: 'indeed, oil prices may become more volatile in future'.[94]

3.112 The *World Energy Outlook 2006* (released in November) revised these projections upwards 'in the expectation that crude oil and refined-products markets remain tight.' The crude oil price is assumed to average slightly over $US60 per barrel through 2007, easing to about $47 by 2012, then increasing gradually to $55 by 2030 (2005 dollars). The reasons given are the same. It is unclear why the same causes are now expected to have significantly more serious effects. The outlook notes that 'some commentators and investors predict further price rises, possibly to $100 per barrel.' It notes that 'new geopolitical tensions or, worse, a major supply disruption could drive prices even higher.' It repeats that prices are likely to remain volatile.[95]

3.113 These price projections reflect the authors' judgement of the prices that would be needed to stimulate sufficient investment in supply to meet projected demand.[96]

3.114 Demand for oil is relatively inelastic, largely because for its major use - transport - there are no easy substitutes. This means that a relatively small shortfall in supply can cause a large increase in price. This will increase the volatility of the price in response to small changes in supply when there is little spare capacity. The oil shocks of 1973-4 and 1979-80, in which prices trebled (1973-4) and doubled (1979-80) in a short period, were caused by supply shortfalls of 8 to 10 per cent.[97]

3.115 In a situation where demand is inelastic, a price rise transfers income from oil importing countries to oil exporting countries, and the net impact on world economic growth is negative.[98]

3.116 The IEA estimates that a permanent doubling of the crude oil price would be expected to cut demand by about 3 per cent in the same year and 15 per cent after more than ten years. This suggests that, other things being equal, a shortfall of supply of 3 per cent would be likely to cause the price to double in the short term.[99]

3.117 Most peak oil commentators refrain from predicting the future oil price, given the uncertainties involved. However 'early peakers' such as ASPO believe that prices much higher than the official agency projections are possible:

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94 International Energy Agency, *World Energy Outlook 2005*, pp 63-5.

95 International Energy Agency, *World Energy Outlook 2006*, pp 38-9 and 60-2.

96 International Energy Agency, *World Energy Outlook 2006*, p. 60.

97 Hirsch, R.L. Bezdek R.& Wendling R., *Peaking of World Oil Production - impacts, mitigation and risk management.*2005, p. 26. US Energy Information Administration, *Annual Oil Market Chronology*, at http://www.eia.doe.gov/emeu/cabs/AOMC/Overview.html

98 Hirsch, R.L. Bezdek R.& Wendling R, *Peaking of World Oil Production - impacts, mitigation and risk management.*2005, p. 28.

99 International Energy Agency, *World Energy Outlook 2006*, p. 286.

> When global peak oil occurs, oil shortages, many-fold price rises and possible international and national oil rationing are all plausible scenarios.[100]

3.118 A study by CIBC World Markets in 2005 considered the effects of growing theoretical demand to 95.7 million barrels per day in 2010, if supply was actually capped at 86.8 millions barrels per day. Using an elasticity of -0.15 (the IEA's long term figure) it found that the crude oil price would need to rise to $US101 per barrel to destroy enough demand to bring supply and demand into balance.[101]

3.119 In the longer term the oil price will depend on the price of substitutes. As noted, ABARE suggested that coal-to-liquids is viable at $US40 per barrel (see paragraph 3.110). The IEA suggests that heavy oil and bitumen are viable at $US40 per barrel, and oil from shale is viable at $US70 per barrel, even with the requirement to make them carbon neutral compared with conventional oil - see Figure 3.3.[102] The problems of mobilising the investment needed to create this supply are considered in Chapter 6.

3.120 It should be noted that peak oil proponents do not claim that peak oil is the cause of present high oil prices. If the oil price declines in the next few years, as ABARE suggests, this does not dispose of peak oil concerns. Peak oil is a different and much longer term concern.

New warnings in *World Energy Outlook 2006*

3.121 The International Energy Agency's *World Energy Outlook 2006* gives serious new warnings about the energy future. Its first words are:

> Current trends in energy consumption are neither secure nor sustainable – economically, environmentally or socially.[103]

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100 ASPO Australia, *Submission 132*, p. 2.

101 CIBC [Canadian Imperial Bank of Commerce] World Markets, *Not Just a Spike*, occasional paper 53, 13 April 2005. At http://research.cibcwm.com/economic_public/download/occ_53.pdf
The demand figure was based on 2.5% trend growth. Capping supply at 86.8 million barrels per day appears to be based on Chris Skrebowski's megaprojects information (see paragraph 3.97 above) although this is not acknowledged. The suggested demand is more than the IEA now predicts for 2010 (which is 91.3 million barrels per day in the reference (business as usual) scenario: *World Energy Outlook 2006*, p. 86); while an April 2006 update of the megaprojects information predicts more short term supply growth than earlier versions. These points would ameliorate the effect on the price.

102 The nonconventional oils consume significant energy in mining and conversion processes to make them usable. Thus their 'well to wheels' greenhouse impact per unit of end-use energy will be significantly greater than that of conventional oil, if production does not include carbon capture and storage.

103 International Energy Agency, *World Energy Outlook 2006,* p. 49.

3.122 A major focus of the report is the need for energy policy to be consistent with environmental goals - chiefly, the need to do more to reduce the fossil fuel carbon dioxide emissions which cause human-induced climate change:

> The current pattern of energy supply carries the threat of severe and irreversible environmental damage – including changes in global climate. … The need to curb the growth in fossil-energy demand, to increase geographic and fuel-supply diversity and to mitigate climate-destabilising emissions is more urgent than ever.[104]

3.123 Key points in the report are:

- rising demand for oil and gas, if unchecked, would accentuate vulnerability to a severe supply disruption and resulting price shock;
- the growing insensitivity of oil demand to price accentuates the possible impact on prices of a supply disruption. The concentration of oil production in a small group of countries with large reserves – notably Middle East OPEC members and Russia – will increase their market dominance and their ability to impose higher prices;
- there is no guarantee that the investment needed to meet demand will be forthcoming; and
- in the reference scenario (a 'business as usual' policy assuming no new policies during the projection period to 2030) fossil fuel demand and greenhouse gas emissions will follow 'their current unsustainable paths'. Energy related carbon dioxide emissions would increase by 55 per cent from 2004 to 2030.[105]

3.124 On the peak oil argument of whether the geological resource will be sufficient to meet demand, the report argues that 'although that is enough to meet all the oil consumed in the Reference Scenario through to 2030, *more oil would need to be found were conventional production not to peak before then*' (emphasis added). The report has already noted that there is no guarantee that the investment needed to do that will be made:

> Sufficient natural resources exist to fuel such [reference scenario] long-term growth in production and trade, but there are formidable obstacles to mobilising the investment needed to develop and use them.[106]

The WEO 2006 Alternative Policy Scenario

3.125 The *World Energy Outlook 2006* describes an 'alternative policy scenario' which would reduce the growth of energy use and greenhouse gas emissions. More than 1400 energy saving policies were considered. Examples relating to oil and

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104 International Energy Agency, *World Energy Outlook 2006*, p. 37.

105 International Energy Agency, *World Energy Outlook 2006*, p. 37ff.

106 International Energy Agency, *World Energy Outlook 2006*, pp 73 and 162.

transport include strengthened fuel efficiency standards for motor vehicles; more use of hybrid cars; some modal shift from air to high-speed rail travel in Europe; and expansion of the European Union emissions trading scheme to other sectors, including civil aviation. The policies assume only technologies which are already commercially proven.[107]

3.126 In the alternative policy scenario total energy demand grows by 1.2 per cent per year instead of 1.6 per cent in the reference scenario. By 2030 it is 10 per cent less than it would be in the reference scenario. Similarly, energy-related carbon dioxide emissions still grow, but by 2030 are 16 per cent less than they would be in the reference scenario.[108]

3.127 In the alternative policy scenario global oil demand reaches 103 million barrels per day in 2030 - 20 million barrels per day more than the 2005 level, but 13 million barrels per day less than the 2030 reference scenario level. Transport sector measures create close to 60 per cent of the oil savings, and more than two thirds of the transport sector savings come from more fuel efficient vehicles.[109]

3.128 A key finding of the alternative policy scenario is that the energy saving measures yield financial savings that far exceed the initial investment cost for consumers. Investment by consumers - for example, in energy-saving appliances or vehicles - is increased, but investment by energy suppliers is reduced more, with a net gain. The total investment required to meet demand for energy services is reduced. In all net oil importing countries, energy-saving investment in the transport sector is more than repaid by the savings in oil import bills. Government intervention would be needed to mobilise the necessary investment.[110]

3.129 The alternative policy scenario also mitigates the risk to secure oil supply, which will come as oil and gas production become increasingly concentrated in fewer countries.[111]

3.130 According to the IEA, achieving the alternative policy scenario will require a strong commitment by government to implement the policies. Implementing only the top dozen policies would achieve 40 per cent of the alternative policy scenario's avoided carbon dioxide emissions by 2030. An almost identical priority list would emerge if the dominant concern was energy security. The IEA stresses the urgency of

107 International Energy Agency, *World Energy Outlook 2006*, pp 167, 169, 172, 227 and 262. Carbon capture and storage is not included on the grounds that it has not been commercially demonstrated: p. 171.

108 International Energy Agency, *World Energy Outlook 2006*, pp 42 and 49.

109 International Energy Agency, *World Energy Outlook 2006*, p. 42.

110 International Energy Agency, *World Energy Outlook 2006*, pp 42, 193 and 204.

111 International Energy Agency, *World Energy Outlook 2006*, p. 186.

the task, because of the long lead times needed to mobilise the necessary investment.[112]

Comment

3.131 The International Energy Agency is a global peak body with 26 developed nation members including Australia and the USA. Its *World Energy Outlook 2006* is the work of almost 200 experts. Its warnings about the unsustainability of a 'business as usual' energy future are serious. Its call to action is clear and uncompromising. Australia needs to respond appropriately.

General comment on peak oil concerns

3.132 The concept that oil production will peak and decline, and there will be a post-oil age, is well accepted. The argument turns on when the peak will come, and how serious its economic effects will be.

3.133 'Early peak' commentators have criticised what they regard as overoptimistic official estimates of future oil supply with detailed and plausible arguments. The committee is not aware of any official agency publications which attempt to rebut peak oil arguments in similar detail.

3.134 Affordable oil is fundamental to modern economies. The risks involved are high if peak oil comes earlier than expected, or if economies cannot adapt quickly enough to the post-peak decline. The 2005 ‘Hirsch report’ for the US Department of Energy argues that peak oil has the potential to cause dramatically higher oil prices and protracted economic hardship, and that this is a problem ‘unlike any yet faced by modern industrial society.’ It argues that timely, aggressive mitigation initiatives will be needed:

> Prudent risk management requires the planning and implementation of mitigation well before peaking. Early mitigation will almost certainly be less expensive that delayed mitigation.[113]

3.135 The essence of the peak oil problem is risk management. Australian governments need better information from which to decide a prudent response to the risk.

Recommendation 1

3.136 The committee recommends that Geoscience Australia, ABARE and Treasury reassess both the official estimates of future oil supply and the 'early peak' arguments and report to the Government on the probabilities and risks involved, comparing early mitigation scenarios with business as usual.

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112 International Energy Agency, *World Energy Outlook 2006,* pp 249-251.

113 Hirsch, R.L. Bezdek R.& Wendling R, *Peaking of World Oil Production - impacts, mitigation and risk management,* 2005, p. 6.

3.137 The committee cannot take sides with any particular suggested date for peak oil. However in the committee's view the possibility of a peak of conventional oil production before 2030 should be a matter of concern. Exactly when it occurs (which is very uncertain) is not the important point. In view of the enormous changes that will be needed to move to a less oil dependent future, Australia should be planning for it now.

3.138 Most of the official publications mentioned in this report seem to regard the 'long term' as extending to 2030, and are silent about the future after that. The committee regards this as inadequate. Longer term planning is needed. Even the prospect of peak oil in the period 2030-2050 - well within the lifespan of today's children - should be a concern. Hirsch suggests that mitigation measures to reduce oil dependence 'will require an intense effort over decades…'

> This inescapable conclusion is based on the time required to replace vast numbers of liquid fuel consuming vehicles and the time required to build a substantial number of substitute fuel production facilities… Initiating a mitigation crash program 20 years before peaking appears to offer the possibility of avoiding a world liquid fuels shortfall for the forecast period.[114]

3.139 As more nonconventional oil is brought on stream, peak oil is postponed. But this prospect should not be a cause for complacency. The later the peak, the more has been invested in enlarging the oil-dependent economy in the interim (assuming business as usual), and the fewer options there are for easily moving away from it later (since a later peak implies that more of the non-conventional oil resource has already been used).

3.140 The committee does not think it is adequate to dismiss these risks simply by saying that conventional oil can be replaced by oil from coal at $40 per barrel (see paragraph 3.110). The main concern about this is that oil from coal, if there is no carbon capture and storage, would be significantly more greenhouse intensive than conventional oil. But carbon capture and storage has not yet been commercially proven,[115] so it is premature to rely on it. (Chapter 6 notes arguments that carbon capture and storage is 'well on the path of being proven' – see paragraph 6.129).

3.141 The 2004 Commonwealth Government energy white paper *Securing Australia's Energy Future* paid little attention to these issues. It discussed the possibility of short term supply disruptions, but gave only a few words to the question

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114 Hirsch, R.L. Bezdek R. & Wendling R, *Peaking of World Oil Production - impacts, mitigation and risk management,* 2005, pp 6-7 and 65.

115 IEA, *World Energy Outlook 2006*, p. 170.

of long term resource availability.[116] It does not appear that the possibility of long term resource constraints influenced its policies.

3.142 This was perhaps reasonable in 2004. Given the way the energy future debate has moved since then - shown most strikingly by the warnings in *World Energy Outlook 2006* - the committee considers that Australia's energy policies need to be updated. As stressed in the *World Energy Outlook 2006*, the policies that reduce our dependence on oil are the same policies that reduce our exposure to the risk of supply disruptions. Many of them are the same policies that reduce greenhouse gas emissions.

3.143 The committee acknowledges present government-sponsored energy efficiency initiatives, in particular the activities of the Commonwealth-State Ministerial Council on Energy to promote the National Framework for Energy Efficiency since 2004.[117] However these initiatives were focussed on stationary energy. There has been little movement to curb the growth of oil use in transport - possibly because that is a harder task.

3.144 The committee considers that more needs to be done to reduce Australia's oil dependency in the long term and to move Australia towards the alternative energy future described in the *World Energy Outlook 2006*. This is desirable regardless of peak oil predictions - to mitigate the costs of the expected long term decline in Australia's net oil self-sufficiency; and to mitigate the risks of supply disruptions as oil production becomes concentrated in a declining number of major oil-producing countries, some of which are politically unstable.

Recommendation 2

3.145 The committee recommends that in considering a less oil dependent policy scenario, the Government take into account the concerns expressed in the World Energy Outlook 2006, namely -

- **current trends in energy consumption are neither secure nor sustainable;**
- **energy policy needs to be consistent with environmental goals, particularly the need to do more to reduce fossil fuel carbon dioxide emissions.**

Will market forces sort things out?

3.146 The question must be asked: if peak oil is a potential problem, what is the role of government in solving it? A strong theme in the 'economic optimist' response is: if

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116 'In the longer term, concerns also exist about the longevity of oil supplies.' The point is raised but not further discussed. Australian Government, *Securing Australia's Energy Future*, Dept of the Prime Minister and Cabinet, 2004, p. 119. The possibility of replacement by oil from gas, coal or shale is mentioned briefly at pages 22, 41 and 124.

117 This involved expenditure of about $33 million over three years to deliver a package of energy efficiency measures across the residential, commercial, government and industrial sectors. See communiques of the Ministerial Council on Energy, 27 August 2004, 27 October 2006, at www.mce.gov.au

and when there is a peak of conventional oil, this is still not a concern: as conventional oil becomes scarcer, market forces will act to bring substitutes on stream in a timely way when the price is right.

3.147 The committee does not agree with this, for several reasons:

- Given the huge investment needed to adapt the economy to a less oil-dependent future, and the long lead times involved, it is possible that price signals resulting from increased scarcity of oil will occur too late to spur alternative developments in a timely way in the quantities required.
- Government initiative is needed to promote investments which are regarded as socially desirable, but which have a longer payback period than private actors are used to.
- There are high barriers to entry for alternative fuels in that the refuelling network must be in place. Arguably government initiative is needed to promote change - as government has accepted with its current initiatives to promote alternative fuels.[118]
- Some responses on the demand management side require policy choices on very long lived public infrastructure. The consequences of decisions made now on how to develop road and rail networks for the sake of fuel efficiency will be with us in 50 years. The shape of new urban development, which has a dominating effect on the amount of car use, is effectively permanent. These decisions are made by government, and they should have a longer time horizon than private economic agents usually consider.

3.148 The IEA argues that government initiative is essential to promote the changes suggested in the Alternative Policy Scenario discussed above. This applies even though the payback period for many demand-side initiatives is very short. The reasons for this are:

> Compared with investment in supply, end-use efficiency improvements in the transport, industry, commercial and residential sectors involve many more individual decision-makers… The most effective way of encouraging investment in energy efficiency improvements in these circumstances is well-designed and well-enforced regulations on efficiency standards, coupled with appropriate energy-pricing policies… it is highly unlikely that an unregulated market will deliver least-cost end-use energy services. Market barriers and imperfections include:

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118 For example: initiatives to promote a target of 350 million litres of biofuels production per year by 2010; various measures in the 2004 Commonwealth Energy White Paper; recently introduced incentives to promote use of LPG. See Australian Government, *Alternative Transport Fuels and Renewable Energy*, *August 2006 Update*, at http://www.pmc.gov.au/initiatives/docs/alternative_fuels.pdf

> • Energy efficiency is often a minor factor in decisions to buy appliances and equipment.
>
> • The financial constraints on individual consumers are often far more severe than those implied by social or commercial discount rates or long-term interest rates….
>
> • Missing or partial information regarding the energy performance of end-use equipment or energy-using systems.
>
> • A lack of awareness regarding the potential for cost-effective energy-savings.
>
> • The decision-makers for energy-efficiency investments are not always the final users who have to pay the energy bill. Thus, the overall cost of energy services is not revealed by the market… A market cannot operate effectively when the value of the goods or services being bought is unknown or unclear.[119]

3.149 These comments are made about energy in general, but also apply as relevant to the use of oil - for example, in encouraging more fuel efficient vehicles. Similar points are made in the Commonwealth Government's 2004 energy white paper.[120]

3.150 The committee agrees that government initiative will be essential to move towards a less oil-dependent future.

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119 International Energy Agency, *World Energy Outlook 2006,* pp 193 and 210-11.

120 Australian Government, *Securing Australia's Energy Future*, Dept of the Prime Minister and Cabinet, 2004, p. 107.

Chapter Four

Economic and social impacts of possible higher fuel prices and reduced oil supply

Introduction

4.1 The terms of reference ask the committee to consider the economic and social impacts of a possible long term rise in the price of transport fuels. The International Energy Agency's reference scenario assumes that the oil price will ease to 2010, then rise again to reach $US55 per barrel by 2030 (though prices are expected to be volatile).[1] Some 'early peak' commentators fear that much higher prices are possible. (see paragraph 3.117ff) It is difficult to predict with reliability what the effects might be of higher and increasingly volatile oil prices.

4.2 The economic and social impacts of peak oil will be determined by how prepared the world is to produce alternative sources of fuels, and the energy efficiency of productive and consumptive processes. Given the long lead time required to implement alternatives to oil consumption the smoothness of the transition will depend upon a range of factors:

- how soon the world reaches peak oil;
- how steep the decline in oil supply is afterwards;
- what the price effect is of a shortfall in supply (which depends on the elasticity of demand);
- how much support governments give to encouraging the alternatives to oil; and most importantly,
- whether market signals are sufficiently clear and timely for the necessary investments in new technologies or other adaptations.

4.3 Submissions and evidence to this inquiry on the possible effects of high fuel prices were mostly qualitative and anecdotal. There appears to have been little detailed research on the effects to date or the likely longer term effects of the range of price increases being predicted.

4.4 A recent report for the US Department of Energy, the Hirsch report, considered the impact of three different scenarios on the world and American economies. One assumed that no mitigating action was initiated until peaking, the second assumed that action is initiated 10 years before peaking and scenario three

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1 2005 dollars. IEA, *World Energy Outlook 2006,* p. 61.

assumed that action is initiated 20 years before peaking. The severity of the impact of peak oil on the world economies was different for each of the three scenarios.

4.5 The Hirsch report claims that only aggressive supply and demand side mitigation initiatives will allay the potential for peaking to result in dramatically higher oil prices, which will cause protracted economic hardship in the world. ASPO-Australia also claims that the economic and social impacts will be very serious unless we take the necessary precautions very soon. The potential seriousness of the problem is also accepted by some political leaders, the W.A. Minister for Planning and Infrastructure, the Hon. Alannah MacTiernan MLA commenting that:

> It is also certain that the cost of preparing too early is nowhere near the cost of not being ready on time.[2]

The effects of recent price increases

4.6 Recent sharp rises in the price of oil have served to demonstrate that there are significant sectors within Australian society which have limited capacity to cope with sustained high oil prices. While prices have recently trended back down, the price spike provides some useful insights into what effects a longer term, sustained price rise might have.

4.7 The committee received submissions suggesting that those with the means to adapt began doing so. This included drivers moving away from larger cars to smaller cars and motor scooters becoming more popular.[3] Patronage of public transport increased.[4] It remains to be seen if these adaptations persist if prices return to more moderate levels for a sustained period.

4.8 The Council of Social Services of New South Wales (NCOSS) expressed concern that for many low income households transport costs consume a comparatively large proportion of household expenditure, with car ownership costing 28 percent of the income of low-income earners compared to the 13 per cent of average incomes.[5] When accompanied by increasing interest rates, the consequence for families can be a substantial cut in discretionary spending and real financial stress. The committee was told that signs of financial stress are already apparent in

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2 The Hon. A. MacTiernan MLA, Address to sustainable transport coalition's oil: living with less conference, 9 August 2004. Retrieved from http://www.stcwa.org.au/index.php?option=com_docman&task=cat_view&gid=13&Itemid=19 on 23 November 2006.

3 D. Bell, *Submission 29*, p. 18.

4 ABC Online *High fuel costs boost commuter numbers* 2/09/2005 retrieved from www.abc.net.au/news/newsitems/200509/s1451578.htm on 1/09/2006

5 The Council of Social Services of New South Wales, *Submission 89*, p.1.

the community, bank repossession of homes having increased in recent years with rising fuel prices and interest rates.[6]

4.9 Notwithstanding the obvious economic difficulty faced by some members of the community, the recent oil price rises have had limited adverse macroeconomic impacts. Economic growth has remained high and current account balances have been less affected than might have been expected given the magnitude of the increases. This is due to the remarkable strength of the world economy with high rates of growth in production and income, coupled with low inflation. Strong economic growth and increasing oil demand is partly responsible for rising oil prices.[7]

Macro economic impacts of rising oil prices

4.10 Oil is a critical commodity that underpins much of our way of life. ABARE noted that with transport consuming three quarters of the petroleum products used in Australia any prolonged spike in prices and/or disruption of supplies could have significant economic and social impacts.[8]

4.11 The Hirsch report cautioned that the world wide impact of increasing oil prices is expected to be a reduction in economic growth.

> Oil price increases transfer income from oil importing to oil exporting countries, and the net impact on world economic growth is negative.[9]

4.12 The way in which this phenomenon occurs was explained by the International Energy Agency's (IEA) 2006 World Energy Outlook:

> [T]he boost to economic growth in oil *exporting* countries provided by higher oil prices has, in the past, always been less than the loss of economic growth in importing countries, such that the net global effect has always been negative. This is explained both by the cost of structural change and by the fact that the fall in spending in net importing countries is typically bigger than the stimulus to spending in the exporting countries in the first few years following a price increase.[10]

4.13 The Hirsch report outlines some of the expected economic consequences that result from higher oil prices.[11]

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6 D. Bell, *Submission 29*, p. 19.

7 International Energy Agency, *World Energy Outlook 2006*, p. 307.

8 ABARE, *Submission 166*, p. 6.

9 R.L. Hirsch, R. Bezdek & R. Wendling, *Peaking of World Oil Production: Impacts, Mitigation, and Risk Management*, 2005, p. 27.

10 International Energy Agency, *World Energy Outlook 2006*, p. 299.

11 R.L. Hirsch, R. Bezdek & R. Wendling, *Peaking of World Oil Production: Impacts, Mitigation, and Risk Management*, 2005, p. 5.

> Higher oil prices result in increased costs for the production of goods and services, as well as inflation, unemployment, reduced demand for products other than oil, and lower capital investment. Tax revenues decline and budget deficits increase, driving up interest rates. These effects will be greater the more abrupt and severe the oil price increase and will be exacerbated by the impact on consumer and business confidence.[12]

4.14 The IEA notes that the severity of the effects of higher oil prices depends partly on endogenous economic conditions:

> Energy-import intensity provides a useful gauge of the vulnerability of a country's economy to an increase in oil and other energy prices. But, in practice, the overall consequences of higher prices for growth, the trade balance, inflation, employment and other economic indicators also depend on economic structures and conditions, and behavioural and policy responses.[13]

4.15 The IEA cautions that it is difficult to predict adjustments in response to increased prices and hence the magnitude of the effects:

> While the mechanism by which oil prices affect economic performance is generally well understood, the precise dynamics and magnitude of these effects – especially the adjustments to the shift in the terms of trade – are very uncertain.[14]

Impacts on GDP

4.16 The IEA attributes falls in domestic output of net oil importing countries resulting from higher oil prices to second-round effects rather than the direct effects of higher oil prices. Nominal wage, price and structural rigidities in the economy typically lead to a fall in GDP in practice in net oil importing countries. This is due to reduced non-oil demand and falling investment. Where businesses are not able to pass on all of the increase in energy costs to higher prices for their final goods and services, profits fall, further dragging down investment.[15]

4.17 The IEA examined a number of studies and although the results were not strictly comparable, it was able to generalise a rule of thumb on the expected global effects of a price rise in oil:

> [W]e estimate that a sustained $10 per barrel increase in international crude oil prices would cut average real GDP by around 0.3% in the OECD and by about 0.5% in non-OECD countries as a whole compared with the baseline.

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12 R.L. Hirsch, R. Bezdek & R. Wendling, *Peaking of World Oil Production: Impacts, Mitigation, and Risk Management*, 2005, p. 28.

13 International Energy Agency, *World Energy Outlook 2006*, p. 301.

14 International Energy Agency, *World Energy Outlook 2006*, p. 301.

15 International Energy Agency, *World Energy Outlook 2006*, p. 298.

> Overall world GDP would thus be reduced by about 0.4%. Oil-exporting countries would receive a boost to their GDP, offsetting part of the losses in importing countries. Oil-importing developing Asian countries would incur bigger GDP losses, averaging about 0.6%. Most of these effects would be felt within one to two years, with GDP returning broadly to its baseline growth rate thereafter.[16]

4.18 The potential impacts on Australia's GDP have been examined by some limited modelling of modest price increases. An ABARE study of the impact of higher oil prices in the APEC region compared a base case scenario of West Texas Intermediate oil prices at US$56/bbl in 2005 falling to $US31/bbl in 2015 with a scenario of oil prices that were assumed to be 30 per cent higher. It found that Australia's Gross National Product (GNP) would average an estimated 0.8 per cent lower than in the reference case at 2010. If oil prices were assumed to be 60 per cent higher than in the reference case, GNP was estimated to average 1.2 per cent lower than in the reference case at 2010.[17]

4.19 The Queensland Treasury's Office of Economic and Statistical Research modelled the consequences of a permanent 100 per cent increase in the price of oil and petroleum, moving from $30 to $60 a barrel over two years. This modelling projected a decline of 1.2 per cent in aggregate export demand and an increase in the prices of imported commodities. The study found that the dominant macroeconomic feature was a decline in the terms of trade. This decline translated to a decline in real income for Queenslanders with a projected fall of 2.98 per cent in real GSP [Gross State Product] by the second year of the simulation. In the long run it found real GSP was projected to recover somewhat, to a level 1.01 per cent lower than it would otherwise have been.[18]

4.20 The difficulty in producing such forecasts needs to be kept in mind. The Commonwealth Treasury sounded this warning:

> Unfortunately, economists do not have an enviable track record predicting how powerful, but countervailing, economic influences will be resolved nor, in particular, the timing of their resolution.[19]

Impacts on Australia's balance of payments

4.21 The impact on Australia's balance of payments of a growing oil deficit was discussed by a number of witnesses. ABARE argued that as Australia is a net energy exporter, a rise in the cost of oil imports would be expected to be offset to a large

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16 International Energy Agency, *World Energy Outlook 2006*, p. 305.

17 ABARE, *Submission 166*, p. 6.

18 Queensland Government, *Submission 155,* attachments, p. 16.

19 Treasury *2006-07 Budget paper no. 1, statement 4 – Australia in the world economy.*

degree by increasing prices and demand for Australia's energy exports, to the extent that there is some substitution between energy sources available.[20]

4.22 Others have disputed this position:

> Many economists have spun the line Australia is a net energy exporter so we are immune. My analysis of our growing oil deficit means we have to export more and more coal and LNG to buy oil. This line will get harder to defend with the oil deficit growing faster than our coal and LNG surplus.[21]

and:

> Remarkably, economists find it very puzzling that our balance of payments keeps on not balancing and they scratch their heads and wonder why all this exporting of minerals to China does not come up in a marvellous balance of payments. Of course it does not, because, on the other side of the ledger, we are going down. They are the absolutely key points.[22]

4.23 The Australian Petroleum Production and Exploration Association (APPEA) pointed out that Australia had historically benefited from being a net exporter of oil, gas and petroleum products, which had made a significant contribution to our overall trade balance and economic position. APPEA said that the last two years had seen a dramatic turnaround as a consequence of both a rise in international energy prices and a fall in the level of domestic crude oil production.[23]

> In 2004/05, imports exceeded exports of petroleum by more than $3 billion. For the year 2005, the amount increased to around $4.7 billion.[24]

4.24 Sasol Chevron quoted a CSIRO study which found that by 2010, Australia will need to import 50-60% of its crude oil requirements which will have a negative impact on the balance of payments of $7-8 billion per year.[25]

4.25 APPEA estimated that that Australia's oil deficit could be in the range A$12-25 billion by 2015 (depending on assumptions about Australian production and price), and significantly higher in later years. The following graph from the APPEA submission illustrates the results of a study conducted on APPEA's behalf by Wood Mackenzie of the possible balance of trade shortfall that will result from declining Australian self sufficiency in oil production.

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20 *Committee Hansard*, Canberra 12 May 2006, p. 9. (Dr B. Fisher, ABARE).

21 D. Bell, *Submission 29*, p. 21.

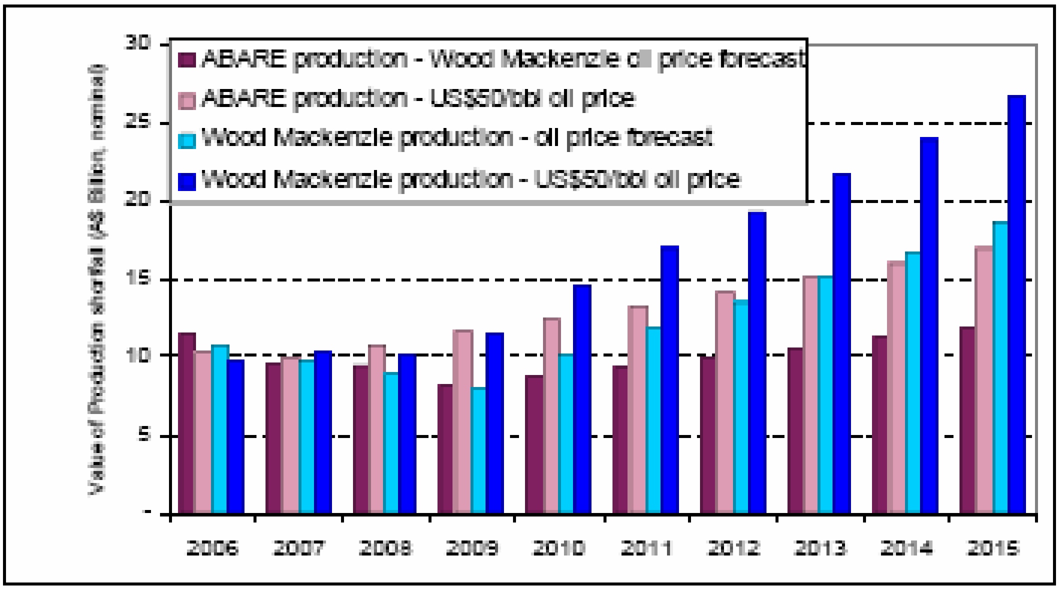
22 *Committee Hansard*, 29 June 2006, p. 22. (Mr R Campbell, ASPO).

23 Australian Petroleum Production and Exploration Association, *Submission 176*, p. 3.

24 Australian Petroleum Production and Exploration Association, *Submission 176*, p. 4.

25 Sasol Chevron, *Submission 54*, p. 55.

Figure 4.1 – Balance of trade consequences of declining Australian oil self sufficiency



Source: APPEA, *Submission 176*, p.8.

Inflation and interest rates and unemployment

4.26 Submissions raised the prospect of increasing oil prices impacting on inflation and hence interest rates:

> The price and availability of virtually everything that we import, export, manufacture, construct, transport, eat, wear, buy, sell, rent, live in or use in our daily lives will be affected by peak oil.[26]

4.27 The IEA sees oil price increases leading to upward pressure on nominal wage levels, which together with reduced demand, tends to lead to higher unemployment. It warns that the effects can be magnified by the negative impact of higher prices on consumer and business confidence.[27]

4.28 The committee also received evidence claiming that the increasing price of oil has already caused plastics, which are derived from oil and gas, to more than double in price in just over a year.[28]

Reduction in globalisation

4.29 The Murdoch University Institute for Sustainability and Technology Policy expects global trade to continue in a post peak oil world, although the character of

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26 Torquay Landcare Inc, *Submission 80*, p. 27.

27 International Energy Agency, *World Energy Outlook 2006*, p. 298.

28 Torquay Landcare Inc, *Submission 80*, p. 27.

global trade is expected to change once it becomes expensive to conduct because of higher transport costs. Trade in future is likely to become more localised.[29]

Impacts on industry

4.30 The Hirsch report noted that end use sectors that are able to switch to other fuels such as natural gas, coal and nuclear will do so but considers that in the transport sector, there are no alternative sources that are able to compete economically.[30] The transport, mining, chemical, electricity generation and agricultural sectors have higher than average fuel utilisation and tend to experience significant first round effects. In addition, construction and agriculture in particular are adversely affected by rising interest rates which tend to accompany rising fuel prices. Tourism is also adversely affected as high fuel costs reduce the amount of discretionary holiday travel:[31]

> Tourism in Queensland will suffer unless alternative transport solutions are considered. Should there be a contraction in overseas visitors, a contraction in interstate air travel and a contraction in discretionary household expenditure on long-distance holidays generally, then it is difficult to imagine a future for remote locations such as Airlie Beach, or even the tourism-based economy of the Gold Coast. Many tourism sites were developed when transport was cheap and the population could afford to be highly mobile. This is not likely to be the case in the future.[32]

Impacts on transport

4.31 More than 95 per cent of Australia's transport fuel is derived from oil.[33] Air transport is the most fuel intensive segment of this industry; hence it is expected to be the most adversely affected industry. Modelling of a permanent doubling in the world oil price, commissioned by the Queensland Government, projected air transport activity to be some 27 per cent lower by 2016-17 than it would otherwise have been. Commentators expressed concern about a lack of preparations in the aviation industry for the severe impact of rising oil prices.[34] Air freight as well as passenger travel was expected to be adversely affected: [35]

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29 Institute for Sustainability and Technology Policy, Murdoch University, *Submission 11*, p. 13.

30 R.L. Hirsch, R. Bezdek & R. Wendling, *Peaking of World Oil Production: Impacts, Mitigation, and Risk Management*, 2005, p. 25, quoting U.S. Department of Energy, Energy Information Administration, *International Energy Outlook 2004*, April 2004.

31 PBB Industry Risk Bulletin July 2005 retrieved from www.ppb.com.au/webdata/resources/files/IRB_Oil_National.pdf#search=%22Industry%20Risk%20Bulletin%20%22 on 01/09/2006

32 M. Gutteridge, *Queensland's Oil Problem: Future Considerations for Governments*, *Submission 76d*, p. 30.

33 Sustainable Transport Coalition WA, *Submission 45,* p. 1.

34 *Committee Hansard,* 11 April 2006, p. 7 and 8 (Mr Beveridge, Office of Industry and Innovation, University of Western Australia).

35 Torquay Landcare Inc, *Submission 80*, p.20.

> So I think the airline industry really needs a bit of a kick up the derriere to say, 'Hey, what are we going to be putting in our tanks in 20 years time?' If JetA-1 is still available, what will the price be? Typically the cost of a seat is roughly 20 per cent…fuel, which does not sound very high. But if the cost of fuel doubles it might be the cost of a seat beyond the point at which mass travel is affordable, apart from business travel and the high end of the market.[36]

4.32 Because increases in the price of oil are expected to result in depreciation of the Australian dollar, sea transport activity was projected by Queensland Government modelling to be some 12 per cent higher than the base case level, because of its strong linkages with commodity exports.[37]

Impacts on agriculture

4.33 The Queensland Farmers Federation (QFF) relied on ABARE data to illustrate the impact that rising fuel prices have had and are expected to have on agriculture. The QFF told the committee that farm costs are projected to rise 4.2 per cent faster than farm gate prices in 2005/06, with farmers continuing to be price takers rather than price dictators.[38] The QFF said that farmers have little capacity to pass on increased fuel charges. Net farm incomes have been falling with fuel being the fastest growing cost input. Fuel costs in 2006 are double what they were eight years ago, while farm revenues have risen by just a quarter.[39] Further increases in fuel costs will severely challenge the viability of many farming enterprises. Inflationary pressures and interest rate rises will also have a significant impact as farm indebtedness has been rising steadily over the last five years.[40]

4.34 The QFF told the committee of its concern that State and Federal Governments have failed to make necessary policy adjustments:

> After the oil shock of 1974, Governments around the world invested in a range of measures which dramatically increased the fuel efficiency of their economies, ultimately breaking the power of the OPEC cartel for two decades. However, such concerted Government efforts at State and Federal levels is sadly lacking at present. [41]

4.35 As well as diesel for farm machinery and transport to and from the farm gate, oil is used to produce chemicals such as fertilisers and pesticides used in modern

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36 *Committee Hansard,* 11 April 2006, p. 8 (Mr Beveridge).

37 Queensland Government, *Submission 155*, attachments, p. 18.

38 Queensland Farmers Federation, *Submission 120*, p. 3.

39 Queensland Farmers Federation, *Submission 120*, p. 4.

40 PBB Industry Risk Bulletin July 2005, retrieved from www.ppb.com.au/webdata/resources/files/IRB_Oil_National.pdf#search=%22Industry%20Risk%20Bulletin%20%22 on 01/09/2006

41 Queensland Farmers Federation, *Submission 120*, p. 6.

agriculture.[42] These chemicals and the mechanisation of agriculture provided by cheap oil have underpinned a sharp rise in world food production. World fertilizer production has risen from 3 million tons in 1938 to 90 million tons in 2003.[43]

> [M]odern industrial agriculture has been described as a way of using land to convert petroleum into food.[44]
>
> The Green Revolution increased the energy flow to agriculture by an average of 50 times the energy input of traditional agriculture.[45]

Impacts on communities

4.36 A study by Dodson and Sipe of Griffith University has found that those Australians affected soonest and most severely by rising petrol costs are likely to be those most reliant on car transport and who lack access to suitable alternatives. These people tend to be those in socioeconomically disadvantaged outer-suburban locations and those on the fringes of urban areas and in regional and remote communities.[46] [47] The Western Sydney Regional Organisation of Councils (WSROC) noted the increasing dependence on car transport by the outer suburbs:

> While Sydney's annual total vehicle VKT [vehicle kilometres) increased on average 2.3% each year from 1991 onwards, the patterns were geographically uneven – with a 23% increase in outer and south-west Sydney compared with a 10% decline in inner and eastern Sydney.[48]

4.37 Further analysis by Dodson and Sipe has found that household mortgages are also spatially differentiated, with higher debt burdens in the outer suburbs.[49] This compounds the impacts of higher fuel prices as these contribute to inflation and lower real wages and result in higher interest rates and lower housing affordability.

4.38 Some commentators condemned current urban development policies that result in oil dependence by generating low density urban sprawl in the outer suburbs, without adequate public transport.[50] For example, the City of Wanneroo described the rapidly growing urban population in the area beyond the current terminus of Perth's Northern Suburbs railway:

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42 D. Bell, *Submission 29*, p. 18.

43 A. Parker, *Submission 12*, Appendix A, p. 2.

44 *Committee Hansard*, 11 April 2006, p.9 (Mr Fleay)

45 Torquary Landcare Inc, *Submission 80*, p. 22.

46 ASPO – Australia, *Submission 136*, p. 2.

47 J. Dodson and N. Sipe, *Submission 165*, attachment: *Oil Vulnerability in the Australian City*, 2005, p. 23.

48 Western Sydney Regional Organisation of Councils, *Submission 43*, p. 7.

49 J. Dodson and N. Sipe, *Shocking the Suburbs: Urban Location, Housing Debt and Oil Vulnerability in the Australian City*, 2006, p. 42.

50 A. Parker, *Submission 12*, Appendix B, p. 1.

> Due to the absence of the railway in this area, conventional low density, single residential housing types are tending to predominate, rather than a more diverse mix of housing (including higher densities) which would have more chance of being attractive to the market if the railway had been in place. A more diverse housing mix would be more supportive of public transit use. [51]

and:

> Poor urban and service planning tied to significant under investment in public transport has led to an over reliance on private motor vehicles in order to 'bridge the geographic' divide between people and jobs and services. [52]

4.39 The International Association of Public Transport has called for homes schools, employment, shopping and recreation to be brought closer together to relieve the need for car use.[53] The Western Sydney Regional Organisation of Councils (WSROC) has cautioned that low density urban development actually contributes to poor public transport services.

4.40 WSROC has called for the development of high quality integrated services which would increase public transport patronage. It notes that Sydney's public transport is split between State Rail, Sydney Transit and a number of loosely coordinated private operators throughout the western region:[54]

> Successive State and Federal governments have failed to adequately address the public transport needs of Western Sydney's growing population.[55]

4.41 WSROC acknowledges recent initiatives by the NSW State Government but regards the level of funding to be insufficient to address years of under-investment:

> The north-west, south-west rail line, assuming it survives several changes of government and everything else, is 2017 to 2020. The bus corridors will probably happen a bit sooner than that. The other planning is going on but it is a fairly slow and, I would say, very under resourced process.[56]

4.42 WSROC called for a substantial increase in funding and the maintenance of high levels of ongoing government commitment. It criticised the Commonwealth Government's complete withdrawal from funding urban public transport

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51 City of Wanneroo, *Submission 19*, p. 2.

52 Council of Social Services of New South Wales, *Submission 89*, p. 1.

53 The International Association of Public Transport (Australia/New Zealand), *Submission 32*, p. 5.

54 Western Sydney Regional Organisation of Councils, *Submission 43*, p. 6.

55 Western Sydney Regional Organisation of Councils, *Submission 43*, p. 4.

56 *Committee Hansard*, 9 June 2006, p. 27. (A. S. Gooding, Western Sydney Regional Organisation of Councils)

infrastructure.[57] The International Association for Public Transport noted that there was an almost complete lack of any mention of public transport on the agenda of the Australian Transport Ministers' meetings over the last decade or more.[58]

4.43 The Western Australian Government advised the committee that it had undertaken a range of measures aimed at improving accessible public transport and more integrated transport and land use planning to address Perth's high level of automobile dependence.[59] Measures include a new Metrorail project for the rapidly growing city of Mandurah south of Perth, which is to double the size of Perth's urban passenger rail system and is expected to carry 35,000 people each weekday and remove 25,000 vehicles from the freeways. It also includes measures to improve the existing public transport infrastructure by making it safer, more accessible and easier to use. The Western Australian Government has also spent $60 million since February 2001 to improve cycling infrastructure in the state.[60]

4.44 NCOSS expects that fuel costs will impact upon the financial viability of non-government human service providers, particularly those that rely heavily on vehicles to deliver services such as meals on wheels, community health, community transport and neighbour aid.[61]

4.45 The Australian Medical Association expressed concern about the potential for continuing rises in fuel costs to exacerbate the social gradient of health that runs across society with the most disadvantaged in society having the most health problems.[62]

The risk of supply side disruptions

4.46 The IEA warned that over the next two-and-a-half decades, oil and gas production would become increasingly concentrated in fewer and fewer countries and that this would add to the perceived risk of disruption and the risk that some countries might seek to use their dominant market position to force up prices.[63] The IEA considered that unacceptable risks would result if policies continued unchanged:

> The energy future which we are creating is unsustainable. If we continue as before, the energy supply to meet the needs of the world economy over the next twenty-five years is too vulnerable to failure arising from under-investment, environmental catastrophe or sudden supply interruption.[64]

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57 Western Sydney Regional Organisation of Councils, *Submission 43*, p. 10.

58 The International Association of Public Transport (Australia/New Zealand), *Submission 32*, p. 23.

59 Government of Western Australia, *Submission 172*, p. 4.

60 Government of Western Australia, *Submission 172*, attachment, pp 2 and 3.

61 The Council of Social Services of New South Wales, *Submission 89*, p. 3.

62 Australian Medical Association, *Submission 88*, p. 1.

63 International Energy Agency, *World Energy Outlook 2006*, p. 186.

64 International Energy Agency, *World Energy Outlook 2006*, p. 3.

4.47 IEA was concerned that $4 trillion of investment over 2005-2030, which was needed to meet growing world demand, might not be forthcoming:

> The ability and willingness of major oil and gas producers to step up investment in order to meet rising global demand are particularly uncertain.[65]

4.48 The issue of transport fuel security was acknowledged in the Australian Government's 2004 Energy White Paper, although the paper regards the security of transport fuels as 'not currently under threat.[66] The paper however acknowledges the dominance of the Middle East as the primary oil-producing region, the ability of those countries to act as a cartel through OPEC, and the political instability of some countries in the region, as well as longer term concerns about the longevity of oil supplies as having 'been major factors behind concerns about transport fuel security'.[67]

4.49 More recently, Treasury expressed somewhat greater concerns. In the 2006-07 budget papers, Treasury noted that given the low level of spare capacity for oil production, there remained a risk of further supply side disruptions. In particular Treasury was concerned about the potential for instability in key oil producing countries to have a more pronounced impact than the demand driven rises experienced to date.[68] Treasury noted that oil demand is unresponsive to price in the short run, and modest disruptions in world supply could raise oil prices very substantially, and for some time.[69]

4.50 Treasury considered the risk to be one that would increase in time with potential disruptions due to conflict involving key energy producers, unfavourable political shifts or major terrorist attacks:

> World oil demand is projected to increase by around 45 per cent over the next 20 years. Potential vulnerability is magnified by reliance on supplies from the Middle East, which already accounts for 30 per cent of world production — of which 11 per cent is from Saudi Arabia. This reliance on Middle East sources is projected to rise to 46 per cent by 2030.[70]

4.51 ASPO-Australia expressed concern about our dependence on oil coming from geopolitically unstable parts of the world:[71]

> President Bush recently acknowledged *"...we have a serious problem: America is addicted to oil, which is often imported from unstable parts of*

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65 International Energy Agency, *World Energy Outlook 2006*, p. 40.

66 Australian Government, *Securing Australia's Energy Future 2004*, p. 115.

67 Australian Government, *Securing Australia's Energy Future 2004*, p. 119.

68 Treasury, 2006-07 Budget paper No. 1, statement 3 - The outlook for the international economy.

69 Treasury, 2006-07 Budget paper No. 1, statement 4 – Australia in the world economy.

70 Treasury, 2006-07 Budget paper No. 1, statement 4 – Australia in the world economy.

71 ASPO Australia, *Submission 136*, p. 2.

> *the world"*. ASPO-Australia agrees with the President about the US and recognises Australia is almost as addicted to oil and automobiles as the US.[72]

4.52 The 2004 Energy White Paper notes Australia's obligations as a member of the International Energy Agency (IEA). The Emergency Oil Sharing System of the IEA Agreement on International Energy requires Australia to maintain emergency reserves equivalent of at least 90 days of net oil imports, provide a programme of demand restraint measures, and to participate in oil allocation measures amongst IEA members in the event of a severe oil supply disruption.[73]

4.53 The White Paper also noted that total national stocks of crude oil and product have been about 50 days of supply, and with petrol and diesel stocks of the order of 15 to 18 days. Commercial practice has seen a tendency to reduce stocks.[74] In the past, such as during the 1991 Gulf crisis, Australia was less dependent on oil imports and was able to meet its required contribution to market contingency of 46,000 barrels per day through surge production and demand restraint.[75]

4.54 Submissions expressed concern about Australia's energy security. Increasing levels of import dependence and a remote geographic location may put Australia at risk, as it does not have an oil security stock holding above that which is commercially optimal.[76]

4.55 The 2006 White Paper update describes the Commonwealth Government's establishment of a new Energy Security Working Group under the Ministerial Council on Energy (MCE) with ongoing responsibility for managing the National Liquid Fuel Emergency Response Plan.[77]

4.56 A submission by Mr David Bennett pointed out the strategic importance of oil security in times of war:

> Yet oil is fundamental to our ability to defend ourselves. The strategies employed by the Nazi Government in the Second World War were aligned to securing oil reserves in order to fight. Rumanian oil fields were the first to be occupied. The advance on the Caspian was stopped at Stalingrad and the advance to the Persian Gulf was stopped at El Alamein. The Japanese occupied the Indonesian fields and a major part of the Allied counter-attack was centred on destroying oil tankers carrying oil back to Japan; a similar tactic was used by the Germans in the North Atlantic.[78]

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72 ASPO Australia, *Submission 135*, p. 5.

73 Australian Government, *Securing Australia's Energy Future*, 2004, p. 122.

74 Australian Government, *Securing Australia's Energy Future*, 2004, p. 124.

75 Australian Government, *Securing Australia's Energy Future*, 2004, p. 122.

76 A. Parker, *Submission 12*, Appendix A, p. 1.

77 Australian Government, *Securing Australia’s Energy Future*, July 2006, Update, p. 3.

78 D. Bennett, *Submission 40*, p. 1.

4.57 ASPO noted that defence currently accounts for 48 per cent of the Commonwealth Government's total energy consumption and argued that rapidly increasing fuel costs will have a significant impact on defence and security budgets and capabilities. ASPO quoted an Australian National Audit Office (ANAO) report that concluded that Defence did not have a fuel procurement price risk management policy:

> The Australian National Audit Office (ANAO) report in 2002 examined the Australian Department of Defence Fuel Management. The report states that "fuel is a critical component of military capability as it is an essential consumable for the mobility of the Australian Defence Force (ADF). The procurement, storage and distribution of fuel by the ADF represent a complex range of activities in a number of Defence sub-programs and are conducted at geographically dispersed locations. The ADF uses eight different types of fuel, four of which are military specification fuels. Military specification fuels include additives that the ADF considers essential for the operation of its ships, aircraft and vehicles, in a range of demanding environments. Factors underlying the military specific requirements include the wide range of climates where the ADF may be required to operate, the need for longer-term fuel storage and safety requirements in combat situations. Over 750 different oils and lubricants are used by the ADF. The Defence fuel and lubricants supply chain is complex and involves a wide range of processes and control structures. The strategic management of this supply chain is fragmented and insufficiently coordinated".
>
> The ANAO also found that Defence does not have a "fuel procurement price risk management policy" and that more needs to be done to effectively "identify, analyse and manage these risks". [79]

Avoiding adverse impacts

4.58 In the *World Energy Outlook 2006*, the IEA reported on a number of forecast scenarios it had modelled to examine the potential economic effects of a range of future investment and policy scenarios. The Alternative Policy Scenario examined the implementation of policies including efforts to improve efficiency in energy production and use, increase reliance on non-fossil fuels and sustain the domestic supply of oil and gas within net energy-importing countries. This modelling predicted that these policies would yield substantial savings in energy consumption and imports compared with the base case Reference Scenario. Implementation of such policies was expected to enhance energy security and help mitigate damaging environmental effects, with the benefits achieved at lower total investment cost than in the Reference Scenario:

> What this scenario shows is that the world economy can flourish while using less energy. The perpetual rise in OECD oil imports can be halted by

79 ASPO Australia, *Submission 193*, p. 1 and p. 4.

> 2015. Carbon dioxide emissions can be cut by thousands of millions of tonnes by 2030. The investment cost is higher for consumers; but their extra cost is more than offset by savings in energy bills and in investment elsewhere. The challenge for governments is to persuade society that it wants this outcome sufficiently to give its backing to the necessary action, even where that means bearing a cost today for the benefit tomorrow.[80]

4.59 The Hirsch report argues that adverse impacts from peak oil could be avoided using existing technologies if given enough lead time.[81] ASPO-Australia argues that many adaptations are justifiable even without peak oil concerns:

> Certainly, preparing well in advance for peak oil is a very prudent strategy. Many of the possibilities are "no regrets" options (those that are already justified on social, environmental, health or economic grounds).[82]

4.60 The Hirsch report argued that mitigation strategies would take 10 to 20 years to put in place. This was also echoed by several submissions (see also discussion in chapter 6 on coal to liquids and gas to liquids):

> A lot of it comes back to market failure, that there is just not enough information for markets to operate efficiently. The point I want to make about why governments need to get involved is around the speed of change. Markets take a long time to move.[83]

4.61 In the 2004 Energy White paper the Commonwealth Government described energy security as involving a balancing of supply reliability versus cost and noted that increasing energy reliability can be expensive. The Paper went on to say that this expense flows onto prices and lowers the competitiveness of the Australian economy. It stated that the Government's energy security policies aim to pursue enhanced reliability while maintaining competitive energy prices.[84]

4.62 The Energy White paper recognised that the potential for disruptions in world oil supplies from any major producing region poses challenges for the world as a whole and that these challenges required a global response. The paper identified Australia's best path to provide for the continuity of oil supplies as multilateral efforts to ensure that world markets remain open and that effective response mechanisms are in place to mitigate the impact of short-term supply disruptions.[85]

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80 International Energy Agency, *World Energy Outlook 2006*, p. 3.

81 R.L. Hirsch, R. Bezdek & R. Wendling, *Peaking of World Oil Production: Impacts, Mitigation, and Risk Management*, 2005 p. 66.

82 ASPO Australia, *Submission 135*, p. 10.

83 *Committee Hansard*, 11 April 2006, p. 31. (Dr Worth, Sustainable Transport Coalition)

84 Australian Government, *Securing Australia's Energy Future 2004*, p. 116.

85 Australian Government, *Securing Australia's Energy Future 2004*, p. 121.

4.63 The November 2006 G20 meeting held in Melbourne discussed the need for resource security to be underpinned by effective domestic and international policy frameworks that support markets.[86]

Committee comment

4.64 The committee notes concerns that markets will not respond in time to provide a smooth transition to a post peak oil world without government action. Given the uncertainty about much of the information on world oil supplies and the geopolitical instability of some key oil bearing regions, it is possible that there may be a risk that markets will under invest in oil and energy technologies, resulting in economic and social hardship when supply of conventional oil falls below demand.

4.65 The information required to make a clear determination on whether peak oil will occur before the market can provide mitigating action is not available. The following chapters discuss possible mitigation actions. These offer options for a prudent approach to managing the possibility of peak oil and associated issues contributing to oil vulnerability, resulting in substantially higher oil prices and a constraint on liquid fuel availability.

86 Treasurer's press release, G-20 Meeting, Melbourne, 18-19 November 2006, retrieved from http://www.treasurer.gov.au/tsr/content/pressreleases/2006/125.asp?pf=1 on 20 November 2006.

Chapter Five

Supply side responses – overview and exploration

Overview

5.1 Regardless of whether peak oil is or is not a pressing problem for Australia, commentators advance a number of what appear to be sound reasons for exploring options for increasing or diversifying Australia's indigenous transport fuel supply, and doing so in the near future. These include:

- Balance of trade – Australia is expected to run an increasingly large deficit in petroleum products in the future. By developing more locally available energy supplies, the country may offset some of the trade imbalance that may result from increasing requirements to import oil, as well as adding value to products currently exported at lower values, for example, natural gas.
- Security of supply – much of the world's oil supply comes from countries that are potentially unstable. Some commentators also consider there is a risk that security of supply may be threatened if larger countries lock in supply contracts from countries that are developing oil resources. There is some evidence that the latter may already be occurring.[1]
- Time lags in developing new supply sources are long. Diversification of supply, whether by finding new supplies of conventional oil or developing alternative sources of liquid fuel supplies, will be a protracted process, requiring lead times of up to a decade and possibly longer. If it is to be successful and sufficiently timely, action may be required sooner rather than later.
- Global warming – some fuel supply diversification options offer possibilities for reducing or limiting transport sector greenhouse gas emissions, while maintaining the necessary functionality of transport systems.

5.2 Demand side measures, that is, seeking to control or reduce the demand for liquid transport fuel supplies through options such as energy efficiency measures, or shifting the transport task to other forms of transport that are less dependent on liquid transport fuels, may make a significant contribution to easing the economic disruption of restricted fuel supplies and high prices, if these come to pass. However, the

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1 CSIRO, *Submission 128* for example discusses this. Smaller countries like Australia, who are at the end of long supply lines, may be more vulnerable to supply disruptions. It is important to note that the energy white paper disagrees that this is necessary, considering security of supply to be adequate. The Australian Institute of Petroleum (AIP) agrees with this assessment – see submission.

economy currently depends significantly on primary industries, in particular mining and agriculture, which are energy intensive and liquid fuel dependent. The transport industries, which also predominantly use liquid fuels, are also vital to economic well-being. Accordingly, it is prudent to also consider options for increasing or diversifying transport fuel supplies – that is, a supply side response.

5.3 The committee has received evidence about a number of supply side options for meeting domestic liquid transport fuel requirements. These options include:

- finding more conventional oil supplies within Australia or in Australian territorial waters;
- sourcing a proportion of fuel requirements from biomass - fuels such as ethanol, biodiesel, DME, methanol and synthetic diesel can be produced from biomass;
- producing fuels by liquefying coal or natural gas, or distilling it from oil shales; and
- using other fuels that can be substituted for petrol and diesel, such as LPG, natural gas (methane) or hydrogen as a transport fuel.

5.4 All of these possibilities come at a cost, economic or environmental, or have limitations. There is no one perfect solution. This chapter gives a broad overview of the evidence received in relation to exploring for more petroleum resources. The following two chapters examine options for deriving some or all of Australia's liquid fuel requirements from sources other than oil, including natural gas, coal and biomass.

Exploring for more oil in Australian territory

5.5 Australia has been nominally[2] self-sufficient in oil for several decades, thanks largely to the discovery of the large oil, gas and condensate fields in the Gippsland and Carnarvon basins. As described in Chapter 2, self sufficiency is declining, partially because the Bass Strait fields are depleting, but also because of rising demand.

5.6 A number of organisations highlighted the effect that this decline in self sufficiency will have on the trade deficit. The Australian Petroleum Production and Exploration Association, for example, told the committee that the trade deficit in crude oil and condensate will be about $20 billion by 2015 – that is, within a decade.[3] This deficit may be off-set wholly or partially by energy exports (coal and gas) and other exported products, but has the potential to have an adverse economic impact if prices or markets for these other exports fail to meet expectations.

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2 Australian oil production is classified as light sweet crude and is of high value on the world market. Most production is exported. Further, Australian refineries require heavier crudes to produce the full range of petroleum products required in the Australian market.

3 *Committee Hansard*, 11 August 2006, p. 2.

5.7 The importance of petroleum products or substitutes for them in Australia's energy mix is likely to continue for the foreseeable future. It therefore appears to be prudent to actively encourage local exploration. This does not necessarily mean that resources, if discovered, will be developed. This will depend ultimately on the economics of bringing any discoveries into production, and on the price at which competing substitutes or imported product can be made available.

5.8 The evidence received by the committee indicates that there is a view, particularly amongst organisations such as Geoscience Australia, that there are good prospects for discovering new oil resources within Australia and in Australian territorial waters. Geoscience Australia told the committee that by world standards, Australian sedimentary basins, particularly those in offshore areas, have only been lightly explored. Fewer than 9,000 exploration and development wells have been drilled in Australia, compared to about 3,000,000 wells in the United States, which has a comparable land area.[4]

5.9 The Australian Bureau of Agricultural and Resource Economics (ABARE) gave similar evidence, stating that more than half of the offshore basins that show signs of petroleum potential remain unexplored.[5]

5.10 The CSIRO also provided an optimistic assessment of Australia's prospectivity, telling the committee that:

> Australia has probably used only a relatively small proportion of its overall petroleum endowment. This is a big advantage that sets us apart from the traditional major OECD petroleum players, including the UK and USA, both of which have sharply declining production.[6]

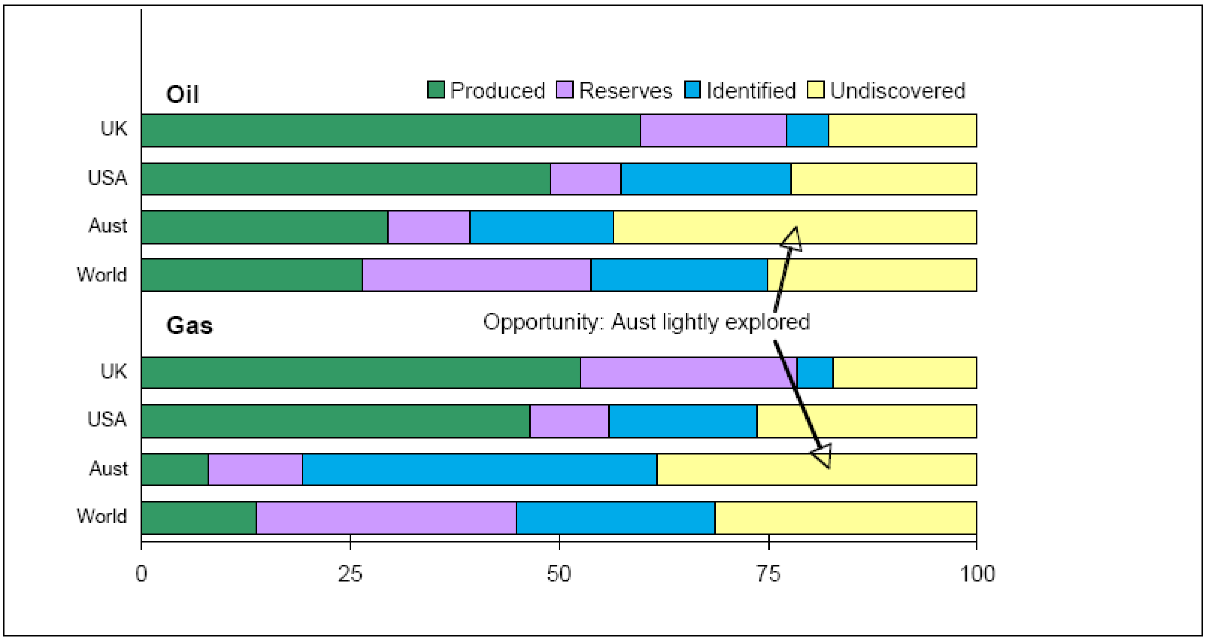
5.11 The following graph, drawn from the CSIRO submission, compares estimated recoverable oil and gas resources, including gas and condensates for Australia and the rest of the world, in percentage terms.

4 *Committee Hansard*, 18 August 2006, p. 51.

5 ABARE, *Submission 166*, p. 4.

6 CSIRO, *Submission 128*, p. 11.

Figure 5.1 – Comparison of the recoverable oil and gas resources (%) for Australia and the rest of the world (including gas and condensates)



Sourced from USGG Estimates, reprinted from CSIRO, *Submission 128*.

5.12 Others are more cautious about the prospects of finding significant quantities of oil in particular. For example, John Akehurst, former Managing Director of Woodside Australian Energy wrote:

> …the general view within the industry [is] that Australia has low oil prospectivity and fields yet to be discovered are of small to medium size and becoming more technically demanding…[7]

5.13 Similarly, Professor David Harries, Director of the Research Institute for Sustainable Energy (RISE) at the Murdoch University submitted that many petrogeologists considered that the prospects of finding significant oil reserves in Australian Territory is not high:

> Many petrogeologists … argue that Australia's prospectivity in oil is inherently low and that while there are likely to be undiscovered oil reserves in Australian territory, these are unlikely to be significant. Some petrogeologists have attempted to explain Australia's low hydrocarbon prospectivity in terms of plate tectonics and a possible north-south planetary asymmetry during the carboniferous period.[8]

5.14 The Australian Academy of Technological Sciences and Engineering (AATSE) agreed that many Australian sedimentary basins remain substantially

7 Akehurt, J. 2002, *World Oil Markets and the Challenges for Australia*, Woodside Australia Energy, ABARE Outlook conference, 2002.

8 RISE, *Submission 104*, p. 5.

unexplored, but also cautioned that many of these are in deep water and difficult environmental conditions. The AATSE noted the Government's programs through Geoscience Australia aimed at opening some of these areas up for exploration, commenting that only by encouraging exploration in these frontier areas can the opportunity of finding a new oil province be realised.

5.15 However, as noted by AATSE and others, the process of bringing the resources of a new province on line, assuming that one is found, involves long delays, as long as a decade. The AATSE said that the release and preliminary exploration of new acreage took around four years, and if a discovery was made, it would take a further six years before it could be brought into production.[9]

Exploration activity

5.16 Intuitively, it might be expected that the high oil prices of 2005 and 2006 would be enough to stimulate exploration activity. As Dr Brian Fisher told the committee when commenting on whether the recent higher oil prices would stimulate exploration activity: 'On the supply side, clearly high oil prices encourage lots of activity in the exploration sector and drive new technology'.[10]

5.17 However, evidence from the Australian Petroleum Production and Exploration Association (APPEA) indicated that while increased prices stimulate exploration in areas known to have produced hydrocarbons in the past (ie: brownfield sites), this was not necessarily the case for exploring new areas:

> While higher crude oil prices result in increased brownfield exploration and appraisal drilling, it does not necessarily deliver increased exploration in those areas where it is needed most, and that is the frontier areas. It does not provide Australia with any relative competitive exploration advantage. Frontier basins, of which Australia has many, are high risk and very high cost, as rightly pointed out by the Prime Minister in his speech to CEDA in July.[11]

5.18 Information provided by APPEA shows that around 100 exploration wells have been drilled in the last year, about half of them in offshore areas.[12] This does not represent a high level of activity in historical terms.

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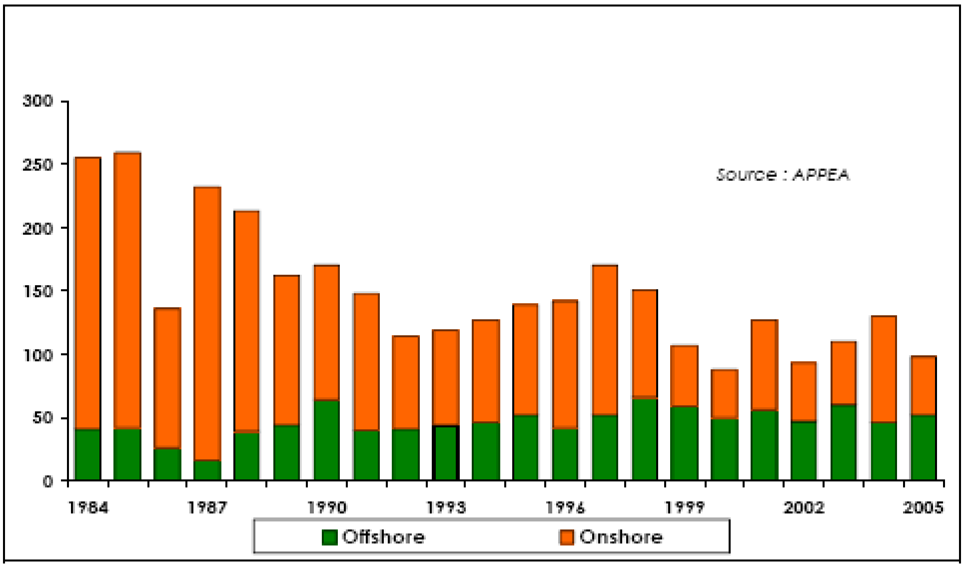
9 AATSE, *Submission 154*, p. 4.

10 *Committee Hansard,* 12 May 2006, p. 8.

11 *Committee Hansard,* 11 August 2006, p. 2.

12 APPEA, *Submission 176*, p. 4.

Figure 5.2 – Exploration wells drilled, 1984 to 2005 (number of wells)



Source: APPEA, *Submission 176*, p. 4.

5.19 There are a number of reasons for this relatively low level of activity. These include:

- exploration costs and risks;
- the longer term price of oil; and
- policy settings including taxation regimes and incentives.

Exploration costs and risks

5.20 The costs of exploring for oil, particularly in offshore areas are high and rising. APPEA provided the committee with information about the costs of drilling, and in particular, how these have risen:

> …where we are seeing really big rises are in rig rates. For the rigs that we use for exploration our industry was paying about $65,000 a day about 18 months ago, and now they are upwards of $250,000 to $300,000, or even $400,000 a day…in general we are seeing cost increases over the past 12 months of between about 30 to 50 per cent depending on the project.[13]

5.21 The costs associated with exploration work are compounded by risk, that is, the chances of commercial success. Commercial success has to be distinguished from the rate of discovery, which is apparently quite high. In 2004, the technical success rate (ie: a well is clearly shown to contain petroleum on the basis of electrical logging) was 53.3 per cent for onshore wells, and 40 per cent for off shore wells. The following table shows the technical success rate for oil exploration wells over the last decade.

13 *Committee Hansard,* 11 August 2006, p. 4.

Table 5.1: Discovery rate per well drilled

Year	Number of exploration wells drilled		Success rate	
	Onshore	Offshore	Onshore	Offshore
2004	59	27	53.3%	40.0%
2003	28	45	39.3%	25.5%
2002	24	31	61.9%	38.2%
2001	49	49	61.7%	26.0%
2000	27	55	39.1%	40.0%
1999	29	44	41.4%	28.6%
1998	74	56	46.6%	22.6%
1997	85	33	54.0%	28.1%
1996	73	30	40.3%	39.5%
1995	63	34	40.7%	25.0%
1994	60	26	57.6%	28.1%

Success Rates (per wells drilled)

Source: Department of Industry, Tourism and Resources, Response to Questions taken on notice, 12 September 2006, p. 4.

5.22 However, as noted by the Department of Industry, Tourism and Resources, technical success does not imply commercial success. Discoveries may be small and the ability to commercialise them depends on a range of technical and economic factors which change over time.[14]

5.23 In Australia, commercial success rates have been considerably lower than in other countries, creating the perception that explorers may be more likely to achieve a return on investment elsewhere. As APPEA pointed out in its submission:

> The offshore Australia region success rate for commercial oil discoveries was 6.5 percent (that is on average one in fifteen exploration wells drilled in the study period resulted in a commercial petroleum discovery in offshore Australia). This compares to a global average success rate of 17 percent.[15]

5.24 Ms Robinson of APPEA elaborated:

> …frontier areas are very high risk and high cost. We are talking about perhaps a risk ratio of 1:15. In other words, if you drill an exploration hole you have about a 1:15 chance of finding something, and it has been very costly because it is deep water and so on, whereas a lot of the companies would prefer to go to, say, North Africa, the Middle East, Russia or other places where the risk ratio is much lower—in the Gulf of Mexico it is 1:4 and in West Africa it is 1:3. I think that is the issue.[16]

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14 Department of Industry, Tourism and Resources, Response to Questions taken on notice, 12 September 2006, p. 4.

15 APPEA, *Submission 176*, p. 6.

16 *Committee Hansard,* 11 August 2006, p. 3.

5.25 Australian commercial discoveries are generally smaller compared to other countries, further increasing the perception that Australia is not an attractive place to explore for petroleum. APPEA advised the committee that the average commercial discovery size in offshore Australia was small compared to other regions (28 million barrels for oil and 197 billion cubic feet for gas). APPEA submitted that this combination of factors 'presents significant challenges from a policy context'.[17]

Lack of confidence in longer term oil price

5.26 A lack of confidence in the longer term cost of oil also appears to act as a disincentive to undertake exploration in frontier areas, which are acknowledged as being more difficult areas in which to achieve an acceptable return on investment. When asked about what would happen if the price of oil returned to $US20 per barrel, Ms Robinson of APPEA responded that:

> If it went back to $20 a barrel I think we would see what we have seen in the past around the world, and which is perhaps part of the reason why we are in the predicament that we are globally, and that is a failure to invest in exploration.[18]

5.27 One factor which holds down the longer term expectation of higher oil prices is substitution – that is, when the price gets to a certain level, substitutes for conventional oil may become economically viable. Dr Fisher of ABARE alluded to this factor in evidence:

> If your long-term expectation is that oil prices will be sustained at very high levels then you bring in all this extra supply. The reason you do not see that extra supply rushing in today is that effectively people are not convinced that oil prices are going to stay at these levels… anyone who calls a price above $40 is not taking into account the liquefaction of coal.[19]

Policy settings

5.28 APPEA was of the view that Australian policy settings need to be adjusted to improve Australia's relative attractiveness as an investment destination on a risk adjusted basis. APPEA also sought an extension of Geoscience Australia's pre-competitive geoscientific information program, commenting that 'probably the most useful service or program that the government provides for the industry as a whole is the collection and provision of… pre-competitive geoscientific information.'

5.29 APPEA also addressed the introduction by the Government of a 150 per cent uplift factor in relation to Petroleum Resource Rent Tax in relation to a limited number of designated frontier exploration areas. APPEA did not appear to regard this measure as particularly useful, pointing out that it is of 'limited interest' in that it is

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17 APPEA, *Submission 176*, p. 6.

18 *Committee Hansard,* 11 August 2006, p. 12.

19 *Committee Hansard*, 12 May 2006, p. 9.

only relevant to those companies paying petroleum resource rent tax who are actually in profit.[20]

5.30 The committee notes that on 14 August 2006, the Prime Minister announced a number of initiatives to stimulate local exploration activity, including the requested extension of the Geoscience information program. The initiatives include the following:

- the allocation of an additional $76.4 million over the next five years to expand Geoscience Australia’s pre-competitive data acquisition program;
- a review of the exploration policy framework, to reduce the red-tape burden on the petroleum exploration industry; and
- $58.9 million to allow Geoscience Australia to 'to pioneer innovative, integrated geoscientific research to better understand the geological potential of onshore Australia for both minerals and petroleum.'[21]

5.31 The committee also notes that in February 2006, the Minister for Industry, Tourism and Resources announced the awarding of a total of 13 new petroleum exploration permits. Nine of these new permits are in Commonwealth waters off WA, two are off Tasmania and two are in the Territory of Ashmore and Cartier Islands offshore area.[22]

Committee comments

5.32 Ultimately, decisions about whether to conduct exploration will be commercial decisions made by companies on the basis of the assessment of commercial risk and likely returns. In making these decisions, companies will undoubtedly make an assessment of whether any resources discovered can be produced at a price that is competitive with alternative fuel sources.

5.33 It remains to be seen whether the Government's initiatives will result in the discovery of significant new oil reserves. The committee accepts that there are reasonable grounds to believe that there are good prospects for discovering further reserves. However, a multifaceted approach to reducing dependence on imported oil is prudent, requiring the parallel consideration of other alternative sources of liquid or substitute fuels, as considered in the following chapter.

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20 *Committee Hansard*, 11 August 2006, p. 9.

21 Transcript of the Prime Minister's statement to Parliament on energy initiatives, Parliament House, Canberra, 14 August 2006 and Department of Prime Minister and Cabinet website, at http://www.dpmc.gov.au/initiatives/docs/exploration.rtf.

22 Transcript of the Prime Minister's statement to Parliament on energy initiatives, Parliament House, Canberra, 14 August 2006 and Department of Prime Minister and Cabinet website, at http://www.dpmc.gov.au/initiatives/docs/exploration.rtf.

Chapter Six

Supply side responses – Alternative fuels from gas, coal and shale

Introduction

6.1 While exploring for more oil in Australian territory may find new resources that will increase self sufficiency in liquid transport fuels, this cannot be guaranteed. Australia is fortunate however in having available a range of other options for meeting transport requirements.

6.2 To some extent, fuel substitution is already taking place. Liquid petroleum gas (LPG) has achieved substantial market penetration in the motor vehicle fleet (currently six per cent of volume), and some biofuels, particularly ethanol, are now marketed as blends with conventional fuels. Overall though, alternative fuels, with the exception of LPG, make an insignificant contribution to Australia's transport energy mix, less than 1 per cent of transport fuel requirements.

6.3 Submissions and evidence drew the committee's attention to a wide range of possible alternative fuels, some derived from fossil sources (gas and coal), and some from biomass. There is also an extensive literature on alternative fuels, including a range of government and independent research reports prepared in Australia and overseas over the past decade or longer that have identified options which could be applied in Australia if required, or if appropriate market conditions existed. Yet with some minor exceptions,[1] in Australia, little has changed. Fossil derived petrol[2] is still the fuel of choice in the light vehicle market, and similarly produced diesel powers heavy transport and off road applications, as it has for decades.

6.4 Most alternative fuel options have already been well canvassed in expert reports such as *Alternative Fuels in Australian Transport*, a report prepared by the then Bureau of Transport and Communications Economics in 1994; in the recent significant report of the biofuels taskforce, and in a range of other publications, all of which are readily available.

6.5 In evaluating alternative fuel options for Australia, the committee is conscious of its limitations in this task. It is not possible for a parliamentary committee with limited expertise and resources to come to a definitive position on such a complex subject. Rather, the aim in the rest of this chapter is to canvass a range of transport fuel options that were particularly drawn to the committee's attention during this

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1 For example, the introduction of fuel standards, and increases in the market share of LPG.

2 That is, refined from conventionally produced oil.

inquiry, highlight those options that appear most viable and to discuss the broad advantages, disadvantages and obstacles to implementation of each, within the framework laid down by the terms of reference.

6.6 In preparing this material, the committee acknowledges and draws on a range of diverse material including submissions, evidence, a selection of the many comprehensive reports referred to in the preceding paragraphs, and some of the research literature that is available on the subject.

6.7 The options the committee has elected to canvass in the remainder of this chapter include:

- substituting gaseous fuels such as LPG, natural gas (methane) or hydrogen for conventional liquid fuels;
- producing fuels by liquefying natural gas or coal; and
- producing oil from oil shales.

6.8 In the following chapter, the committee examines the option of producing a proportion of fuel requirements from biomass.

6.9 In relation to alternative fuels, the terms of reference for this inquiry ask the committee to report on 'the potential of… alternative transport fuels to meet a significant share of Australia's fuel demands, taking into account technological developments, environmental costs and economic costs'.

6.10 Economic considerations (which may or may not include carbon costs) will ultimately decide whether any or all of the alternative fuels options are eventually developed and brought to production. Governments may provide incentives or tax breaks which may encourage the development of particular options, but ultimately, companies will make decisions to invest what must be substantial sums (if there are to be any real inroads made on replacing imported supply) based on their assessments of longer term risks and returns.

6.11 As with petroleum exploration, financial risks associated with unknown future costs and prices (e.g. the long term oil price, the cost of feedstocks, a possible price on carbon) inhibit investment until potential investors consider that risks are sufficiently quantified and returns likely to be realisable before they are willing to proceed. This can mean that action may be delayed past the point where it would be timely, as many of these potential technologies have long lead times. Some point to this as a market failure.

6.12 The long term oil price appears to be the most significant risk factor for companies contemplating alternative fuels developments. Conventional oil has long been cheap energy, and alternatives to it are inevitably more costly than pumping oil out of the ground. These alternatives must compete against oil, and many are only viable if the long term oil price is maintained over a certain level. For example, in the case of coal to liquids (CTL), Dr Brian Fisher of ABARE told the committee that CTL was viable at an oil price of $US40. Similarly, alternatives such as ethanol and biodiesel can only be competitive on an open market if they can be produced and marketed at rates which are competitive with or better than the price of conventional petroleum products. A prime example of this is LPG, the price of which is now sufficiently attractive to provide strong substitution incentives even after the costs of converting vehicles are taken into account, stimulating the development of this energy source.

6.13 In the weeks leading up to the tabling of this report, the long standing issue of climate change associated with the emission of greenhouse gases, particularly carbon dioxide (CO2), has also received intensified attention. While transport currently contributes only 14.4 per cent of Australian greenhouse gas emissions,[3] this is relative and appears of minor importance only because of Australia's large scale use of coal for stationary energy (electricity generation) – it would be higher if more stationary energy was derived from renewables such as hydro, or from gas. Transport sector emissions of CO2 are also growing rapidly, in line with the strong growth of demand for transport. The Bureau of Transport and Regional Economics (BTRE) projects that under a 'business as usual' scenario, transport sector emissions will have risen by 47 per cent in the period 1990 – 2010, and be 68 per cent above 1990 levels in 2020.[4]

6.14 The Australian Government has stated that Australia 'will play an active role in developing an effective global response to climate change'.[5] While a smaller part of the problem, there are possible opportunities in what may be an evolving transport fuels mix to contribute to reducing Australia's emissions. There are also possible pitfalls that must be considered. Different fuel choices can lead to quite different CO2 outcomes, and increasingly, it is becoming clear that this factor may need to be considered as part of any decision making process on future fuel supply options, particularly in relation to any incentives that the Government may decide to provide to encourage the development of alternative fuel options. The committee notes that this is a core message in the IEA's *World Energy Outlook 2006*.

6.15 Several of the alternative fuel sources to be considered, such as coal to liquids and gas to liquids, require substantial energy inputs (and consequently produce CO2 emissions) during manufacture, in addition to that released when they are used. Technologies such as carbon capture and storage are under active development to address this issue and have the potential to reduce the adverse greenhouse implications of some of these technologies if they can be proven viable at a large, commercial scale. The Government has provided substantial funding for this research.

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3 Australian Government, *Securing Australia's Energy Future*, Dept of the Prime Minister and Cabinet, 2004, p. 134 (2002 estimate).

4 BTRE, *Greenhouse Gas Emissions to 2020: Projected trends for Australian Transport*, Information sheet 21.

5 *Securing Australia's Energy Future,* Prime Minister's foreword.

6.16 Other options, such as natural gas, are commonly promoted on the basis that they release less CO_2 when used in place of petrol or diesel, and while this is generally true in the use phase, a 'well to wheels' or lifecycle analysis, (that is, an examination of the total CO_2 or CO_2 equivalents released from the original production phase right through to final consumption), shows that this is not always so.

6.17 If a policy decision is taken by Government to encourage the development of a particular alternative fuel source, it would appear prudent to consider the CO_2 consequences, not just because of how it might affect emissions targets, but also because of possible future carbon pricing and effects this will have on future economic viability of companies developing the resources.

6.18 In a similar vein, biofuels proponents commonly argue that fuels such as ethanol and biodiesel result in substantially lower greenhouse gas emissions because they are derived from renewable biomass. This is true in some cases, however, closer examination reveals that for some biofuels, almost as much or more fossil fuel energy is consumed to produce the fuel as is made available in the fuel itself. This is because of factors such as the use of fertilisers derived from fossil resources (natural gas is used to produce some common fertilisers for example) and conventional diesel to operate tillage and harvesting equipment. Here, consideration of the 'energy return on energy invested' is important.

Gaseous fuels – LPG, natural gas and hydrogen

6.19 Naturally occurring gases such as natural gas, propane and butane, and synthetic gases such as dimethyl ether (DME), can be used in appropriately converted petrol and diesel internal combustion engines as a substitute for liquid petroleum fuels. As such, they offer another option for replacing liquid fuels, should oil supplies become constrained or governments choose to encourage their use for economic reasons such as import replacement or supply security.

6.20 While Australia has limited and declining supplies of conventional oil, it has large reserves of natural gas, which is principally methane. Natural gas wells frequently also contain a range of heavier hydrocarbons, ranging from gases such as propane and butane (the components of Liquid Petroleum Gas, or LPG) to light liquids described as condensate.

6.21 The committee received evidence from a number of witnesses that advocated the use of these gaseous fuels as a substitute for imported oil. Natural gas was also suggested as a bridging fuel to a hydrogen-based transport system.

6.22 Proponents argue that using locally produced gaseous fuels could have significant economic benefits by reducing the impact on the balance of payments that will otherwise result from the inevitable decline in oil self-sufficiency. Proponents also argue that using domestically produced gaseous fuels would improve longer-term energy security by reducing dependence on oil produced in the Middle East.

6.23 Further, they point to environmental benefits of using these fuels, as they generally burn cleaner than oil products and produce less CO2 for each unit of energy supplied.

6.24 The three principal gaseous fuels commonly discussed are natural gas, liquid petroleum gas (LPG) and hydrogen.

6.25 DME is also a gaseous fuel with similar properties to LPG (ie: liquefies readily and at relatively low pressure, without the need to reduce its temperature, unlike LNG) that is suited to use in suitably configured diesel engines, as it has a high cetane number, but as far as the committee is aware, it has not been suggested as an alternative fuel in this country. It can be produced from natural gas, coal or biomass. Considerable work has however been done on this fuel in Scandinavian countries, and in China.

Natural gas

6.26 Natural gas (which is predominantly methane) is used as a transport fuel in two possible forms:

- a compressed gaseous form (typically stored at between 16 and 25 megapascals) known as compressed natural gas or CNG; and
- a refrigerated liquid form (cooled to -163C and stored in cryogenic tanks) known as liquified natural gas or LNG.

6.27 Natural gas can be used in both diesel and petrol engines. Both require extensive modification, but the technology is regarded as mature. Cummins Australia told the committee that it now has in excess of 12,000 gas engines (ie: heavy diesel engines built specifically to operate on gas) in operation around the world.[6]

6.28 Natural gas has both advantages and disadvantages as a transport fuel. Its advantages include its ready availability, gas being reticulated to 70 per cent of Australian urban areas; the extensive pipeline system for distributing it now in place; its relative abundance (although this is disputed); relative price stability; and environmental advantages.

6.29 Disadvantages include the weight and size of cylinders necessary to store the gas on board which in the case of trucks reduce load capacity; limited range (particularly for light vehicles which normally operate on CNG rather than LNG); a considerable energy cost associated with compressing and liquifying gas (where used as liquid natural gas or LNG) and the cost of conversion. For potential users of the fuel, a nationwide lack of refuelling infrastructure appears to be the single greatest obstacle to wider use, particularly for heavy vehicles.

6 Cummins, *Submission 84*.

6.30 Natural gas use as a transport fuel in Australian light and heavy vehicles is minimal, although the committee notes that a number of companies are trialling the use of natural gas trucks and several public authorities operate natural gas buses. Gas is, however, extensively used in some other countries as a transport fuel, and some countries are planning to expand this use substantially.

6.31 The Asia Pacific Natural Gas Vehicles Association (ANGVA) told the committee that in Brazil, there are in excess of 1 million natural gas vehicles (NGVs) on the road; and that the European Union had set a target for 10 per cent of vehicles to run on this fuel by 2020.[7] In Europe, there are reportedly 575,000 NGVs, of which 375,000 are in Italy, which has used gas as a fuel since the 1930s.[8] Similarly, Motive Energy stated that the market penetration of NGVs was up to 30 per cent in some countries.[9] In Argentina for example, there are reportedly 800,000 CNG vehicles.[10]

6.32 While the committee received a number of submissions advocating the wider use of natural gas as a transport fuel, other evidence cast doubt on whether available reserves are sufficiently large to meet transport fuel requirements.

Natural gas supply

6.33 So, is there enough gas in Australia for it to be used on a large scale as a transport fuel? Natural gas reserves are estimated to be substantial, although there was a wide variation in estimates given to the committee in submissions and evidence, some claiming that reserves are sufficient for over 100 years use. According to Geoscience Australia, which the committee regards as an authoritative source, current and recoverable reserves total 146 trillion cubic feet (Tcf) or 4085.46 billion cubic metres.[11] At current rates of production, this corresponds to a resource life of 65 years.[12]

6.34 These reserves do not include coal seam methane, which is an emerging and potentially large natural gas resource. Coal seam methane resources on the Eastern Seaboard alone have been estimated at up to 400Tcf.[13] The coal seam methane industry is developing rapidly, particularly in Queensland, where it now reportedly supplies 30 per cent of the state's gas requirements.[14] If coal seam methane estimates

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7 Asia-Pacific Natural Gas Vehicles Association, *Submission 75*.

8 Envestra Pty Ltd, *Submission 105*, attached report by Mr O. Clark AM, p. 10.

9 Motive Energy, *Submission 64*, p. 13.

10 Reuters news article, *Natural gas cars a hit in Argentina*, 9 April 2003.

11 Geoscience Australia, *Submission 128*, Table 6, p. 28.

12 Geoscience Australia, *Submission 128*, p. 32.

13 Chemlink Consultants, NSW, http://www.chemlink.com.au/nswchem.htm, as accessed 17 November 2006.

14 Keith Orchison, *Abundance, ease of access make methane attractive*, article in *The Australian* newspaper, 9 September 2006.

are correct and a significant proportion of the resource is readily recoverable, then Geoscience's estimate may be conservative.[15]

6.35 With the exception of coal seam methane, the bulk of Australia's reserves are on the North-West shelf of Western Australia. As such, they are currently inaccessible to the eastern seaboard, where most of the population lives. A large proportion of the WA reserves are also considered 'stranded' – it is not currently economic to recover and use them.

6.36 A further possible obstacle to the wider use of natural gas is doubt about the long-term price. Unlike oil and LPG, which are readily transportable and therefore priced at world parity, natural gas is much less amenable to long distance transport and consequently is not subject to international pricing. Nonetheless, the development of LNG tankers has meant that a world trade in natural gas has developed, and indeed most of the output of the North West shelf is for export. According to some commentators, declining natural gas production in Europe and North America and rapidly increasing demand in China has stimulated a boom in LNG exports. World LNG export/import capacity as been estimated to double by 2010.[16] This has led to concerns that the price will rise substantially and international natural gas pricing may emerge – that is, the Australian price will track the international price.

6.37 Dr Kelly Thambimuthu, CEO of the Centre for Low Emission Technology and Chair of the IEA greenhouse gas R&D program, told the committee that international pricing for natural gas was possible in the near term:

> In relation to the situation with gas that you mentioned, certainly Australia has a lot of gas, but I would argue that a lot of the vast deposits of gas that we have is currently earmarked as LNG exports. Once LNG becomes a tradable international commodity in the world in a big way—and by all estimates the International Energy Agency is estimating that the gas rate is going to grow phenomenally through countries like China, India and the United States, for example, picking up the demand—it will command international prices. We would be left behind in a sense in terms of our own domestic users relying upon traditional sources of gas, on a land based source. How long are we going to be immune from international gas prices? I do not know. But I think it will be a short period of time before we start competing at international levels.[17]

15 The coal seam gas industry has been described as 'burgeoning', and as the main driver of continuing investment in pipeline construction – Australian Pipeline Industry Association, Media release, 16 October 2006.

16 See for example Mr Brian Fleay, *Submission 74B*, p. 4.

17 *Committee Hansard*, 30 June 2006, p. 45.

6.38 Others however dismiss concerns about future gas pricing, pointing out that there is not yet an international price for gas, and unlike petroleum, the price of natural gas in many parts of the world is reliable and relatively stable.[18]

6.39 Mr Kevin Black, representing the Natural Gas Vehicles Group, maintained that the price of gas was much more stable than other fuels, and compared it to the price of diesel:

> … natural gas is the only one of the gaseous hydrocarbon type fuels that does not operate on world parity pricing. Indeed, a lot of the cost of natural gas is regulated by government. For instance, the transmission cost through pipelines is regulated. The retail price of natural gas today is 52c per cubic metre, which is equivalent to 52c a litre for diesel, 47c a litre for petrol and 32c a litre for LPG. The price has gone up since 1996 from 38c to 52c. That is 4.4c for the GST inclusion and the rest is CPI adjustments, and that is all that happens with the price of gas. Sydney Buses, as an example, who are a huge buyer of natural gas for their buses, have a 10 year fixed price contract, which is only adjustable for CPI, and they know today what their fuel is going to cost them in 10 years time. Ask any operator on diesel, 'What are you going to be paying in 10 years time?' and they will just roll their eyes.[19]

6.40 Similarly, the ANGVA said that pricing is stable, and that fleet operators in some cases have fixed pricing contracts as much as ten years in advance. The ANGVA maintained that extensive use of natural gas as a fuel would provide an effective buffer to the effects of international crude oil pricing.[20]

6.41 Mr Blythe of Advanced Fuels Technology Pty Ltd told the committee that stability of pricing was one of the most attractive features of the fuel for fleet users. He thought though that the prospect of excise posed a risk:

> One of the big selling opportunities to the LNG and CNG markets is that the gas companies are able to offer five- and seven-year fixed term price contracts with CPI escalation. That is extraordinarily attractive to a fleet operator who is running on margins of less than 1c per kilometre. The big risk right now, I would say, is the excise regime; that is No. 1. What is helping the industry right now is the Alternative Fuels Conversion Program. It certainly does de-risk it from a fleet-user perspective.[21]

Natural gas vehicles in Australia

6.42 Much of the committee's evidence on natural gas vehicles in Australia focussed on heavy vehicles, concerning which there seems to have been the most

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18 Envestra Pty Ltd, *Submission 105*, attached report by Mr O. Clark AM, p. 2.

19 *Committee Hansard*, 9 June 2006, p. 106.

20 Asia-Pacific Natural Gas Vehicles Association, *Submission 75*, p. 2.

21 *Committee Hansard*, 29 June 2006, p. 3.

operational experience. There was also comprehensive discussion of natural gas vehicles in general.

6.43 In relation to light vehicles and cars, the committee notes that a fledgling light vehicle natural gas industry showed signs of developing in Australia some years ago, but it did not develop. The two largest factors that have prevented development appear to be a lack of vehicle range, and a lack of refuelling infrastructure. These are problems common to both light and heavy vehicles.

6.44 Ford Australia told the committee that it did a number of trials with compressed natural gas cars, but found that the size of the tanks that were necessary to give adequate range significantly intruded on luggage space, and range was limited.[22] Similarly, Honda's dedicated natural gas Civic, which is now sold in several states in the USA, has a range of only 200 miles (320km).[23]

6.45 In Australia, Boral Transport Ltd is one of a number of companies that is using natural gas to power some of its shorter haul trucks such as concrete agitators as part of a demonstration project under the auspices of the Government's Alternative Fuels Conversion Program, which is administered by the Australian Greenhouse Office.[24]

6.46 Similarly, the Murray-Goulburn Co-operative (MGC) has converted 33 of its heavy transport prime movers to LNG, advising the committee that 21 of these conversions attracted 50 per cent funding from the Federal Government Alternative Fuels Grant Scheme, the remaining 12 being fully funded by MGC.[25]

6.47 The MGC, which stated in its submission that it has the largest privately owned fleet of LNG vehicles in Australia, told the committee that it considered that LNG offered significant potential benefits to both light and heavy vehicle operators:

> The benefits to transport operators are real and many, and include:
>
> Economic - reduced diesel costs and operational cost per kilometre, oil change frequency reduced, fuel filter changes reduced, greater export sales and being able to compete at a sustainable level.
>
> Environmental - reduced particulate emission, reduced noise, reduced greenhouse gas emissions.
>
> Social - improved business viability means greater job security and the flow on effects throughout the wider community are potentially very great.[26]

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22 *Committee Hansard*, 11 August 2006.

23 The US Federal Government offers a tax credit of $US4,000 to purchasers of such vehicles - see www.honda.com for specifications and details.

24 Boral Transport Ltd, *Submission 106*, p. 2.

25 Murray Goulburn Co-operative, *Submission 53*, p. 7.

26 Murray Goulburn Co-operative, *Submission 53*, p. 10.

6.48 However, the MGC expressed a number of concerns about its continued use of the fuel, stating that the company is exposed to a significant risk of changing availability and price for the fuel, and the possibility of taxation changes. The MGC also expressed concern that there is currently only one LNG supplier on the Eastern seaboard. The lack of distribution infrastructure appears to be of a lesser concern to MGC as its trucks are depot based, but the lack of infrastructure would severely limit operations over a wider area:

> If however, we were a general freight carrier not operating specific routes, we would be unable to operate freely through any of the normal and highly used transport routes without an extensive infrastructure rollout most particularly at strategic locations up and down the Eastern and across the Southern Seaboard.[27]

6.49 The MGC listed a number of issues that it thought needed to be addressed if the fuel was to be used more in the heavy vehicle industry, including future availability, price and excise on LNG; lack of refuelling infrastructure; and chassis length and weight limits. The MGC listed the following possible incentives that State Governments and the Commonwealth could introduce to encourage the wider use of LNG as a heavy transport fuel:

- vehicle length and weight concessions [to compensate for reduced load carrying capacity caused by the weight of the tank]; and
- continued supportive funding of conversions, technology development, education and training support.[28]

6.50 Boral Transport's experience with natural gas is with CNG powered heavy vehicles, as distinct from LNG. Boral's view was far less optimistic than that of MGC.

6.51 Boral told the committee that the cost of converting trucks was high (in the case of concrete agitators, 25 per cent more expensive than the standard truck)[29] and that it was not an attractive proposition from an economic perspective unless fuel consumption and mileage were very high.[30] Mr Rowlands of Boral told the committee that in the case of the concrete agitators used by his company, the payback period was estimated to be 7½ years.[31] He also highlighted how the lack of refuelling infrastructure acted as a disincentive to the wider market penetration of gas trucks:

> Potential customers, like ourselves, are very reluctant to invest in alternate fuel technology unless they can get the fuel. You would really have to ask why a small operator would go out and put a CNG engine in his truck now. He just has nowhere to fill up. Unless you have a lot of trucks, you cannot

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27 Murray Goulburn Co-operative, *Submission 53*, p. 9.

28 Murray Goulburn Co-operative, *Submission 53*, p. 9.

29 Murray Goulburn Co-operative, *Submission 53*, p. 9.

30 Boral Transport Ltd, *Submission 106*, p. 2.

31 *Committee Hansard,* 9 June 2006, p. 88.

> amortise the cost of your own in-house refuelling station, and you are just going to burn money.[32]

6.52 Boral representatives also confirmed that the extra weight of tanks makes it more difficult for gas fuelled trucks to operate profitably:

> If it costs more to buy the truck and it is heavier, you have higher costs to overcome and the vehicle is going to earn less because it can carry less. That, in many cases, far outweighs the fuel cost, so you are not going to get people wanting to change. It is a simple equation in the transport industry. The more you can carry, the more you get paid.[33]

6.53 Like MGC, Boral called for changes to the allowable mass limits for alternate fuel trucks, identifying this as the 'best incentive':

> The best incentive for take-up of an alternate fuel, including natural gas, is to simply increase the allowable mass limit for trucks using alternate fuels to conventional diesel engine trucks.

Infrastructure limitations

6.54 The requirement for new distribution infrastructure is a major barrier to the introduction of any alternative fuel that cannot be blended with existing fuels. This creates an economic 'chicken and the egg' dilemma in that companies are reluctant to invest in infrastructure unless assured of a customer base and reasonably secure supply; and potential customers will not buy gas cars and trucks if there are no refuelling facilities available.

6.55 In some cases, refuelling issues can be addressed to a limited extent by depot refuelling (such as described by Boral Transport in its submission) or in the case of cars, home refuelling devices such as that marketed by the Fuelmaker corporation of Canada.[34] However, for natural gas to make major inroads into the fuels market, particularly for heavy haulage, much more widely available facilities would almost certainly be required.

6.56 The Commonwealth has previously conducted a number of programs to encourage the take-up of natural gas as a fuel. These include the Alternative Fuels Conversion Program (AFCP) and the Compressed Natural Gas Infrastructure Program (CNGIP). Mr Kevin Black of the Natural Gas Vehicles Group submitted that these programs, particularly the CNGIP, had failed to achieve their aims because of:

> … constant Government policy changes and inappropriate AGO [Australian Greenhouse Office] policy and administration settings… effectively killed off the industry in Australia. No sensible investor was prepared to fund the infrastructure without a secure and supportive policy environment and since

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32 *Committee Hansard,* 9 June 2006, p. 91.

33 *Committee Hansard,* 9 June 2006, p. 88.

34 See http://www.myphill.com/index.htm

> 2004, most of the infrastructure that was in place has been wound back or removed.[35]

6.57 Mr Black argued that one factor that had contributed to the program's lack of success was what he considered to be the AGO's flawed administration of the program, which had included a requirement that the refuelling stations put in place had to remain open for three years:

> … so three years and one day later they were gone. Through some financial partners in Singapore, we were prepared to buy all of their natural gas vehicle infrastructure. They had five refuelling stations—three in Sydney, one in Goulburn and one in Canberra—they [AGL] had 50 depot based refuelling stations for a courier company and forklifts and what have you. We said, 'We're happy to buy that in a single package and continue to operate it,' and they [AGL] broke it up piecemeal and sold it off for export.[36]

6.58 A report prepared for Envestra Pty Ltd by Mr O. Clark OAM also said that the Commonwealth's announcements to introduce excise on LGP and natural gas when used as a transport fuel 'put paid to the level of interest that had been generated over many years' in the fuel.[37]

6.59 The committee asked Mr Black what it would take to revitalise a natural gas vehicles program in Australia. He argued that the most effective strategy would be a variant of the previous policy:

> The most effective strategy, I believe, is a variant of what they did before, but instead of paying up-front, providing some form of subsidy for the refuelling infrastructure post installation and requiring them to operate not for three years but for 10 years. The life of a natural gas refuelling facility, be it CNG or LNG, is a minimum of 15 years. Within 10 years of having a comprehensive roll-out of refuelling sites, the calculations we have done indicate that for eastern Australia, Tasmania and South Australia—we have not taken Western Australia and the Northern Territory into consideration at this stage, simply because we do not have enough information—you would need around 800 refuelling sites. That would provide sufficient security of supply to encourage people to buy vehicles, both as fleet operations and as private vehicles.[38]

6.60 Advanced Fuels Technology also put forward a detailed set of recommendations to increase the use of natural gas as a transport fuel:

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35 Natural Gas Vehicles Group, *Submission 119*, p. 3.

36 *Committee Hansard*, 9 June 2006, p. 102.

37 Envestra Pty Ltd, *Submission 105*, p. 16.

38 *Committee Hansard*, 9 June 2006, p. 105.

1. Set a minimum target for the conversion of a percentage of the diesel fleet to operate on Natural Gas (10-15% of all new commercial vehicles being by 2010).
2. Sponsor the development of a strategic corridor of LNG refuelling stations along the Adelaide – Melbourne – Sydney – Brisbane corridor.
3. Fund the introduction of new gas engine technology to the Australian market.
4. Continue to support end-users via the Alternative Fuels Conversion Programme (AFCP) funding of 50% of the conversion cost of a diesel vehicle to enable it to operate on gas.
5. Establish a long-term view of fuel excise to ensure fleet users can confidently invest in new fleets that have a typical life of 5 years or more.
6. Sponsor the development of small LNG and CNG depot based refuelling stations.
7. Implement an Import Duty Regime that will enable products imported for use in the gaseous transport fuels industry to have zero duty.[39]

Environmental impacts of natural gas as a transport fuel

6.61 Natural gas is frequently claimed to be amongst the most environmentally friendly fossil fuels. For example, Advanced Fuels Technology Pty Ltd submitted that natural gas vehicles:

- are up to 30% quieter;
- reduce oxides of nitrogen by up to 90%;
- reduce particulate matter by as much as 99%; and
- reduce Greenhouse gas emissions by up to 17%.[40]

6.62 Some of the published literature confirms that emissions resulting from its use are typically lower than petrol or diesel, particularly in relation to CO2, non-methane hydrocarbons and particulates.[41] The reason it is associated with lower CO2 emissions is because of the physical make up of methane, which is the lowest carbon weight of all fossil fuels. The combustion of one megajoule (MJ) of natural gas will result in the emission of about 40 grams of CO2, compared to 67 from petrol. However, well-to-wheels analysis or full fuel cycle analysis shows a somewhat less favourable outcome.

39 Advanced Fuels Technology Pty Ltd, *Submission 50*, pp 6-7.

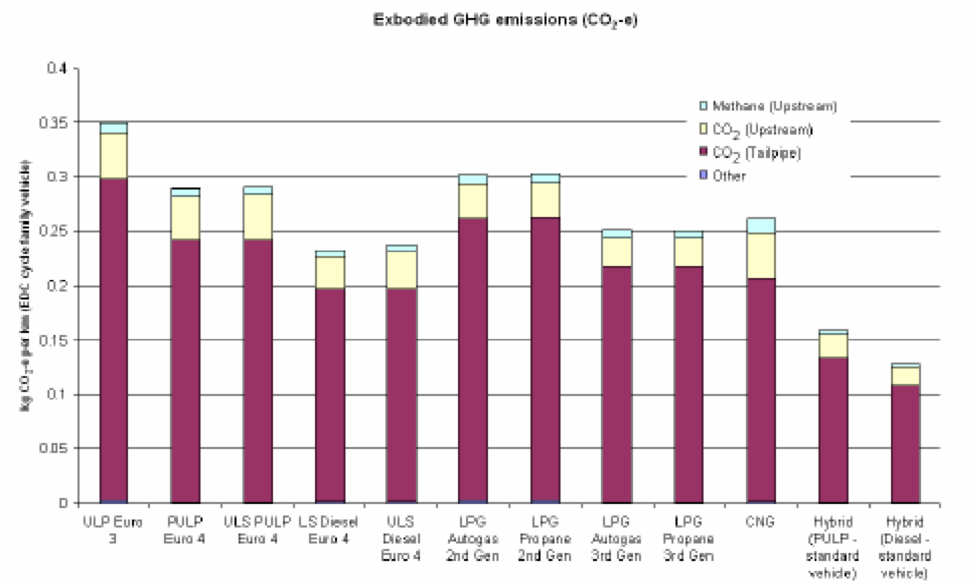
40 Advanced Fuels Technology Pty Ltd, *Submission 50*.

41 For a comprehensive analysis of this subject, see Bureau of Transport and Communications Economics, *Alternative Fuels in Australian Transport*, Information Paper No. 39, 1994, Chapter 7.

This shows a reduction in CO2 of 16 per cent for natural gas compared to petrol.[42] These statistics will vary according to the configuration of engines and their relative efficiency.

6.63 A 2004 study conducted by the CSIRO for the Australian Greenhouse Office showed that on a full fuel cycle basis, for light vehicles, CNG vehicles have lower emissions than petrol or 'second generation' LPG vehicles, but emit more CO2 per kilometre than Euro 4 diesels. Diesels however emit more particulates than any other vehicle class. The following table graphically illustrates the findings of this study.

Figure 6.1 – Exbodied greenhouse gas emissions from family-sized vehicles[43]



6.64 A similar study conducted by CSIRO in relation to heavy vehicles shows that the total greenhouse gas emissions for LNG powered heavy vehicles may be worse than for vehicles powered by conventional diesel. The following graph illustrates the findings in relation to non-bus heavy vehicles:

42 Bureau of Transport and Communications Economics, *Alternative Fuels in Australian Transport*, Information Paper No. 39, 1994, Chapter 7.

43 CSIRO, *Life-cycle Emissions Analysis of fuels for light vehicles*, Report to the Australian Greenhouse Office, May 2004.

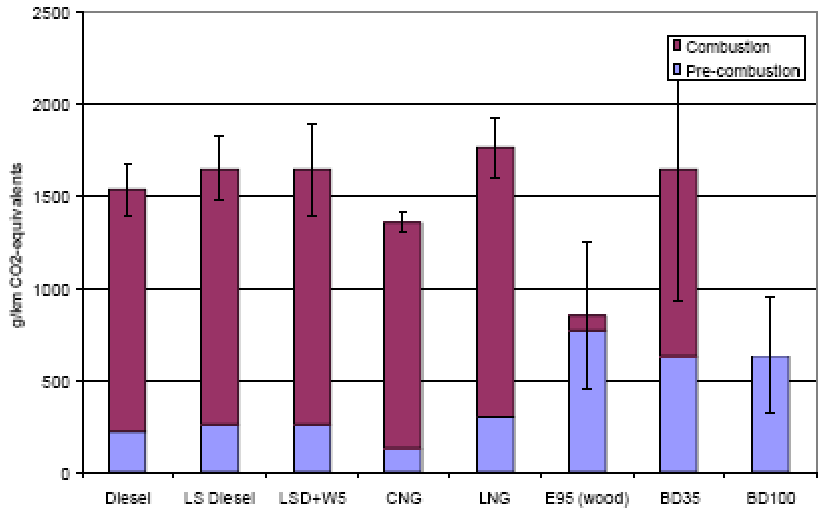


Figure 6.2 – Total greenhouse gas emissions (CO2 equivalents) in g/km for non-bus heavy vehicles[44]

6.65 There are a number of other issues that also need to be considered in relation to the environmental impact of natural gas as a transport fuel. First, energy has to be expended to compress or refrigerate natural gas to make it useable for a transport fuel. In the case of LNG, as the study cited above shows, this energy expenditure apparently cancels out any CO2 advantage over conventional petroleum.

6.66 Secondly, methane itself is a powerful greenhouse gas, so any inadvertent release, for example from fuel tanks or distribution systems, will detract from its advantages over conventional petroleum transport fuels. The Department of Environment and Heritage (DEH) advised the committee that on a life cycle analysis, natural gas has the potential to offer greenhouse gas emissions reductions of up to 20 per cent, but cautioned on the effects of losses:

> However, natural gas is primarily composed of methane, which has a global warming potential 21 times that of carbon dioxide. This means that if not managed, fugitive methane emissions may cancel out the greenhouse gas reductions from the lower carbon content of natural gas and in some cases may give rise to a negative greenhouse outcome.[45]

6.67 Thirdly, natural gas wells themselves frequently contain substantial quantities of CO2 which is generally released in the production process. The Cooper Basin fields for example are 35 per cent by weight and 12.7 per cent by volume CO2;[46]and Gorgon

44 CSIRO, *Life-cycle Emissions Analysis of Alternative Fuels for heavy vehicles*, Report to the Australian Greenhouse Office, March 2000, p. xvii.

45 Department of Environment and Heritage (DEH), *Submission 171*, p. 3.

46 Bureau of Transport and Communications Economics, *Alternative Fuels in Australian Transport*, Information Paper No. 39, 1994, Chapter 7, p. 114.

field (production from which is planned to include CO_2 re-injection and geo-sequestration) contains 13 per cent CO_2.[47]

6.68 These findings do not mean that natural gas should be dismissed as a transport fuel on environmental grounds. In some situations, it does appear to offer advantages, but the picture is not as clear or unequivocal as sometimes painted by proponents.

Conclusions on natural gas as a transport fuel

6.69 The committee has altered its view expressed in the interim report, that it would be prudent to put in place measures to encourage the rapid take-up of natural gas in the transport fuels mix.

6.70 From the perspectives of the beneficial impacts on the terms of trade and energy security and as an indigenous replacement for depleting conventional oil stocks, the fuel must be considered, particularly from the perspective of its relative abundance. There are potential economic benefits from using gas for transport. The committee considers that better use can be made of the resource than is currently the case, where most gas is exported.

6.71 The committee is not persuaded by those arguments that supplies are insufficient to make a significant contribution to the transport fuels mix. New and unconventional sources of gas are becoming available (eg coal seam methane) and availability does not appear to be a significant limiting factor within the medium term. Nonetheless, the committee is of the view that consideration should be given to establishing a national domestic gas strategy, to ensure that supplies are sufficient for domestic purposes well into the future.

6.72 From an environmental perspective, consideration is required about whether the gas will be used as fuel, and if so, in what form. Appropriate safeguards would also need to be put in place to minimise possible adverse impacts.

6.73 There are, however, significant obstacles to the wider use of gas for transport. These include a lack of distribution infrastructure, incompatibility with most of the transport fleet, economic penalties for some users if appropriate adjustments are not made, a slow return on investment for some users, and possible consumer resistance from limited range and a lack of a clear price differential from LPG.

Liquefied Petroleum Gas (LPG)

6.74 LPG is comprised of varying proportions of propane and butane. It can be produced as a result of the oil refining process, but also occurs naturally in oil and gas wells, where it can be readily separated out from other gases.

47 From http://www.chemlink.com.au/gas.htm

6.75 LPG has several significant advantages over other alternative fuels in that there is a high degree of market acceptance of the fuel; vehicle range is between 75 and 100 per cent of that attainable for petrol vehicles[48] (ie: comparable and superior to CNG); and extensive distribution infrastructure is already in place. Unlike natural gas however, LPG is parity priced, and rapid and large fluctuations in the autogas price have been observed.

6.76 Australia is the world's largest per capita user of automotive LPG,[49] and over 500,000 LPG vehicles are now on the roads in Australia[50] and this figure is increasing rapidly, spurred by the Government's recently introduced fitting subsidy. The committee notes the recent Government initiatives to encourage motorists to take up this fuel by paying a subsidy of $2000 for a conversion and $1000 towards the cost of a new vehicle with LPG fitted. This is a major program, which is expected to cost a total of $766.1 million over 8 years.[51]

6.77 The Government's LPG fitting subsidy is expected to substantially increase the use of this fuel, and media reports suggest that there are now long waiting lists for vehicles to be converted. Before the introduction of the subsidy, about 30,000 vehicles per year were converted.[52] The Department of Industry Tourism and Resources expects that 28,800 extra vehicles [ie: a total of about 58,200] will be converted this financial year (2006-07) and 7,200 new LPG fuelled vehicles sold. In 2007-08, this is expected to rise to a total of 42,900 extra vehicles converted over the base rate and 10,700 new LPG vehicles sold, and the number is expected to peak in 2008-09 at 64,000 extra conversions and 16,000 new vehicles sold.[53] Ford report having sold 50,000 dedicated LPG Falcons since 2000.[54]

6.78 The availability of a well developed distribution infrastructure is also a major advantage for this fuel. Over 3,500 filling stations are now available,[55] and there are now sufficient refuelling stations in place for a motorist to drive around Australia.[56]

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48 Michael Gutteridge and others, *Queensland's oil problem: Future considerations for Governments*, in M. Gutteridge, *Submission 76*, p. 23.

49 CSIRO, *Submission 128*, p. 6.

50 Australian Liquefied Petroleum Gas Association, *Media Release*, 13 October 2005, p. 2.

51 Department of Industry, Tourism and Resources, Response to questions taken on notice, 4 September 2006.

52 *Committee Hansard,* 18 August 2006, pp 33-4.

53 Department of Industry, Tourism and Resources, Response to questions taken on notice, 4 September 2006.

54 *Committee Hansard*, 11 August 2006, p. 28.

55 ALPGA, *Submission 91*, p. 5.

56 *Committee Hansard*, 11 August 2006, p. 28 (Mr Scoular, Ford).

6.79 Questions have been raised however about whether Australian LPG resources are sufficiently abundant for LPG to meet a significant proportion of the transport fleet's fuels requirements for an extended period. For example, Michael Gutteridge and others have written that after 2008, the bulk of LPG will come from imported crude oil and from NW Shelf gas fields. He points out that these fields contain a relatively small proportion of propane and butane (around 5 per cent) and that they are propane deficient, requiring the export of excess butane and the importation of propane. Mr Gutteridge pointed out that based on ABARE statistics, Australia produced 107 PJ of LPG in 2001, which compares to a 975PJ energy requirement. He suggests that LPG cannot be produced in sufficient quantities to meet transport energy requirements:

> There is little scope to expand indigenous supplies of LPG especially to meet the quantities required to replace our current demand of 975PJ/a, principally derived from oil, for road transport energy.[57]

6.80 The CSIRO also sounds a note of caution about LPG reserves, submitting that:

> If the Australian oil supply becomes more scarce, then it will be more difficult to source LPG from oil. Thus one would need to look to the gas fields to produce LPG. However, the difficulty with this is that the supply of LPG from gas fields depends on how "wet" or "dry" the gas is. It is possible to estimate present LPG reserves, but not what they would be in the future.[58]

6.81 Others claim that Australian LPG resources are relatively abundant. The Australian Liquefied Petroleum Gas Association (ALPGA) told the committee that it considered that reserves are sufficient to fuel around 1.1 million vehicles, or around 10 per cent of the vehicle fleet.[59]

6.82 ABARE estimates that Australia's demonstrated LPG reserves are currently 210 gigalitres, less than the estimated condensate reserves of 247 gigalitres.[60] Economically demonstrated resources have been estimated to be sufficient to last 34 years at the 2004 production rate.[61] It seems reasonable to suggest that these reserves will diminish more rapidly as more and more people take up the LPG conversion incentives.

57 Michael Gutteridge and others, *Queensland's oil problem: Future considerations for Governments*, in M. Gutteridge, *Submission 76*, p. 23.

58 CSIRO, *Submission 128*, p. 18.

59 *Committee Hansard*, 9 June 2006, p. 62.

60 Department of Industry, Tourism and Resources, *Energy in Australia 2005.*

61 Department of Industry, Tourism and Resources, Response to questions taken on notice, 12 September 2006, p. 3.

Environmental impacts of LPG as a transport fuel

6.83 Like natural gas, LPG is claimed to be an environmentally friendly transport fuel. The ALPGA claims a saving of up to 20 per cent on CO2 emissions over conventional petrol.[62]

6.84 Independent evaluation of these statistics broadly confirms these claims. While LPG can be used in conjunction with diesel in diesel engines, it is generally considered to be most suited to use in spark ignition petrol type engines rather than diesels, so a comparison with CNG is appropriate. As shown in the graphs produced by the CSIRO in Figure 6.1, greenhouse gas emissions associated with the latest third generation LPG vehicles, which employ more advanced technology than previous conversions, are comparable with CNG. LPG also liquefies more readily than LNG, requiring much less energy in the production and storage processes.

6.85 The picture in relation to other emissions such as carbon monoxide, nitrous oxides and other pollutants is far less clear. CSIRO research has shown wide variations across older and newer vehicles, which were built to different Australian design rules. In relation to the latest Euro-3 petrol engines, the CSIRO concludes:

> The data show that LPG is not the easy clean fuel it was in the time of high emission 'no control' cars. To meet Euro 3, and especially Euro 4, emission specifications requires vehicle and catalytic converter technology to be very tightly designed for optimum performance and minimum emissions. A vehicle designed for optimum petrol performance is very unlikely to be optimised to minimise emissions under LPG use.[63]

6.86 The committee notes that analysis of these issues, in relation to both LPG and natural gas, is extraordinarily complex, and do not lend themselves to either verifying or refuting blanket claims about environmental advantages and disadvantages of various fuels, particularly in relation to non-CO2 emissions.

6.87 The committee commends interested readers to the CSIRO paper, *Life-cycle Emissions Analysis of fuels for light vehicles*, Report to the Australian Greenhouse Office, May 2004[64] for a thorough and up-to-date evaluation of environmental impacts of various fuels; and to the BTCE's paper 39, *Alternative Fuels in Australian Transport*,[65] which contains a thorough if somewhat dated evaluation of a range of other pertinent issues in relation to the use of LPG, natural gas and other fuels.

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62 See for example *Committee Hansard*, 9 June 2006, p. 62.

63 CSIRO, *Life-cycle Emissions Analysis of fuels for light vehicles*, Report to the Australian Greenhouse Office, May 2004, p. 67.

64 CSIRO, *Life-cycle Emissions Analysis of fuels for light vehicles*, Report to the Australian Greenhouse Office, May 2004.

65 Bureau of Transport and Communications Economics, *Alternative Fuels in Australian Transport*, Information Paper No. 39, 1994.

Conclusions on LPG as a transport fuel

6.88 The committee agrees that LPG has the potential to provide an alternative fuel for a proportion of the Australian transport fleet, probably not exceeding 10 per cent. It has a number of clear advantages, not least of which is a well developed distribution infrastructure and apparently good acceptance by consumers.

6.89 Its use has a number of economic advantages for both users, who enjoy substantial fuel cost savings (although parity pricing can influence these), and more broadly in relation to directly substituting an indigenous fuel for one that will increasingly be imported.

6.90 There are some doubts about the extent of future supplies of LPG, although these appear to be adequate for at least a number of decades, depending on the proportion of the vehicle fleet that is converted to operate on it.

6.91 Environmental advantages are reasonably clear, at least in relation to CO2, particularly in the case of modern, third generation conversion technology. The picture in relation to non-CO2 pollutants is less clear.

6.92 Government initiatives to encourage the take-up of this fuel appear to have been extremely successful, and do not need to be expanded.

Hydrogen

6.93 Hydrogen is often put forward as an alternative transport fuel, although it is more correctly described as an energy carrier. Theoretically, a vehicle fuelled by hydrogen would have zero emissions. However, what is often overlooked is that hydrogen does not occur naturally and must be produced as part of a manufacturing process. It can be produced by reforming natural gas, coal or biomass, or by electrolysis, but currently, substantial CO2 emissions accompany all of these methods of producing this fuel. Geosequestration may alter this picture.

6.94 However, hydrogen is generally not regarded as a near-term transport fuel, as there are formidable technical issues to be overcome before it could be widely used. These include:

- the very large amounts of energy required to convert it to a liquid and maintain it in a liquid state, or compress it sufficiently to make it suitable for transport fuel use;
- storage problems arising from its propensity to leak through and embrittle the walls of metal pipes and tanks;
- in cars, large heavy tanks that limit luggage space and provide very limited range;
- in trucks, similar issues to LNG and CNG in relation to weight and volume of tanks and reduced cargo carrying capacity;

- the lack of a source of supply (although it could be produced in volume by reforming natural gas); and
- a complete lack of distribution infrastructure.

6.95 In the committee's view, hydrogen is a fuel that might be considered in the distant future, but is not a useful option to consider in Australia's current or medium term transport fuels mix. Mr Black of the NGVG summed up the argument in relation to hydrogen very well:

> Everybody seems to pinning their hopes on hydrogen, which is still, frankly, pie in the sky. We do a lot of work with the CSIRO and we talk to them fairly frequently. I am on a hydrogen panel with the CSIRO. The greatest fear of hydrogen researchers in this country is that governments and the media will hype it up so much that people will have expectations that will never be met.[66]

Synthetic fuels derived from coal or gas

6.96 Technologies have been readily available for several decades for synthesising liquid transport fuels from either natural gas or from coal. During the apartheid era, South Africa produced all its liquid fuels from coal using the Fischer-Tropsch (F-T) process and still produces 40 per cent of its fuel needs though this process.[67]

6.97 A range of direct substitutes for conventional oil can be produced from coal or natural gas, using a variety of processes and conversion routes. These include synthetic diesel, light hydrocarbons suitable for producing petrol or which can be used as chemical feedstocks, and kerosene.[68] It is also possible to produce a range of other hydrocarbons which can be used as fuels including methanol, dimethyl ether (also known as DME - a gaseous fuel with similar properties to LPG which is suitable for use in appropriately configured diesel engines), and hydrogen.

Gas to liquids

6.98 A number of companies, including Sasol-Chevron, Shell, and ExxonMobil, have either constructed pilot or commercial plants exploiting variations of this technology. Shell operates a 12,500 barrels per day plant in Bintulu, Malaysia and is reportedly planning to construct a 140,000 barrels per day plant in Qatar.[69]

6.99 Sasol Chevron, whose representatives made a submission and gave evidence to the inquiry, advised the committee that it is close to bringing a 34,000 barrels a day

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66 *Committee Hansard*, 9 June 2006, p. 103.

67 Sasol Chevron, *Submission 54*, p. 4.

68 See for example Chemlink Australasia, *Gas to Liquids*, at http://www.chemlink.com.au/gtl.htm as accessed 16 November 2006.

69 *Catalyzing GTL*, Chemical and Engineering News, Vol 81, No. 29, 21 July 2003.

plant into operation, also in Qatar, and has a plant under construction in Nigeria, to be commissioned in 2009.[70]

6.100 The Sasol Chevron company advocated[71] the construction of a FT-GTL diesel plant in Western Australia. While the committee is aware that there have been other GTL proposals (for example, the now abandoned Methanex proposal to produce methanol in Western Australia) the committee has elected to devote most of its discussion to GTL diesel, as unlike others, this product appears to be most suited to seamless introduction into the Australian market, without modification of infrastructure or vehicles. It is also a proposal about which the committee received detailed evidence.

6.101 Sasol Chevron argued that a GTL industry would have a number of benefits for Australia. Among these, it would:

- create a new value adding market for Australia's natural gas reserves;
- develop strategically important gas infrastructure;
- bring new technology and new jobs to Australia;
- reduce Australia's dependence on imported transport fuels;
- reduce diesel air pollution in Australia's urban centres; and
- become a foundation for the emerging global synthetic fuels industry.[72]

6.102 GTL diesel produced from natural gas has the major advantages as an alternative fuel that it is compatible with existing distribution infrastructure, can be blended with conventional diesel, and does not require any modification of diesel engines in the existing vehicle and machinery stock. It also does not require any further refining to make it ready for use. Its zero sulphur content and high cetane rating also facilitate the introduction of higher efficiency diesel engines which are currently emerging in Europe.

6.103 However, the capital cost of constructing a large scale GTL plant is high, with attendant difficulties in attracting the necessary capital. Sasol Chevron told the committee that building a plant to produce 200,000 barrels per day of oil equivalent from natural gas would require an investment of approximately $20 billion.[73] ABARE estimates a capital cost of US$25-40,000 per barrel of daily capacity for a gas-to-liquids plant, compared with US$15,000 for a conventional oil refinery.[74]

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70 Sasol Chevron, *Submission 54*, p. 6.

71 The Sasol Chevron project has been withdrawn. Source: Chemlink Australasia, at http://www.chemlink.com.au/index-info.htm, accessed 16 November 2006.

72 Sasol Chevron, *Submission 54*, p.14.

73 Sasol Chevron, *Submission 54*, p. 11.

74 *Australian Commodities*, June 2006, p. 306.

6.104 According to the CSIRO, GTL does appear to be economically viable, at least in places where the gas price is low. The gas price, and in particular returns that gas producers are able to achieve for LNG, appears to be one of the major factors preventing the establishment of a GTL plant in Australia:

> With the current robust LNG market climate and LNG's long history, GTL must offer a more compelling value proposition to the gas resource holders to be successful. In Qatar and Nigeria, this has been achieved. In Australia, this has not yet happened.[75]

6.105 Representatives of the Department of Industry, Tourism and Resources confirmed that GTL projects so far have tended to be built where there are low gas prices:

> It is very difficult for us to produce at a rate that is comparable with the Middle East—or Qatar in particular. So gas to liquids, some of those other sorts of downstream users, are more likely to go to those sites where they have a much lower cost feedstock.[76]

6.106 Uncertainty about the longer term oil price also appears to be a factor holding back investment in this country and elsewhere.[77]

6.107 Sasol Chevron submitted that the taxation regime that currently applies to natural gas does not favour large scale, long term investments such as its proposal:

> … the current tax and PRRT regime does not facilitate such large, long term capital investments. The Australian fiscal regime is not internationally competitive with regards to capital depreciation and the facilitation of strategic, Greenfield investment. There are a number of mechanisms available which could allow a more competitive payback for the investor without compromising the value return to the nation. These should be considered if there is a desire to better attract GTL investment.[78]

6.108 Establishing a gas to liquids industry may present economic opportunities for Australia by allowing the use of gas resources which are currently uneconomic. A significant proportion of Western Australia's gas reserves are off-shore, and are considered to be 'stranded', in that it is not currently economic to bring the gas on-shore for processing using current technology. The CSIRO points out that if such gas could be brought ashore by converting it into a more easily transported product, then this could result in significant economic benefits. However, the CSIRO noted that there are difficulties relating to the large physical size of FT–GTL diesel plants which make them less suitable for constructing off-shore on gas platforms. Other GTL

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75 Sasol Chevron, *Submission 54*, p. 13.

76 *Committee Hansard,* 18 August 2006, p. 48.

77 Chemlink Australasia, *Gas to Liquids*, at http://www.chemlink.com.au/gtl.htm , accessed 16 November 2006.

78 Sasol Chevron, *Submission 54*, p. 13.

technologies with a smaller physical footprint may be better suited for this purpose. CSIRO advised the committee that it is currently working on a new process involving methane pyrolysis, which will produce synthetic petrol rather than diesel.[79]

6.109 A number of commentators have cast doubt on the future of GTL in Australia, arguing that the price of gas feedstock will be prohibitive, as natural gas becomes subject to international pricing. (see paragraph 6.36ff above).

6.110 From an environmental perspective, GTL products have both advantages and disadvantages. GTL diesel is claimed to be a superior product to conventional diesel, in that it has virtually zero sulphur and aromatics content and a very high cetane number.[80] The principal environmental disadvantages of the fuel are that considerable energy is consumed producing it, and it is still a fossil fuel with comparable greenhouse gas (GHG) emissions to conventional diesel in most applications.

6.111 The extent of CO2 emissions associated with GTL is somewhat disputed. Sasol Chevron claimed that on a well-to-wheels basis, its technology for producing GTL diesel is on a par with conventional oil:

> Sasol Chevron, ConocoPhillips and Shell International Gas commissioned a study by Five Winds International to report on the Life Cycle Analysis of GTL production. The study found that production and use of GTL fuel can contribute less greenhouse gas and reduced emissions to the atmosphere than production and use of conventional diesel fuel.[81]

6.112 The Five Winds study quoted by Sasol Chevron acknowledges that higher GHG emissions are associated with the production phase of GTL, but says that these are offset in the use phase.[82] However, other evidence conflicts with this view. For example, a well-to-wheels study conducted by the Mizuho Information and Research Institute for Toyota in Japan showed somewhat higher GHG emissions for FT diesel than conventional diesel, although this was still below the emissions from conventional petrol.[83]

6.113 Similarly, information provided by the CSIRO shows that the production process (using natural gas as a feedstock) results in the emission of about 1.87 tonnes of CO2 for each tonne of hydrocarbon produced, or 233 kg per barrel, or 1.46 kg per litre, before the fuel is used.[84]

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79 CSIRO, *Submission 128*, p. 17.

80 Sasol Chevron, *Submission 54*, pp 7-8 and p. 12.

81 Sasol Chevron, *Submission 54*, p. 9.

82 Sasol Chevron, *Submission 54,* Appendix B, p. 9.

83 Mizuho Information and Research Institute, *Well-to-wheels analysis of Greenhouse Gas emissions of automotive fuels in the Japanese context*, from www.mizuho-ir.co.jp/english/knowledge/wtwghg041130.html, accessed 14 November 2006.

84 CSIRO, response to questions taken on notice, 27 June 2006. (Appendix 3)

6.114 The committee asked the CSIRO to calculate what a theoretical carbon tax of \$40 a tonne of CO2 would amount to per barrel of fuel produced. In the case of FT-GTL, this amounts to \$9.20 per barrel.[85] Given the potential importance of the possible price being placed on carbon dioxide emissions to the future competitiveness of GTL and CTL projects, the committee has included the CSIRO's letter at Appendix 3.

Coal-to-liquids

6.115 Coal, of which Australia has vast, accessible resources, can be used to produce a similar range of liquids as the GTL processes described in the previous section. Indeed, some of the processes to produce liquids from coal are very similar to the GTL processes, for example conversion of the feedstock to syngas (a mixture of carbon monoxide and hydrogen) and subsequent F-T conversion using a catalytic process to the desired end products.

6.116 Like GTL, coal-to-liquids (CTL) is established technology,[86] and it is seen by a number of groups within Australia[87] and overseas as a viable method of producing liquid fuels on a large scale in the near future.

6.117 In the United States in particular, the Government has been active in encouraging the development of CTL fuel and has established a fuel tax credit of US 50 cents per gallon (US\$21/barrel) for diesel fuel produced from coal using the F-T process.[88] ABARE advised the committee that by 2025, up to 10 per cent of liquid fuels used in the USA will be produced from coal.[89]

6.118 Arguments advanced by CTL proponents include:

- potential to reduce reliance on imported fuel;
- quality of the product – a synthetic diesel which is high cetane and low sulphur;
- the process of conversion is versatile, and a range of other valuable products ranging from fertiliser to hydrogen can be produced if required;
- development of the technology can also provide technologies for reducing CO2 emissions from the electricity industry;
- a large, accessible feedstock; and

85 CSIRO, Response to questions taken on notice, 27 June 2006. (Appendix 3)

86 Although the Sasol plant in South Africa is the only industrial size plant in the world in operation.

87 For example, the Monash Energy Consortium and the Centre for Low Emission Technology, both of which made submissions and gave evidence.

88 Monash Energy, *Submission 58*, p. 14.

89 *Committee Hansard*, 18 August 2006, p. 53.

- feedstock resources are much larger than natural gas, which may be substantially depleted by 2050.[90]

6.119 According to ABARE, these processes become commercially viable once the long-term oil price is above $US40-45 per barrel.[91]

6.120 Like GTL, the capital investment required for building plants to produce fuels from coal is large. ABARE suggests a capital cost of $US50-70,000 per barrel of daily capacity, which is somewhat higher than a GTL plant.[92] The Monash Energy project submission states that it would cost about $A5 billion to construct a plant capable of producing 60,000 barrels of synthetic hydrocarbon liquids a day, 80 per cent of which would be diesel.[93]

6.121 Critics of CTL technology point out however that from an environmental perspective CTL fuels have very high well-to-wheels CO2 emissions compared to most other fuels. Additionally, in terms of greenhouse gas emissions CTL diesel is equivalent to conventional diesel, as confirmed by Dr Kelly Thambimuthu, CEO of the Centre for Low Emission Technology and Chair of the IEA greenhouse gas R&D program:

> Senator MILNE—To finish that off, even if you got this up and produced it as a transport fuel, its CO2 omissions are going to be equivalent to conventional oil?
>
> Dr Thambimuthu—Yes, that is true, if you use the coal…[94]

Should a price be placed on carbon dioxide emissions at some point in the future, this could affect the price at which the fuel could be produced, and thus the viability of this option for producing fuels.[95]

6.122 It is important to quantify the nature of this potential problem. Information provided to the committee by the CSIRO shows that 3.9 tonnes of CO2 will be produced in the gasification phase, and a further 1.2 tonnes at the FT liquids production phase, a total of 4.3 tonnes of CO2 for each tonne, or 537kg of CO2 per barrel of liquid hydrocarbon fuel produced. Calculations prepared for the committee by the CSIRO show that if a carbon tax was ultimately introduced at $40 per tonne of CO2 emitted, the level of tax applied would be $22.60 per barrel.[96]

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90 Monash Energy, *Submission 58*, p. 7.

91 *Australian Commodities*, June 2006, p. 306.

92 *Australian Commodities*, June 2006, p. 306.

93 Monash Energy, *Submission 58,* covering letter and p. 10.

94 *Committee Hansard*, 18 August 2006, p. 46.

95 Monash Energy acknowledges this – see p. 9.

96 CSIRO, Response to questions on notice, 27 June 2006, p. 1.

6.123 In Australia, CTL proponents are obviously aware of and sensitive to the emissions issue and its potential cost implications. Monash Energy (Monash), a wholly owned subsidiary of Anglo-American, proposes to build a 60,000 barrels per day CTL plant in the Latrobe Valley in Victoria. Monash submitted that this plant is planned to be the first CTL project predicated on carbon capture and storage. The first stage of the plant is scheduled to be commissioned in 2016. The project is based on the availability of the very large brown coal deposits in the Latrobe Valley, and the proximity of the depleting oil and gas reservoirs in the Gippsland basin, where the captured CO2 is to be stored.[97]

6.124 The company claims that this project would have significant economic benefits, including avoiding $80 billion in oil imports over 50 years, spending $20 billion on goods and services (mainly within Australia), and paying $15 billion in corporate income tax.[98]

6.125 The company is understandably concerned about the risks involved, not just in relation to possible carbon pricing, but a range of other factors including the oil price and the legislative environment in which it will operate:

> It is a large-scale investment. One of the things that comes with a large-scale investment is that to manage the risks of that large amount of capital you need to have as much certainty about the future as you possibly can. That includes not just country risk but things such as legislative risk. In being able to install this facility the investors are looking at a very long-term plant. We are talking about something that will run for 50 to 100 years, so it is a very long-term investment project. It has a very high level of capital, but it is reliant on having a long-term understanding of such things as oil price, exchange rate and other effects that might come into play—carbon, carbon pricing.
>
> For us that means that having some certainty about the policies that are going forward is critical to being able to manage the risk of the investment, and it certainly helps to have a firm view on what the legislative environment will be.[99]

6.126 The Monash Energy project incorporates a detailed plan to capture and store the CO2 generated. Monash stated that 'this would be the largest carbon capture and storage project in the world when it is up and running'.[100] It follows that if this feature is part of the project, it would reduce pricing risks associated with carbon pricing, assuming that the capture and storage technology is demonstrated as successful on a

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97 Monash Energy, *Submission 58*, p. 9.

98 Monash Energy, *Submission 58*, p. 12.

99 *Committee Hansard (private briefing – Monash Energy)*, 29 June 2006, p. 2. (Mr Cochrane, CEO)

100 *Committee Hansard (private briefing – Monash Energy)*, 29 June 2006, p. 2. (Mr Cochrane, CEO)

large scale. Equally however, if no price is ultimately put on carbon, the project would be placed at a disadvantage to potential competitors unencumbered by this cost.

6.127 The committee sought information about whether this technology has been successfully demonstrated, and what the likely costs of implementing it would be.

6.128 Monash advised the committee that there is a successful project in Norway that captures and stores 2 million tons of CO2 a year,[101] that re-injection is commonly used as an enhanced oil recovery tool in the USA, and that the activities associated with capture and storage have been used routinely by the oil industry for a number of years. Monash also advised the committee that it is participating in a trial CO2 capture and storage exercise in the Otway Basin.[102]

6.129 Dr Kelly Thambimuthu, CEO of the Centre for Low Emission Technology and Chair of the IEA greenhouse gas R&D program also told the committee that the process is well on the way to being proven:

> In fact, it has been practised in many different ways over about 20 years in relation to enhanced oil recovery. Currently, there are three major projects in the world that are actually capturing and storing in the order of three million tonnes per year of CO_2 underground. It is well on the path of being proven.[103]

6.130 The Cooperative Research Centre for Greenhouse Gas Technologies (CO2CRC), which researches the capture and geological storage of carbon dioxide for the purposes of greenhouse gas abatement, also told the committee that this technique has been used in a range of large-scale projects in Norway, Canada and Algeria and is planned for other projects such as the Gorgon project in Western Australia. Representatives also informed the committee that it is in the process of establishing a geosequestration research project in the Otway Basin in western Victoria, which is intended to sequester 50 million tonnes per year of CO2 over a 40 year project life.

6.131 CO2CRC representatives told the committee that their research had shown that in the chosen site, the costs of CO2 capture and storage would be in the range of $8.50 to $10.90 per tonne of CO2 avoided.[104]

Comments on GTL and CTL

6.132 The committee considers that from a technical perspective, both GTL and CTL technologies are capable of supplementing Australia's future transport fuels requirements, on a large scale if required. Both use technologies that are proven on a

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101 Sleipner natural-gas platform - CO2 separated from natural gas is re-injected.

102 *Committee Hansard (private briefing – Monash Energy)*, 29 June 2006, p. 7. (Mr Cochrane, CEO)

103 *Committee Hansard*, 30 June 2006, p. 45.

104 *Committee Hansard*, 11 August 2006, p. 17.

commercial scale – there are few unknowns, at least in relation to the gasification and liquids production processes. The resource base for both also appears to be sufficiently large for both to have a place, although this is less certain in relation to GTL. Nonetheless, even for gas, there are large undeveloped resources of stranded gas that may well lend themselves to developments of this kind, if technical obstacles such as processing gas in situ on offshore platforms can be overcome.

6.133 Both technologies offer the prospect of economic advantages, particularly in relation to adding value to resources, trade balances, employment and taxation revenue.

6.134 Further, the products they would produce are compatible with the current vehicle and machinery stock, and with existing distribution infrastructure. The synthetic diesel which both CTL and GTL proponents intend to produce is an ultra low sulphur product and thus has significant environmental advantages over conventional diesels, is ready for use, requires no further refining, and can be blended with conventional diesel. These are major advantages over other alternative fuel options.

6.135 Either technology will require very large capital investments if it is to provide a product stream of sufficient volume to replace fuels that would otherwise have to be imported. The difficulty associated with raising the capital required for such projects in the face of risks that are hard to predict and manage, such as the longer term price of oil, or in the case of GTL, the gas feedstock price, and the possibility of carbon pricing, should not be underestimated. However, this is probably true of any large scale fuel switching program.

6.136 Large scale projects of this type also require very long planning and construction lead times, of at least a decade. There are questions about whether market forces would be sufficient to enable the timely development of such projects, if for example oil supplies were constrained unpredictably by supply-demand imbalances or instability in oil producing countries.

6.137 Both technologies, but CTL in particular, suffer from a number of environmental disadvantages in relation to greenhouse gas emissions. Emissions at the conversion phase are higher than conventional fuels, and in a world that is becoming increasingly concerned about climate change, this cannot be disregarded. The committee notes that a great deal of work is being done on carbon capture and storage in this country and overseas, which if successfully implemented on a large commercial scale, may address this issue.

6.138 On the basis of the evidence the committee received, it appears that there are grounds for cautious optimism that carbon capture and storage technology has good prospects for success. However, the committee also notes the comments in the recently released IEA *World Energy Outlook 2006* that carbon capture and storage has not yet been demonstrated on a commercial basis.[105] The committee notes that the Government is providing financial support for developing and demonstrating this technology, which is likely to be of critical importance if CTL and GTL industries are to proceed in a CO2 constrained world. Demonstration on a commercial scale is essential, and must proceed as soon as possible.

Oil Shale

6.139 Oil shale is a 40 to 50-million year old sedimentary rock which contains a range of organic matter called kerogen. Kerogen is a precursor to oil that has not been subjected to the pressure and temperature regimes over geologic time that are required to transform it into crude oil. Some of the largest deposits of oil shale are located in the United States (in the upper Colorado River Basin), Brazil, Scotland, China, Estonia and Australia.[106]

6.140 Deposits of oil shale exist in the coastal strip between Proserpine and Bundaberg in Queensland. The Queensland Government and others have estimated that this area alone could possibly yield more than 4,629 gigalitres (or approximately 27.774 billion barrels) of oil – which is around 46 times Australia's initial crude oil reserves.[107]

6.141 There are, however, a number of economic, technological and environmental impediments to the commercialisation of oil shale as a future source of oil. Oil shale is surface-mined, and in its natural state does not contain any liquid hydrocarbons. It requires heating and distillation before the shale yields an oil-like product. This process is energy intensive, resulting in a high level of greenhouse gas emissions and other air pollutants such as hydrogen sulphide. The process is also reportedly water intensive.[108]

6.142 Although a number of attempts have been made to produce economically viable oil from shale, so far none have proved successful. The latest attempt to trial commercially viable oil-from-shale was by Southern Pacific Petroleum and its sister company, Central Pacific Minerals. Working on the Stuart oil deposits, the project produced trial quantities of shale oil using a new process developed by a Canadian company, Suncor, a company active in tar sands development.

6.143 The Stage 1 pilot plant began construction in 1998 and was designed to produce 4,500 barrels per day from 6,000 tonnes of shale (1.33 tonnes per barrel). The pilot project involved the shale being mined, crushed and fed into a four stage process which incorporated rotary kilns, similar to those used to manufacture cement. The process involved:

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105 IEA, *World Energy Outlook 2006*, p. 170.

106 Mr Brian Fleay, *Submission 74*, Appendix 2.

107 Queensland Government, *Submission 155*, supporting material, p. iii.

108 Queensland Government, *Submission 155*, supporting material, p. iii.

- a flash dryer operating at 150 degrees centigrade to reduce the moisture content to 8-10 per cent;
- heating to 250 degrees centigrade in a rotary kiln;
- heating to 500 degrees centigrade in another furnace to crack the kerogen to yield hydrocarbons as gases that are then distilled into products as in a normal refinery; and
- the remaining carbonised rock is ignited with oxygen to 750 degrees centigrade in another furnace that provides the heat for the preceding processes.[109]

6.144 A major impediment to the commercial viability of oil shale production is that the volume of overburden removed to access the shale is comparable to the volume of shale mined. In addition, the waste shale from the furnaces expands by approximately 10 per cent and the mine site is not large enough to receive the spent shale and returned overburden. If the project is operated on a large scale, this becomes a large and costly problem.[110]

6.145 Southern Pacific Petroleum, until quite recently, has been having difficulty raising the required funds and the project has effectively been on hold. In November 2006 however, a United States based company, Sandefer Capital Partners, indicated a willingness to advance A$51 million to the project:

> The money is earmarked for both working capital needs and upping the Stage 1 plant to its 4,500-bbl/d design capacity, as well as advancing design and development of Stage 2 – the 'commercial' stage – which would expand productive capacity to some 15,000 bbl/d (as per Suncor's original schedule).[111]

6.146 The committee sought information from several sources about the economics of shale oil production. Dr Brian Fisher, Executive Director of ABARE said that if CO2 emissions are internalised, the cost of producing shale oil is 'about $US70-$US95 a barrel, so shale oil is a long way out of the money at this stage.'[112]

6.147 Mr Lex Creemers, however, said that:

> … world wide only some 5-10 shale oil reserves could be considered economically viable at a price of $US40 per barrel back at 1986 prices… the good news for Australia was that four of those reserves are located in Queensland, so if there were to be any serious development of shale oil, chances are, it would take place here.[113]

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109 Mr Brian Fleay, *Submission 74*, Appendix 2.

110 Mr Brian Fleay, *Submission 74*, Appendix 2.

111 Article entitled *Cavalry Arrives to Help Stuart Project,* www.rigzone.com/news/article

112 *Committee Hansard*, 12 May 2006, pp 17 & 18.

113 Mr Lex Creemers, *Submission* 125, pp 2 & 3.

Committee comments on shale oil

6.148 The committee notes that shale oil could theoretically make a significant contribution towards meeting Australia's transport fuel requirements. However, there are formidable technical issues to be resolved before this is likely to take place. The committee particularly notes Dr Brian Fisher's assessment that shale oil is 'well out of the money at this stage'.

Chapter Seven

Supply side responses – Alternative fuels – Biofuels

Introduction

7.1 In Australia, the two biofuels that are commonly discussed as alternatives or supplements to conventional oil are ethanol and biodiesel. While these two fuels are the most commonly discussed in Australia, it should be noted that it is possible to produce a range of other possible fuels, for example synthetic diesels, methanol and DME, and there are research and demonstration projects in progress in a number of countries in relation to these fuels. This section of the report concentrates principally on the two mainstream biofuels, ethanol and biodiesel.

7.2 The report of the Biofuels Taskforce to the Prime Minister (August 2005), provides a reference point for all consideration of biofuels in the Australian transport fuels mix.

7.3 The terms of reference for the taskforce asked it to:

> … examine the latest scientific evidence on the impacts of ethanol and other biofuel use on human health, environmental outcomes and automotive operations; and
>
> On this basis, and taking into account the most recent economic analyses of fuel supply in Australia, assess the costs and benefits of biofuel production.[1]

7.4 The Taskforce was asked to examine:

- the findings of the December 2003 desktop study by the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Australian Bureau of Agricultural and Resource Economics (ABARE) and the Bureau of Transport and Regional Economics (BTRE) into the appropriateness of a 350 million litre (megalitre, ML) biofuels target;
- the findings of the Department of the Environment and Heritage study into the impacts of 10% ethanol (E10) and 20% ethanol (E20) on engine operation;
- other international and Australian scientific research on the health and environmental impacts of supplementing fossil fuels with oxygenates such as ethanol and other biofuel blends; and

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1 Australian Government Biofuels Taskforce, *Report of the Biofuels Taskforce to the Prime Minister*, August 2005.

- the economic and scientific bases upon which decisions have been made to support ethanol and other biofuel production in North America, Europe and other countries.

7.5 The committee regards this report as the current benchmark for all consideration of the possibilities of biofuels, and necessarily draws on it heavily throughout this section of the report.

Government initiatives in relation to developing a biofuels industry

7.6 The committee notes a number of government initiatives intended to contribute to the development of a biofuels industry. These include:

- the payment of production grants of 38.143 cents per litre (cpl) for fuel ethanol and biodiesel. These arrangements ensure that the effective rate of excise for biofuels is zero until 1 July 2011;
- capital grants for projects that provide new or expanded biofuels production capacity;
- a 50 per cent discount to alternative fuels entering the excise net under the recent reforms to the fuel excise system; and
- the establishment of the Ethanol Distribution Program, to commence from 1 October 2006. This program provides grants to encourage the development of facilities at services stations to sell ethanol blended petrol.[2]

Biofuels target

7.7 The committee notes that the Government has announced a Biofuels Target of 350 ML per year by 2010. This is about 6,000 barrels per day, which would be about 0.75 per cent of Australia's expected oil consumption by 2010 of 800,000 barrels per day.

7.8 Several submissions considered that this target was inadequate. CSR Ltd agreed that it was 'a start' but submitted that it was 'but a drop in the ocean', arguing that Australia needs to give serious consideration to how future transport fuel requirements will be met under a peaking oil scenario.[3]

7.9 Similarly, the Queensland Government, which urges the expanded use of alternative fuels in the Australian fuel market, including the range of fuels discussed elsewhere in this report as well as biofuels, maintained that the current target 'is not sufficient to stimulate large scale production and guarantee the future of the biofuels

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2 Department of Industry, Tourism and Resources, *Government Biofuels Initiatives*, at http://www.industry.gov.au/content/itrinternet/cmscontent.cfm?objectID=A9D9A207-0351-51FB-F20C287758203878, accessed 24 November 2006.

3 CSR Ltd, *Submission 148*.

industry'. The Queensland Government submitted that planned ethanol production in Queensland alone would account for the whole biofuels target.[4]

7.10 The Biofuels Taskforce considered that on current settings and consumer demand that it was unlikely that the 350 ML biofuels target would be met. The Taskforce held this view for a number of reasons, including an absence of consumer demand for ethanol blends and a lack of consumer confidence in the fuel; and commercial risk considerations for potential producers that are difficult to overcome.[5]

7.11 A number of submissions confirmed the Biofuels Taskforce assessment of a poor perception of ethanol by consumers. For example, the Australian Cane Growers' Council (ACGC) attributed this poor perception to media reporting of alleged vehicle damage caused by high percentage ethanol blends of up to 30 per cent. The ACGC noted that none of these allegations were ever substantiated.[6] Clearly however, overcoming this poor perception and indeed resistance to ethanol as a fuel, is a major obstacle to its wider adoption.

Why biofuels?

7.12 The arguments that are put forward for developing a more extensive biofuels industry that can make a significant contribution to Australia's transport fuel requirements have much in common with those advanced in relation to other alternative fuels. These include:

- energy security - biofuels are advanced as a means of supplementing fuel supplies if and when conventional petroleum supplies become constrained, and making Australia less dependent on imported oil;
- economic reasons, reducing the impact of oil imports on the future balance of payments;
- adding value to low value products; and
- for environmental reasons, biofuels being claimed to result in much lower greenhouse gas emissions as well as other atmospheric pollutants.

7.13 Regional development and employment benefits are also frequently advanced as reasons for supporting the development of a biofuels industry. For example, the ACGC submitted that:

> An ethanol industry, adding to the range of value adding opportunities for crops such as grains and sugar, would strengthen regional economies and provide additional employment. Each plant could create around 30 new

4 Queensland Government, *Submission 155*, p. 7.

5 Australian Government Biofuels Taskforce, *Report of the Biofuels Taskforce to the Prime Minister*, August 2005, pp 1 and 3.

6 Australian Canegrowers' Council, *Submission 36*, p. 3.

> permanent jobs and generate investment spending of around $80 million and operational spending of around $20 million a year.[7]

7.14 Similarly, the WA Farmers' Federation linked the establishment of ethanol and biodiesel to the opening up of other regional industries:

> The other side of a biofuels industry is that if you go to grain alcohol—we produce plenty of grain—and use canola to produce biodiesel, that opens up the ability for the agricultural areas to develop feed-lotting industries. Western Australia does not have the amount of feed lotting you do on the eastern seaboard. That would allow farmers an extra outlet for their grain. At the moment, we are highly export dependent and, from a social impact perspective, we would really appreciate some more inland industries. That is another industry that could be positioned inland. That is value added.[8]

Ethanol

7.15 Ethanol is used extensively as a fuel in some countries. Brazil, which mandates the use of 22-26 per cent ethanol - petrol blend, is the leading user of fuel ethanol, and it is also reasonably widely used in the United States. In Brazil, 70 per cent of new vehicle sales are 'flexi-fuel'.[9] Ethanol is currently produced in Australia from either sugarcane, generally using molasses as a feedstock, and from grain and grain residues.

7.16 Ethanol's use as a fuel in Australia is small scale. There is a statutory limit of 10 per cent by volume, introduced in 2003. It is now available in Australia as a petrol blend in some locations, most visibly marketed by BP Australia. A number of independent petrol retailers also sell ethanol blends, and Shell's premium fuel (now marketed as Shell V-power Racing) contains 5 per cent ethanol.

7.17 Several contributors to the inquiry questioned whether it is possible for ethanol to make a significant contribution to the fuels mix, arguing that the availability of competitively priced feedstocks which would allow ethanol to be produced at a price competitive with conventional fuels is a major limiting factor.

7.18 For example, Mr Brian Fleay submitted that:

> … the energy content of anhydrous ethanol from sugar and wheat would be a small fraction of the energy content of annual consumption of petroleum-based fuels, especially in drought years. While anhydrous ethanol from biomass is technically viable as a transport fuel it cannot be produced on a scale that replaces current petroleum products. Similar limits would apply

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7 Australian Canegrowers' Council, *Submission 36*, p. 8.

8 Committee Hansard, 12 April 2006, p. 95. (Mr DeLandgrafft)

9 Australian Canegrowers' Council, *Submission 36*, p. 2. Flexi fuel vehicles are designed to operate on a range of different ethanol blends, ranging from 0 to 85 per cent. They are available in Brazil, the United States, Sweden and the United Kingdom.

> to biodiesel. It is not remotely possible to divert much of these agricultural products to fuel production at the expense of food supply.[10]

7.19 The Australian Cane Growers' Council (ACGC), which argues for the wider use of this fuel, said that it was nonetheless possible to meet a relatively modest target. The ACGC submitted that it would be possible to produce enough ethanol using grains and molasses to meet a mandated target of 2 per cent ethanol in petrol, and that a higher 10 per cent target could be met but would require the diversion of higher value sugar products and grains.[11]

7.20 Similarly, CSR also suggested that it should be possible, but acknowledged that some feedstocks are either too valuable in their own right or impractical to use for ethanol production. CSR pointed to sorghum and wheat as the most likely economic feedstocks, concluding that a higher target could be met:

> Overall it would not be unrealistic to foresee sufficient bioethanol to satisfy a 10% national average blend from domestic production.[12]

7.21 The Biofuels Taskforce reported that proposed ethanol projects other than those of the three current commercial producers (Manildra, CSR and Rocky Point Sugar Mill) could theoretically increase ethanol production to 1,005ML by 2010.[13] This falls short of the quantity required to meet a 10 per cent ethanol target.

7.22 However, whether these levels of production could be attained reliably using grain or sugar by-products appears doubtful. The committee notes media reports that Australia will, for the first time in ten years, import grain to offset a national wheat shortage due to crop failure and will have to buy wheat on the international market to honour export contracts.[14]

7.23 Questions were also raised during the inquiry about whether the energy return on investment from ethanol was sufficient to justify the investment in its production, at least using current technology. For example, according to Emergent Futures, the most recent analysis of grain based ethanol has the farm to tank process producing only 1.36 units of energy for every 1 unit of fossil fuel energy used up.[15] Others have claimed that the return can be even lower.

7.24 A submission from Drs Hongwei Wu and Mike Ewing said that an analysis conducted by Dr Wu showed the return on corn-to-ethanol can be as little as 1.0.[16]

10 Mr Brian Fleay, *Submission 74*, Appendix 5.

11 Australian Cane Growers Council, *Submission 36*, p. 5.

12 CSR Ltd, *Submission 148*, p. 6.

13 Australian Government Biofuels Taskforce, *Report of the Biofuels Taskforce to the Prime Minister*, August 2005, pp 1 and 38.

14 Article published in Sydney Morning Herald, *Wheat imports loom as drought bites*, 15 November 2006, p. 3.

15 Emergent Futures, *Submission 117*, p. 21.

16 Dr Hongwei Wu and Dr Mike Ewing, *Submission 179*, p. 3.

These figures are disputed by some commentators. For example, the ACGC said that a review it had commissioned showed a return of up to 50 per cent (ie: return of 1.5); and that Brazilian studies showed a return of 8 to 1.[17]

7.25 Production of ethanol from cellulose (or lignocellulose), while not yet proven on a large commercial scale, offers the potential to greatly increase ethanol production and improve the return on energy invested.

7.26 This technology, which is the subject of considerable research both in this country and overseas, seeks to break down the cellulose portions of plants into a form that can then be fermented to produce ethanol. It opens up the possibility of a much larger feedstock becoming available, increasing potential productive capacity. A submission from an Australian research company, Microbiogen, argued that the sugar industry alone produces sufficient quantities of lignocellulose in the form of bagasse to produce enough ethanol to replace at least 10 per cent of the Australia's oil consumption.[18]

7.27 Microbiogen specialises in the development of yeasts that can digest a portion of plants that are currently impossible to ferment, hemicellulose (xylose). Dr Bell, the Manager of Research and Development of Microbiogen, told the committee that the company believed they were about 18 months from achieving their alcohol yield goals. Like a number of others, Dr Bell said that the lack of a market for ethanol, the inability to guarantee sales, is one of the principal factors holding back development of ethanol as a transport fuel.[19]

7.28 On the possibilities offered by lignocellulose ethanol, the Biofuels Taskforce had this to say:

> A new generation of technology offers the prospect of producing biofuels competitively and from more readily available lignocellulosic feedstocks such as wheat straw, grasses and wood waste. Given these prospects, and the International Energy Agency's (IEA) forecasts for a significant and continuing increase in global demand for biofuels, there would be value in a closer examination of this technology as a platform for a potential new industry for Australia.
>
> In addition, the Taskforce suggests that, given the potential for lignocellulosic ethanol to impact materially on the economics of the biofuels industry in the coming decade, further policy interventions based on current industry technologies and feedstocks should be limited, without a close assessment of the potential impact of ethanol made from lignocellulose.

7.29 The Taskforce concluded:

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17 ACGC, *Submission 36*, p. 8.

18 Microbiogen, *Submission 92*, p. 4.

19 *Committee Hansard*, 30 June 2006, pp 88-9.

> The Taskforce notes the potential for lignocellulosic ethanol technology to impact materially on the economics of the ethanol industry in the coming decade. Policy interventions based on current industry technologies and feedstocks should be limited without further assessment of the impact of lignocellulosic technology.[20]

7.30 The Biofuels Taskforce appears to consider that ligncellulose technology has the potential to make traditional ethanol technologies based on sugar by-products and grain redundant, hence its warning to 'consider carefully' new policy interventions to assist investment in production from current technology. The committee shares the Taskforce's views on this issue.

7.31 Techniques for producing ethanol using cellulose[21] are also claimed to achieve a much better energy return on energy invested than grain based ethanol. For example, Emergent Futures submitted that such techniques can produce up to 10 units of energy for every unit of fossil fuel energy used up[22] and the submission from Drs Hongwei Wu and Mike Ewing said that when based on mallee, the return on a fifty year cycle was 41.7.[23]

7.32 The question arises then as to whether lignocellulose is 'five to ten years away', or whether it is near-term. Microbiogen submitted that:

> The two challenges to commercialization of the lignocellulose to ethanol industry are being overcome and suggest the industry will be viable within 2 - 3 years.[24]

7.33 The committee notes that a Canadian company, Iogen Corporation, has signed an agreement with Petro-Canada to build a demonstration cellulose ethanol plant. This plant is expected to cost $C30 million and is expected to produce 3-4ML annually.[25] Iogen, Shell and Volkswagen have also signed a letter of intent to investigate the feasibility of establishing a lignocellulose ethanol factory in Germany.[26]

7.34 In an article published in Australian Forest Grower, Mr Alan Cummine claimed that an Australian company, Apace Research Ltd, had developed a version of

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20 Australian Government Biofuels Taskforce, *Report of the Biofuels Taskforce to the Prime Minister*, August 2005, pp 1 and 15.

21 Two possible routes are available – fermentation or gasification.

22 Emergent Futures, *Submission 117*, p. 21.

23 Dr Hongwei Wu and Dr Mike Ewing, *Submission 179*, p. 3.

24 Microbiogen, *Submission 92*, p. 5.

25 Australian Government Biofuels Taskforce, *Report of the Biofuels Taskforce to the Prime Minister*, August 2005, pp 1 and 44.

26 http://www.iogen.ca/key-mesages/overview/m4-fuels-vehicles.html, accessed 9 November 2006.

this technology to the pilot plant phase in the 1990s, and that the plant was 'still awaiting adequate government and industry support' to demonstrate the process.[27]

Environmental impacts of ethanol as a transport fuel

7.35 There are two key criteria against which the environmental performance of ethanol used as a transport fuel can be assessed. These are effects on air quality; and greenhouse gas impacts. The Biofuels Taskforce report sums up the state of knowledge on the effect on non-CO2 emissions that affect air quality as follows:

- There is considerable uncertainty about effects of fuel ethanol on air quality. Prima facie evidence exists that E10 may significantly reduce fine particulate emissions.
- More smog-chamber research is needed to understand properly the effect of adding ethanol to petrol on secondary organic aerosol formation.
- Emissions of CO are reduced under E10 compared with neat petrol, there is little change in volatile organic compounds emissions, and NO_x emissions are increased.
- The impact on air toxic levels in the atmosphere from the use of E10, relative to petrol, is difficult to assess. Combustion of E10 results in lower tailpipe emissions of some toxic compounds (e.g. benzene and 1,3 butadiene), but higher levels of others (e.g. the aldehydes).[28]

7.36 The Taskforce considered that a properly designed Australian in-service vehicle emission (tailpipe and evaporative) study, combined with an air quality monitoring programme and including health risk assessment, would be required to assess the air quality impacts of biofuels more effectively. It also considered that there is a need to carry out extensive experimental work to evaluate the impact of E10 and E5 on particulate emissions from petrol vehicles under Australian conditions. Further, the Taskforce considered that more smog-chamber research is needed to understand properly the effect of adding ethanol to petrol on secondary organic aerosol formation.[29]

7.37 The use of ethanol as a transport fuel is also claimed to have significant greenhouse gas benefits. Whether this is the case will depend on the source of the ethanol, whether its production processes result in a positive or negative energy return on the energy invested in the production process, and the proportion of ethanol used in the fuel mix.

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27 Alan Cummine, *Ethanol history being ignored at our cost*, Australian Forest Grower, Autumn 2003.

28 Australian Government Biofuels Taskforce, *Report of the Biofuels Taskforce to the Prime Minister*, August 2005, pp 1 and 69.

29 Australian Government Biofuels Taskforce, *Report of the Biofuels Taskforce to the Prime Minister*, August 2005, pp 1 and 69.

7.38 According to the Biofuels Taskforce report, savings from E10 in greenhouse gas emissions over neat petrol are generally from 1 per cent to 4 per cent , depending on feedstock. It noted that a recent life-cycle analysis for a proposed ethanol plant has suggested that savings of between 7 per cent and 11.5 per cent can be achieved with optimum use of non-ethanol co-products.

7.39 Other publications make more extensive claims in relation to the CO2 benefits. For example, the Iogen Corporation compares the CO2 emissions of a Toyota Prius hybrid vehicle running on conventional petrol, and producing 115g of CO2 per kilometre, with those of a Ford Focus (a 4 cylinder small car of comparable size) flexible fuel vehicle operating on cellulose E-85. The Focus produces less than half the CO2 of the Prius, 40g per kilometre. Iogen concludes that:

> Running any of the many flexible fuels vehicles on cellulose ethanol e85 is one of the most cost effective ways to reduce greenhouse gas emissions in transport.[30]

Economics of ethanol as a transport fuel

7.40 The oil price at which ethanol is competitive with conventional petrol will vary widely according to the level of government assistance by way of producer grants and excise concessions, the exchange rate, the cost of feedstocks, the efficiency of production processes and the technology employed.

7.41 Information provided by the ACGC indicated that ethanol could be produced from conventional sources (grain, molasses) for between 60 and 70 cents per litre. This could rise to between 75 and 80 cents if higher value feedstocks were used. The ACGC cautioned that these were indicative costs only.[31]

7.42 The ACGC provided the committee with useful information about the price competitiveness of ethanol at different oil prices, and with the effect of changing excise regimes built in. These showed that ethanol can compete with petrol on price at $US50 per barrel of crude oil and at an exchange rate of $US0.75/$AUD. However, this picture changes when the long-run oil price predictions are taken into account and the Government's excise changes come into effect.

7.43 The ACGC said that at a long run oil price of $35 and exchange rate of 65 cents, the current excise regime 'may provide opportunities for ethanol production from grains and molasses, but would make production from sugar streams marginal.' When the excise changes come into effect, ethanol from grain and molasses may be in a 'reasonably competitive position' but other feedstocks would be uneconomic. The ACGC pointed out that domestic ethanol producers would have to compete on equal

30 http://www.iogen.ca/key-mesages/overview/m4-fuels-vehicles.html, accessed 9 November 2006.

31 ACGC, *Submission 36*, pp 4-5.

terms with imports from 2011, which would make capital investment in production facilities difficult.[32]

7.44 The ACGC's views corroborate reasonably well with the views of the Biofuels Taskforce:

> At a long-term exchange rate of US65c, the long-term world price of oil (West Texas Intermediate) would need to average US$42-47/bbl in 2004 dollars (depending on the feedstock used) for new ethanol producers to be viable post-2015 without assistance.[33]

7.45 In relation to lignocellulosic production, it is difficult to predict the price at which a full size commercial plant could produce ethanol. Drs Wu and Ewing cited an Enecon 2002 study which indicated that current cellulosic ethanol production could produce ethanol for 82 cents per litre in a 200ML plant, with a woody feedstock cost of $30/green tonne delivered.[34]

7.46 Consideration of the economics of ethanol production also requires examination of the effects that such an industry, if adopted on a large scale, would have on competing users of feedstocks, particularly grain.

7.47 The Livestock Feedgrain Users Group (LFUG) was amongst those who raised serious concerns about a grains based ethanol industry and the impact it would have on their industry:

> We are opposed to the ongoing subsidisation of grain based ethanol in Australia; this will disadvantage our grain dependent industries, and result in the propping up of an essentially non viable industry at the expense of successful industries.
>
> …
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> Subsidised ethanol plants may, in the short term create regional grain shortages, and force up local prices as grain has to be freighted in for livestock customers. This instability would be accentuated in drought years, and is at the heart of our opposition to ethanol subsidies.[35]

7.48 The fundamental objection of the LFUG to ethanol industry assistance is that the livestock industry is required to compete for a limited amount of grain against an industry that enjoys a subsidy. The LFUG submitted that they did not object to an ethanol industry developing, but that after 2011, it should be required to compete on its own merits, without subsidy:

> … current ethanol subsidies, in particular the ethanol excise concession, should run their course. If the ethanol industry has not responded to this

32 ACGC, *Submission 36*, pp 6-9.

33 Australian Government Biofuels Taskforce, *Report of the Biofuels Taskforce to the Prime Minister*, August 2005, conclusion 28, p. 18.

34 Dr Hongwei Wu and Dr Mike Ewing, *Submission 179*, p. 3.

35 Livestock Feedgrain Users Group, *Submission 55*, p. 3.

> support by 2011, and cannot compete with imported product subsequently, it is not a viable transport fuel option for Australia, at least on a large scale basis.[36]

7.49 The Biofuels Taskforce also acknowledged the potential for adverse effects on feed grain prices, and that there is the potential for costs to be imposed on other parts of the economy.[37]

7.50 Even if the ethanol industry is able to become competitive against the petrol price in its own right, and new technologies for producing it become commercially viable, increasing its attractiveness both on environmental and economic grounds, it appears that there are, nonetheless, quite significant barriers to the growth of the industry. Without this necessary growth, it will be difficult for it to make a significant contribution to the transport fuels mix.

Barriers to growth

7.51 Several of the barriers to growth of the ethanol industry have already been covered in part in this section of the report. The most significant barrier appears to be commercial risk for organisations contemplating establishing ethanol production facilities and for retailers. This risk arises at least in part out of a lack of a ready market for the product. Unlike some other countries, there is a limited market for ethanol as a fuel in Australia, and consumer resistance to using it. This is despite widespread assurances that almost all cars can use E10 without modification.

7.52 The Biofuels Taskforce addressed this issue comprehensively, explaining the nature of the 'chicken and the egg' dilemma the development of the industry faces:

> A key barrier cited by stakeholders is the high level of commercial risk associated with market entry, particularly for ethanol. Low consumer confidence in ethanol means low demand, especially with no significant price advantage to the consumer. Consequently, the oil majors are reluctant to enter off-take contracts with ethanol suppliers. Without such contracts, prospective producers cannot get investment backing. The majors also have first mover concerns—the first company making a significant commitment to E10 could be seriously disadvantaged if confidence issues are not resolved.
>
> …
>
> The Taskforce considers there are real and significant commercial risks associated with market entry, facing both fuel suppliers and biofuel producers.
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> For the oil majors, the Taskforce considers that, at present, there is little commercial incentive for them to develop a mainstream bulk market for ethanol blend fuel and, in the absence of some form of intervention

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36 Livestock Feedgrain Users Group, *Submission 55*, p. 4.

37 See conclusions 29 and 30, pp 18 and 19.

> designed to improve confidence and reduce commercial risks, there will be at best, continuation of small, trial-based marketing of fuel ethanol by the oil majors.[38]

7.53 Evidence received by the committee illustrated some of the costs and risks to fuel companies introducing ethanol into their fuel blends. For example, BP explained that getting a supply of anhydrous ethanol[39] suitable for blending required some quite counter-intuitive logistics:

> At this stage it is not cheap for us. It is low volume and the actual logistics are quite difficult. We get virtually all our product from CSR in Mackay and it has to be shipped down to Melbourne for drying and then shipped back to Brisbane. It is trucked out into sites in Brisbane and, I think, up to Mackay. A lot of it ends up about 20 miles from where it started. As you can appreciate, that is not exactly an ideal way of doing it…[40]

7.54 Similarly, Shell explained that uncertainty of price trends for both petrol and ethanol represented a risk:

> Of these, the price fluctuations of the commodities ethanol and petrol are the most difficult to manage. Future scenarios where companies are committed to ethanol blends and the ethanol price becomes more expensive than petrol represent a significant risk.

7.55 Shell also described the additional costs of selling ethanol blends:

> There are significant costs associated with the blending, distribution and sale of biofuels – particularly ethanol. Terminal costs depend on the size of installation and cover storage tanks, modified firefighting equipment, linework, pumps and gantry loading arms. Retail site costs incorporate additional tank testing (due to ethanol's propensity for water), filters and branding and signage.[41]

Committee comments on ethanol

7.56 The committee is supportive of the development of an ethanol industry in Australia, but notes the very significant barriers that need to be overcome before it becomes a mainstream fuel.

7.57 Lignocellulose ethanol production is the only realistic way that the industry can become more than a niche player. If large scale production of ethanol using a feedstock that is available in volume becomes commercially feasible in the medium

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38 Australian Government Biofuels Taskforce, *Report of the Biofuels Taskforce to the Prime Minister*, August 2005, p. 13.

39 Ethanol produced by distillation still contains a small percentage of water which cannot be removed in the distillation process. This must be removed before blending. Ethanol with the water removed is referred to as anhydrous ethanol.

40 *Committee Hansard*, 29 June 2006, p. 37.

41 Shell Australia, *Submission 181*, p. 14.

term, and the fuel proves to have the environmental benefits claimed for it, it could make a worthwhile and sizeable contribution to Australia's transport fuel requirements.

7.58 The committee notes and agrees with the Biofuels Taskforce comment to 'consider carefully' new policy interventions to assist investment in production from current technology.

7.59 The committee does not consider that there is any point at this time in mandating a minimum percentage of ethanol in petrol. Unless lignocellulose technology becomes viable with unexpected speed, supply will not be sufficient to produce the necessary quantities of fuel.

7.60 While the Committee notes that several of the oil companies, (particularly BP and to a lesser extent, Shell) have taken some measures to introduce ethanol into some of their fuels, the committee is unconvinced that all of the companies take the biofuels target set by the government seriously.

7.61 The committee also notes the relevant comments of the Biofuels Taskforce in relation to what is stopping progress towards attaining the biofuels target:

> • Oil companies in a highly competitive market, with no forcing regulation or long term economic incentive, have no commercial reason to surrender market share to others – whether to other oil or biofuels suppliers.

and

> • Under current market conditions, and with no consumer demand, oil majors have little commercial incentive to promote ethanol blends as a bulk fuel. But without contracts for sales to oil majors, new ethanol producers cannot invest in bulk fuel ethanol production.[42]

7.62 The Committee considers that there is a need to increase transparency in relation to whether or not these targets are being met, and by whom.

Recommendation 3

7.63 **The Committee recommends that the Government publish the results of its review of progress made towards meeting the biofuels target of 350ML per year, including which companies are meeting the target.**

Recommendation 4

7.64 **The committee recommends that the Government examine the adequacy of funding for lignocellulose ethanol research and demonstration facilities in Australia, and increase funding, where appropriate.**

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42 Australian Government Biofuels Taskforce, *Report of the Biofuels Taskforce to the Prime Minister*, August 2005, p1.

7.65 The committee suggests that the Government establish a high level interdepartmental committee consisting of representatives from the Departments of Prime Minister and Cabinet, the Treasury and the Department of Industry, Tourism and Resources and other relevant agencies to closely monitor the development of this technology in Australia and overseas, and to develop both options to facilitate research in Australia into this technology, and a range of programs that could be rapidly deployed to ensure a market for the fuel develops when it is appropriate.

Biodiesel

7.66 Biodiesel is a diesel-like fuel produced by chemically modifying vegetable oils or animal fats. It may be manufactured from a range of feedstocks including waste cooking oils, oil seed oils such as canola, from palm oil and from many other oil producing plants, some suitable for human and animal consumption, and some that are unsuitable but which may be grown because of the high yield of oils that can be extracted from them.

7.67 Biodiesel may also be produced by more advanced biomass gasification processes, using the same Fischer Tropsch process used to produce synthetic diesel from gas or coal, but as far as the committee is aware, this process is not under consideration in this country at this stage (with the possible exception of using biomass mixed with coal).

7.68 A limited amount of biodiesel is produced in Australia but it is not available at the retail level, except in a small number of locations. BP plans to market a diesel blend that is formulated in part (5 per cent) from a hydrogenated tallow product. According to Gardner-Smith holdings, production has increased from 4ML in 2003-04 to 14ML in 2004-05, and was projected to be more than 150ML in 2005-06.[43]

7.69 Biodiesel can be readily blended with conventional diesel, in which case it is sold using a classification that describes the proportion of biodiesel (eg: B20), or it may be used straight (B100). Blends of 5 per cent or less are classified in Australia as diesel.

7.70 Biodiesel proponents commonly claim that it is compatible with most diesel engines, although many manufacturers will not honour engine warranties if the proportion of biodiesel exceeds B5, and some will not allow it at all. The only exception to this in the light vehicle market is Peugeot, which will permit the use of up to B30, subject to the appropriate fuel standard being met.[44]

7.71 The committee notes that a useful examination of the use of biodiesel in cars and trucks is contained in Bureau of Transport and Communications Economics, *Alternative Fuels in Australian Transport*, Information Paper No. 39, 1994, Chapter 6.

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43 Gardner-Smith Holdings, *Submission 185*, p. 4.

44 http://www.peugeot.com.au/PEUGEOT/AU/me.get?site.home&FFFF1765

Biodiesel was also discussed comprehensively in the Report of the Biofuels Taskforce.

7.72 As in the case of ethanol, the Government has provided support to assist the new industry to develop. The support provided is described above in paragraph 7.6. A key part of this support is the payment of production grants of 38.143 cents per litre, which ensure that the effective rate of excise for biodiesel is zero until 1 July 2011. The future viability of the industry appears to be heavily dependant on continued Government support. The Biofuels Taskforce considered that between 2010 and 2015, biodiesel is likely to become commercially unviable.[45] Gardner Smith acknowledges the need for continuing Government support for the industry to survive in its submission:

> In order for the bio diesel industry to develop Gardner Smith (Holdings) Pty Limited believes it is essential for the government to play a significant role. Factors that need to be considered when assessing the viability of biofuels, … include:
>
> • government support for the industry to ensure the price of bio diesel remains competitive with more traditional petroleum and diesel; …[46]

7.73 The Queensland Farmers Federation, a biofuels proponent, comprehensively summed up the economic challenges faced by the biodiesel industry if there is no on-going support from Government:

> However, the production costs of biodiesel are such that is even further away from being economically viable than ethanol without substantial continuing subsidies or mandates. ABARE estimates that without subsidies, the estimated cost of producing biodiesel in new facilities using used cooking oil is 18c/L above, and using tallow is 24c/L above, the long-term energy equivalent benchmark price for biodiesel against petrol. To be commercially viable (and achieve a 7% return on capital) over the longer term, ABARE has identified that biodiesel produced from used cooking oil would require a fuel tax subsidy of 21c/L and tallow-based biodiesel would require a fuel tax subsidy of 32c/L in nominal terms over the longer term. These estimates compare with the current fuel tax subsidy of 19.1c/L.[47]

Effect of fuel tax changes

7.74 Recent changes to the fuel taxation system included in the *Fuel Tax Act 2006* have reportedly had an adverse impact on the prospects for the future development of the industry. These changes do not appear to have been foreseen by the industry, despite the report of the Biofuels Taskforce warning of their impact.[48] The effects of

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45 Australian Government Biofuels Taskforce, *Report of the Biofuels Taskforce to the Prime Minister*, August 2005, p. 1.

46 Gardner-Smith Holdings, *Submission 185,* p. 11.

47 Queensland Farmers Federation, *Submission 120*, p. 18.

48 See pp 13-14 of report.

the changes were explained in evidence at a public hearing by Mr Lake of the Biodiesel Association of Australia:

> The changes to the treatment of biodiesel under the new tax excise regime mean that from 1 July 2006 there will be a severe impediment to biodiesel production. This has the effect of making biodiesel more expensive than diesel.[49]
>
> …
>
> Under the current system with the combination of the producer grant and the effect of the offset of excise, and also the energy grants credits and other schemes available for biodiesel and all other alternate fuels, the new bills which are to be enacted as of 1 July effectively reduce and wipe out the energy grants credit offset in a very short time frame. The way the tax system is evaluated effectively puts an additional 38c for all on-road and off-road applications for biodiesel. I have with me a copy of a paper… which shows the change in [balance], where biodiesel in an establishing market can be a cost benefit at the moment and, as of next month, there will be a cost penalty to adopt it. For the case of on-road applications that penalty is anywhere from about 10c. By 2015 it goes up considerably. For off-road applications it is effectively the full excise rate.[50]

7.75 Mr Humphreys of the Biodiesel Association elaborated:

> Let me give you, if I may, two examples of the impact of the changes that you rightly refer to. Let us do an on-road with a trucking company and off-road with a farming situation. Today, if a farmer buys biodiesel, he can claim the excise for that biodiesel back providing he or she does not blend greater than 49 per cent. So providing you have a fuel mix that does not exceed B49—that means 51 per cent fossil and 49 per cent biodiesel—they can claim back the full 38c on that fuel blend, as if it were classed as a diesel. As of 1 July with the legislation before parliament as currently written that disappears. They cannot claim anything back on the biodiesel as of 1 July because of an interpretation that says as of 1 July you can only have a user grant—that is, the refund of the excise—on the net tax paid. The net tax paid is actually the killer statement…[51]

7.76 The key issue for the biodiesel industry in the Fuel Tax Act changes appears to be that the payment of a producer grant under the *Energy Grants (Cleaner Fuels Scheme) Act 2004* is taken to have extinguished the fuel tax liability. This means that the purchaser of biodiesel whose producer has received a grant cannot claim a fuel tax credit.

7.77 The committee notes evidence tendered to the Senate Economics Legislation Committee during its inquiry into the then bill in the form of a quotation from a letter

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49 *Committee Hansard*, 9 June 2006, pp 39-40.

50 *Committee Hansard*, 9 June 2006, p. 41.

51 *Committee Hansard*, 9 June 2006, p. 41.

written by the former Assistant Treasurer, the Hon. Mal Brough MP, to Dr Humphreys of the Australian Biodiesel Group:

> The cleaner fuels grant was not intended as a stimulus package for the biodiesel industry.[52]

7.78 While sympathetic to the dilemma in which the industry finds itself as a result of the fuel tax changes, the committee notes that the benefit previously enjoyed by the industry is considered by the Government to have been a loophole. Nonetheless, it serves to illustrate the relatively precarious economics of biodiesel production in Australia.

Biodiesel production in Australia

7.79 Biodiesel is currently produced in Australia from used cooking oils and animal fats (tallow). Some plants are also being built that will use imported feedstocks, mainly palm oil. Natural Fuels Australia (NFA) is currently constructing a plant in Darwin with the capability of producing 147ML of biodiesel per year.[53]

7.80 Like conventionally produced ethanol, future biodiesel production will be limited by the availability of affordable feedstocks. Unlike ethanol, for which production from cellulose looks to be on the near horizon, biodiesel does not appear to have a cost competitive alternative method of making the fuel in development.[54] It is thus dependent on oil bearing vegetable matter like seeds and palm.

7.81 Biodiesel proponents acknowledge that one of the major challenges facing the industry is obtaining enough of the right source of fats and oils. However, the Biodiesel Association (BDA) maintains that there is 'more than enough available in Australia to well exceed the current goal of 350ML...'[55]

7.82 The BDA told the committee that biodiesel production facilities planned for construction over the next two years would have a production capacity of more than 700ML/year, and that this capacity would use all of the used cooking oil collected and a large proportion of the tallow available. The BDA said that if the industry is to grow further, new sources of supply are needed.[56]

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52 Quoted from para 3.78 of the Report of the Senate Economics Legislation Committee into the Fuel Tax Bill and a related bill, 14 June 2006.

53 Natural Fuels Australia, *Submission 95*, p. 1.

54 The committee acknowledges the possibility of producing biodiesel through gasification technology, but notes the assessment of the U.S. Energy Information Administration that biomass-to-liquids plants have high capital and operating costs, and their feedstock handling costs are especially high. Further, BTL gasifiers are significantly more expensive than those used in GTL and CTL. Source: Energy Information Administration Annual Energy Outlook 2006, p. 45.

55 See for example Biodiesel Association of Australia, *Submission 68*, p. 4.

56 Biodiesel Association of Australia, *Submission 68*, p. 4.

7.83 The BDA maintained that there are large areas of Australia that receive high rainfall, but which are unsuitable for conventional agriculture. The BDA maintains that if an area equivalent to canola currently planted could be used for producing non-food crops, up to 15 per cent of Australia's diesel requirements could be met, with a multi-billion dollar improvement in the balance of payments.

7.84 NFA also acknowledged the difficulty in obtaining feedstock, and the difficulty of competing for oil seeds that are also required to meet domestic food requirements:

> Currently, Australia has a total edible oil requirement of around 400,000 tonnes per year, which can barely be met from local seed crushing capacity. A small proportion (28,000 tonnes) is exported. The climatic and soil conditions, plus the lack of copious water supply in most parts of the country, seem to work against the agronomy of high oil bearing seed crops. The advent of new varieties and more research might change this in time, but for the moment, biodiesel producers will have to look to imports to help satisfy their needs.[57]

7.85 Gardner-Smith also submitted that it would be necessary to import fats and oils to supplement the domestic supply, as an 'interim measure'. These imports would be palm oil and soya oil. The use of such oils has been a cause for concern by some commentators, because of the possibility of tropical forests being turned into palm oil plantations, and the displacement of crops otherwise intended for human and animal food. Both RFA and Gardner-Smith were somewhat defensive about this, advising the committee that they are members for the Roundtable for Sustainable Palm Oil, and the Roundtable on Responsible Soy.[58]

Environmental implications of biodiesel use

7.86 Biodiesel is claimed to be an environmentally benign fuel, particularly in relation to reduced greenhouse gas emissions. One of its major advantages is that it is wholly biodegradable. According to Gardner-Smith, it has particular applications in the marine industries, as spills have no environmental effects because the fuel is wholly biodegradable.[59]

7.87 The fuel also results in significantly lower emissions of most pollutants except NOx. The committee notes the conclusion of the Biofuels Taskforce in relation to air pollutants:

> **Conclusion 18:** The benefits of the 5% biodiesel blend (B5) diminish against increasingly lower sulphur diesel, with PM [ie particulate matter] emissions even increasing slightly over XLSD [extra low sulphur diesel] (to be introduced in 2009). However, on life-cycle analysis, pure biodiesel

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57 Natural Fuels Australia, *Submission 95*, p. 2.

58 Gardner-Smith Holdings, *Submission 185*, p. 4.

59 Gardner-Smith Holdings, *Submission 185*, p. 4.

> (B100) has significant benefits over XLSD for CO, VOC [non-methane volatile organic compounds] and PM (especially with waste cooking oil as the feedstock), but NOx emissions increase by between 16% and 30%.[60]

7.88 Biodiesel is also acknowledged as associated with lower greenhouse gas emissions than conventional diesel. The extent of the benefit varies according to the blend used, and also the feedstock. Some feedstocks (eg canola) are associated with significant CO2 emissions during the production process, and a full life cycle analysis is needed to give the true picture of these emission levels. Nonetheless, the Biofuels Taskforce concluded that there were benefits:

> **Conclusion 19:** On life-cycle analyses, B100 from waste cooking oil produces 90% less greenhouse gas emissions than XLSD. Biodiesel from tallow or canola reduces emissions by 23% and 29%, respectively. There are negligible benefits for canola or tallow derived B5 against XLSD, though waste cooking oil achieves a 3% reduction.[61]

Committee comments on biodiesel

7.89 The committee considers that biodiesel can make a small scale but worthwhile contribution to Australia's fuel mix. In the absence of the development of a biodiesel equivalent to lignocellulose technology, the industry will be limited by the availability and price of feedstocks. There are significant environmental benefits associated with its use, but the economics of the industry are at best precarious, particularly if government assistance is reduced, as is the current policy.

Committee comments on alternative fuels in general

7.90 If alternative transport fuels are to successfully replace or supplement conventional oil to any significant degree, massive investment in large scale production will be essential, regardless of whether these fuels are to be derived from biomass or fossil sources.

7.91 This investment is seen as risky by corporations contemplating development of alternative fuel industries, for a number of reasons. All are more expensive than conventional oil, and thus the long term oil price constitutes a source of risk. Some technologies face uncertainties about the price of feedstocks and the price of carbon. (This will affect the economics of processes such as CTL that create significant emissions in the conversion process) Some such as fuel ethanol face difficulties associated with consumer acceptance and marketing the product. In the absence of

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60 Australian Government Biofuels Taskforce, *Report of the Biofuels Taskforce to the Prime Minister*, August 2005, p. 86.

61 Australian Government Biofuels Taskforce, *Report of the Biofuels Taskforce to the Prime Minister*, August 2005, p. 89.

mandatory targets, there is little incentive for the oil companies to sell these fuels, even if available in quantity.

7.92 Additionally, all large scale projects involve long lead times before they attain production. In the case of some projects which the committee has discussed in the preceding chapters, these lead times can be ten years or more. This adds to the risk profile for prospective investment.

7.93 Unless companies can control or quantify the nature of the investment risks they face, investment will not be forthcoming. As has been seen in the case of failed GTL projects in Western Australia, it is difficult to get projects to a point where they are judged sufficiently commercially viable. Equally, there are anecdotal reports of investment in ethanol production being held up because of difficulties in finding a market.

7.94 The committee considers that there is a need for the Government to develop strategies for addressing the risks that prospective investors in new fuel technologies face, to ensure that timely investment occurs. As noted at paragraph 6.136, there are serious questions about whether market forces will operate in a way that will ensure the timely development of such projects.

7.95 The committee further considers that the issues of long term sustainability of alternative fuels must be addressed, particularly from the perspective of climate change.

Recommendation 5

7.96 **The committee recommends that the Government commission a research group within the Department of the Treasury to identify options for addressing the financial risks faced by prospective investments in alternative fuels projects that are currently preventing such projects from proceeding. This group should determine how these risks might be best addressed in order to create a favourable investment climate for the timely development of alternative fuel industries, consistent with the principles of sustainability and security of supply.**

Chapter Eight

Demand side responses

8.1 Demand side responses to reduce oil dependence have two main strands:

- improving the fuel-efficiency of vehicles; and
- reducing the demand for fossil-fuelled transport (or at least, restraining its growth). Under this heading, the main ideas mentioned in submissions were congestion charges to improve the efficiency of urban road use; encouraging walking, cycling and public transport in cities; promoting urban planning policies that reduce the need to use cars; and encouraging more use of railways for long-distance freight.[1]

8.2 Demand side responses can also serve other goals, such as controlling urban congestion and pollution, and reducing greenhouse gas emissions.

Increasing the fuel efficiency of vehicles

8.3 Fuel efficiency improvements are the most important demand side measure, because road transport dominates oil use. Modelling by ABARE suggests that more rapid uptake of fuel-efficient transport technologies, including more efficient engines and electric or hybrid electric vehicles, could significantly reduce the rate of growth of oil consumption in APEC countries.[2]

8.4 Since 1979 the fuel efficiency of light vehicle engines has improved significantly - from about 5 to 4 litres per 100km per vehicle tonne. However the efficiency of the Australian light vehicle fleet has improved more slowly, as consumers have moved to larger, more powerful vehicles. During the 1990s the fuel efficiency of passenger cars continued to improve slowly, but the fuel efficiency of the passenger fleet as a whole showed no further improvement, because of the increasing sales of heavier all terrain wagons (four wheel drives). As a proportion of new light vehicle sales these increased from below 3 per cent in 1979 to 15 per cent in 2001.[3] [4]

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1 For a concise discussion of these matters see also Productivity Commission, *The Private Cost Effectiveness of Improving Energy Efficiency*, 2005, pp 239-272.

2 Australian Government, *Securing Australia's Energy Future*, Dept of the Prime Minister and Cabinet, 2004, p. 137. ABARE, *Submission 166*, p. 9.

3 BTRE information sheet 18, *Fuel consumption by new passenger vehicles in Australia*, 2001.

8.5 The International Energy Agency, commenting on this trend, argues that 'governments can play an important role by introducing fuel efficiency regulations':

> Car manufacturers can use technological advances in vehicle design either to increase the power and performance of the vehicle or to improve its fuel efficiency. Often these aims conflict, with power improvements damaging fuel efficiency. Market forces often favour increased power. Governments can play an important role by introducing fuel efficiency regulations to force automakers to devote new technology to improving fuel efficiency.[5]

8.6 The Bureau of Transport and Regional Economics (BTRE), writing in 2002, warned that the growth of four wheel drive sales would continue to put upward pressure on fleet fuel consumption:

> Even if the ATW [all terrain wagon] share of new *sales* stabilises immediately at 15 per cent, the current share of ATWs in the *fleet* will continue to rise from the present 8 per cent, with consequent upwards pressure on fleet fuel consumption… The desire of an increasingly affluent population for vehicle characteristics that increase fuel consumption… has meant that potential reductions in fuel consumption made possible by technological advances have not been fully realised. This is a world-wide trend in the automobile sector, and it cautions against undue optimism about realising reductions in fuel use and emissions stemming from technological change.[6]

8.7 As reported in 2002 (which is the most recent BTRE information), the Australian National Average Fuel Consumption (NAFC) of new passenger cars in 2001 was 8.28 litres/100km; for all terrain wagons about 11 litres/100km, and for the light vehicle fleet as a whole about 9 litres/100km.[7]

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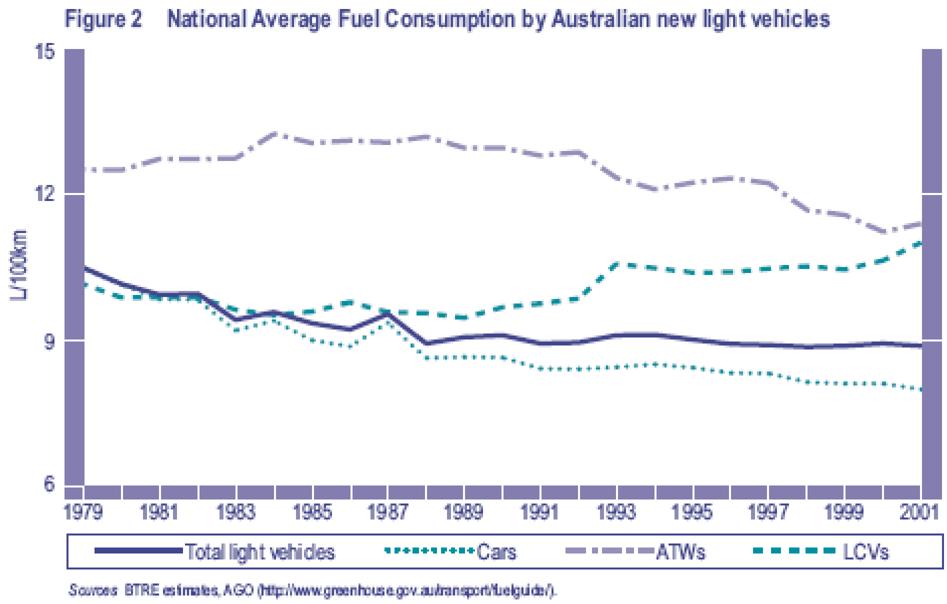
4 This mirrors experience in the USA, where there is a mandatory corporate average fuel economy (CAFE) standard for passenger cars, and a lower standard for 'light trucks' (sports utility vehicles). As the market penetration of light trucks for passenger use has grown, the fuel efficiency of the US light vehicle fleet as a whole has worsened steadily since 1988, and now stands at about 24 miles per gallon (9.8 litres per 100 km). Pew Centre on Global Climate Change, *Comparison of Passenger Vehicle Fuel Economy and Greenhouse Gas Emission Standards Around the World*, 2004, p. 7.

5 International Energy Agency, *World Energy Outlook 2006,* p. 226.

6 BTRE information sheet 18, *Fuel consumption by new passenger vehicles in Australia*, 2001.

7 BTRE information sheet 18, *Fuel consumption by new passenger vehicles in Australia*, 2001. Australian Automobile Association, *Submission 151,* p. 10.

Figure 8.1 – Fuel consumption of Australian new light vehicles
ATW = all terrain wagon. LCV = light commercial vehicle



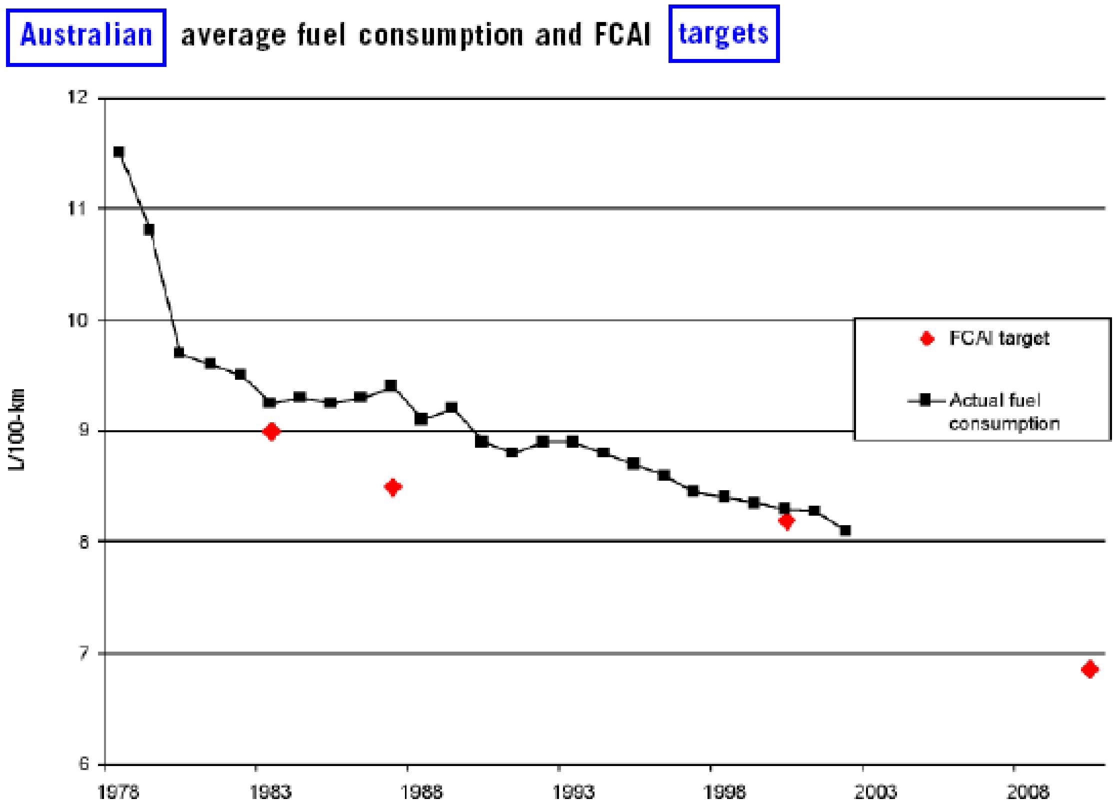
Source: Bureau of Transport and Regional Economics, information sheet 18, *Fuel consumption by new passenger vehicles in Australia*, 2002

FCAI[8] *code on reducing fuel consumption of new passenger cars*

8.8 Over the years there have been several voluntary industry codes of practices aiming to reduce fuel consumption of new passenger cars. Codes in operation from 1978 to 1987 and from 1996 to 2001 achieved significant improvements, although they did not meet their targets:

8 Federal Chamber of Automotive Industries

Figure 8.2 – Fuel consumption of Australian new passenger cars, and FCAI targets

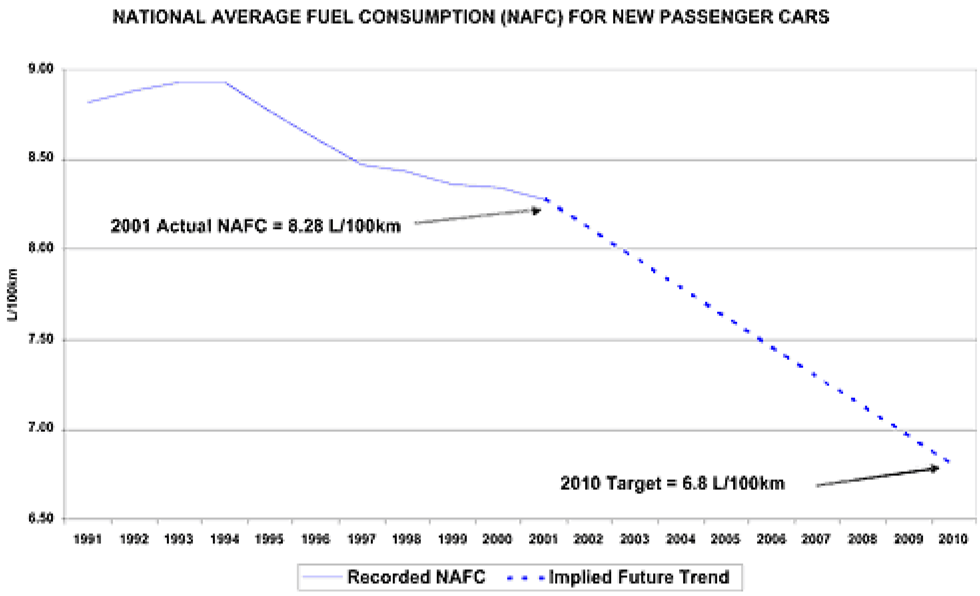


Source: Pew Centre on Global Climate Change, *Comparison of Passenger Vehicle Fuel Economy and Greenhouse Gas Emission Standards Around the World*, 2004

8.9 The current voluntary code, agreed between government and the Federal Chamber of Automotive Industries (FCAI) in 2003, calls on FCAI members to improve the national average fuel consumption of new passenger cars to a target of 6.8 litres per 100 km by 2010 'with the objective of continuing improvement in the environmental performance of the Australian automotive industry.'[9] This would be a reduction of 18 per cent over the decade. It would require a significant improvement on the trend of the decade before 2001.

9 Federal Chamber of Automotive Industries, *Voluntary Code of Practice - Reducing the Fuel Consumption of New Light Vehicles*, 15 April 2003.

Figure 8.3 – National average fuel consumption of new passenger cars in Australia, with future trend implied by FCAI target



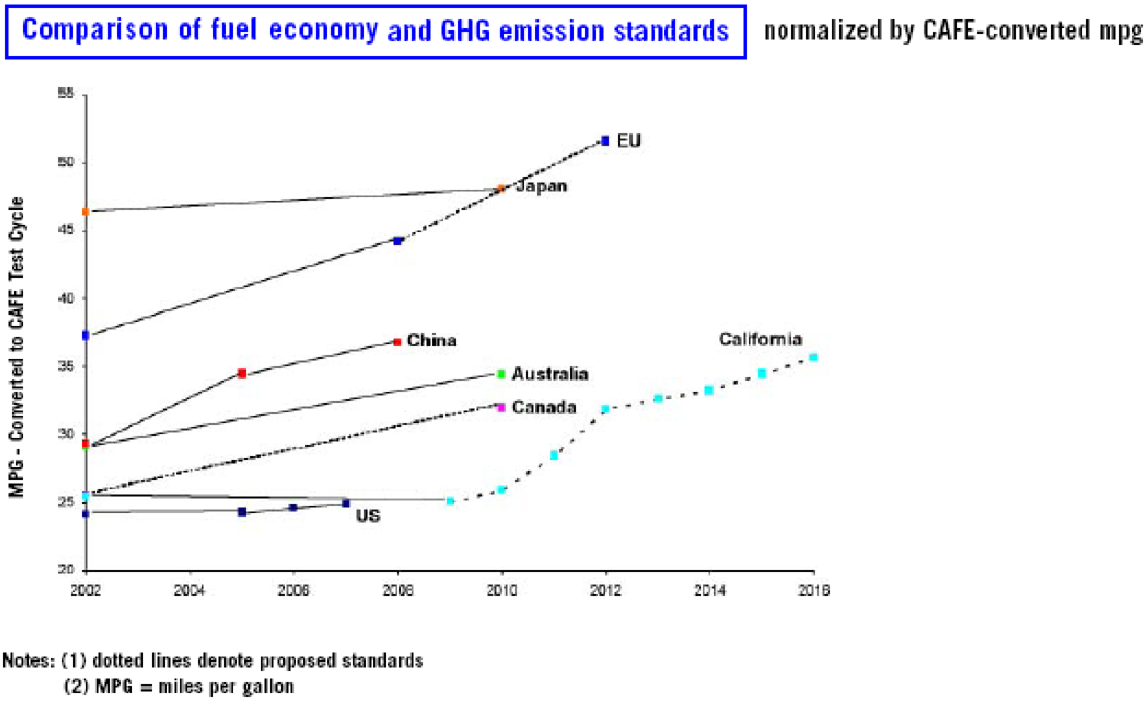
Source: Federal Chamber of Automotive Industries, *New target for reduced fuel consumption*, media release 15 April 2003 at

http://www.fcai.com.au/media/2003/04/00000011.html

8.10 The code is more demanding than standards in the USA and Canada, but less demanding than those in China, Japan or the European Union:[10]

10 Standards are mandatory in the United States, California, China and Japan, and voluntary in the European Union, Canada and Australia. The US Corporate Average Fuel Economy standards, though mandatory, are not particularly demanding: 27.5 miles per gallon (8.5 litres per 100km) for passenger cars, and 22.2 miles per gallon (10.6 litres per 100km) from 2007 for light trucks. Pew Centre on Global Climate Change, *Comparison of Passenger Vehicle Fuel Economy and Greenhouse Gas Emission Standards Around the World*, 2004, p. 6. For more discussion and comparisons, see International Energy Agency, *World Energy Outlook 2006*, p. 226ff, and Productivity Commission, *The Private Cost Effectiveness of Improving Energy Efficiency*, 2005, p. 246.

Figure 8.4 – Comparison of fuel economy standards for new passenger vehicles.



Source: Pew Centre on Global Climate Change, *Comparison of Passenger Vehicle Fuel Economy and Greenhouse Gas Emission Standards Around the World*, 2004

8.11 The code applies to new passenger cars, not to other light vehicles such as four wheel drives. Thus it does not touch the problem of efficiency improvements being counteracted by the rising market share of heavier vehicles.[11] When the voluntary code was established in 2003 the FCAI indicated it would develop appropriate targets for other categories of light vehicles. It appears that this is still under negotiation with government. It is also intended that an updated code will express the target in terms of greenhouse gas emissions rather than fuel consumption. According to the Australian Greenhouse Office updating the code is proving 'fairly complicated'.[12]

8.12 It is unclear what progress has been made to achieve the code's target. The Australian Automobile Association is concerned that 'options for improving fuel efficiency do not seem to be adequately taken up, particularly by car manufacturers':

> Although the Code commits the FCAI member companies to report annually on progress with the target, the figures are not readily available

11 There is some evidence that the higher petrol prices of the last two years have turned consumers back towards smaller cars: Productivity Commission, *The Private Cost Effectiveness of Improving Energy Efficiency*, 2005, p. 249. Federal Chamber of Automotive Industries, *Small cars drive half yearly motor vehicle sales,* media release 5 July 2006.

12 *Committee Hansard,* 11 August 2006, p. 55. (Mr G. McGlynn, Australian Greenhouse Office)

> and so it is difficult to ascertain what improvements have taken place since 2003.[13]

8.13 According to the Australian Greenhouse Office 'at this stage it is really impossible to measure':

> It is a target for 2010. The nature of vehicle fuel efficiency changes is such that you do not see steady progress; you tend to see jumps here and there when new models are introduced. So it is not something you can easily monitor on a year by year basis.[14]

8.14 It should also be noted that expressing the trend in fuel economy in terms of fuel consumption per vehicle kilometre overstates the benefits. This is because an improvement in fuel economy will reduce the cost of driving, and that will encourage more driving. This 'rebound effect' is said to be typically 20-30 per cent, reflecting the elasticity of demand for travel with respect to fuel price. At that rate a 10 per cent improvement in fuel efficiency per vehicle kilometre would cause a 7-8 per cent reduction in fuel consumption and a 2-3 per cent increase in distance travelled. The increased travel may have other costs, such as congestion, which should be considered.[15]

8.15 The Productivity Commission has argued that fleet-wide fuel efficiency targets that go much beyond what the market would deliver would not be privately cost effective, in the sense that consumers would value the fuel savings less than the associated costs and constraints on vehicle choice.[16] The implication is that such measures need to be justified by perceived public benefits of reducing long term oil use and greenhouse emissions. This appears to be the rationale for the present voluntary code, which speaks of 'improved environmental outcomes through the progressive reduction in the carbon dioxide emissions and fuel consumption of new passenger cars and other light vehicles.' [17]

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13 Australian Automobile Association, *Submission 151*, p. 10. Mr L. Mackintosh (AAA), *Committee Hansard,* 18 August 2006, p. 65.

14 *Committee Hansard,* 11 August 2006, p. 55. (Mr G. McGlynn, Australian Greenhouse Office)

15 International Energy Agency, *World Energy Outlook 2006,* p. 228. Victoria Transport Policy Institute, *Rebound effects - implications for transport planning*, at http://www.vtpi.org/tdm/tdm64.htm

The Productivity Commission notes research suggesting that a 10 per cent increase in fuel efficiency leads to a 2 per cent increase in distance travelled: *The Private Cost Effectiveness of Improving Energy Efficiency*, 2005, p. 248.

16 Productivity Commission, *The Private Cost Effectiveness of Improving Energy Efficiency*, 2005, p. 248.

17 FCAI, *Voluntary Code of Practice – Reducing the Fuel Consumption of New Light Vehicles*, 2003, clause 2.

Other fuel efficiency measures

8.16 Other suggestions made in submissions to improve fuel efficiency of cars included:

- measures to encourage smaller and hybrid vehicles in government and similar fleets;[18]
- measures to encourage diesel cars, which are more expensive than similar petrol cars but much more fuel efficient (they use 30-50 per cent less fuel than petrol cars of similar power);[19]
- measures to encourage smaller cars, for example by adjusting registration fees to favour them;
- removing the concessional tariff treatment of imported four wheel drives;[20] and
- increasing the fuel excise as an environmental measure. This could be coupled with lower registration charges to be cost neutral overall. It would reduce the flagfall cost of car ownership but increase the marginal cost of a trip, and so would be expected to encourage more fuel efficient cars and reduce the kilometres driven.

8.17 A particular point of interest was the Reva electric car, which is now on sale in several countries. The Reva is a 13 kilowatt powered car with a top speed of 65kph. A sample is in Australia for safety testing. The Department of Transport and Regional Services advised that the States, when asked, did not support registering the Reva, because of concerns about safety.[21]

8.18 It is also sometimes suggested that improving roads to relieve urban traffic congestion will improve overall fuel efficiency. Fuel consumption per kilometre is up to twice that in congested conditions as in free-flowing traffic.[22]

8.19 The committee notes the work of the Ministerial Council on Energy in promoting the National Framework for Energy Efficiency from 2004. Stage One of the NFEE was focussed on stationary energy. The Ministerial Council in October

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18 This has been done in Queensland and Western Australia. Queensland Government, *Submission 155*, p. 5. Mr G. Head (WA Department for Planning and Infrastructure), *Committee Hansard,* 11 April 2006, pp 3-4.

19 SASOL Chevron, *Submission 54*, Appendix C.

20 Imported new passengers cars attract a tariff of 10 per cent; four wheel drives, 5 per cent. This anomaly will end in 2010 when the tariff on cars falls to 5 per cent.

21 Mr P. Robertson (DOTARS), *Committee Hansard,* 18 August 2006, p. 9. Hon. J. Lloyd, *Reva vehicle must comply with safety standards first,* media release 11 October 2006.

22 Bureau of Transport and Regional Economics, *Urban congestion - the implications for greenhouse gas emissions*, information sheet 16, 2000.

2006 resolved to consider new energy efficiency measures.[23] As well, COAG has asked the Australian Transport Council (council of transport ministers) and the Environment Protection and Heritage Council (council of environment or related ministers), to report by the end of 2006 on incentives to promote more fuel efficient vehicles and strategies for demand management including increasing the use of public transport.[24]

Comment

8.20 Measures to improve the fuel efficiency of vehicles should be supported. The committee is concerned at the slow rate of improvement in the fuel efficiency of the light vehicle fleet, and the apparent uncertainty about what has been achieved to date by the current industry voluntary code.

Recommendation 6

8.21 The committee recommends that the Government, in consultation with the car industry, investigate and report on trends in the fuel efficiency of the light vehicle fleet and progress towards the 2010 target for the fuel efficiency of new passenger cars. If progress under the present voluntary code seems unlikely to meet the target, other measures should be considered, including incentives to favour more fuel efficient cars; or a mandatory code.

8.22 If progress under the present voluntary code seems unlikely to meet the target, other measures should be considered, including incentives to favour smaller or more efficient cars (for example, by adjusting registration charges); or a mandatory code.

8.23 Upgrading the national car fleet would be facilitated by government mandating the use of fuel efficient and hybrid vehicles in the government car fleet, which traditionally feeds into the taxi and second-hand car market.

8.24 Any proposal to increase fuel excise as an environmental measure would have to consider the distributional effects. People in the outer suburbs of cities and in rural and regional areas would be most affected. These people spend a relatively high proportion of their income on transport already, and for most purposes have no public transport alternatives. Positive measures to provide more alternatives to the use of cars would probably be more politically acceptable.

8.25 The committee comments on the proposition that building roads to reduce urban congestion improves fuel efficiency: this may be so in the short term, considered per vehicle kilometre. But it is not necessarily so in the longer term, because building roads also encourages more traffic, and entrenches patterns of urban development that make high car use necessary. What the overall result of these

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23 Ministerial Council on Energy, communiqué 27 October 2006.

24 Department of Environment and Heritage, *Submission* 171, p. 7. Australian Transport Council, communiqué 2 June 2006.

conflicting tendencies is, is hotly debated by transport planners and public transport advocates. The committee notes that the Council of Australian Governments (COAG) is now investigating options for managing urban transport congestion.[25] The committee trusts that COAG's deliberations will take account of this point.

Reforming urban road use charges: congestion charges

8.26 Congestion charging has been discussed more and more in recent years as a way of making more efficient use of the road system.

8.27 A motorist entering a congested road suffers delay, but also causes delay to others. A cost that a person imposes on others without paying for is an 'external cost.' If motorists are not required to pay for the costs they impose on others, their behaviour will not respond to the full cost, and economically inefficient overuse of the road will result. The resulting congestion, as well as causing delay to all motorists, increases fuel consumption as noted above.

8.28 Other external costs of car use are noise, pollution and greenhouse gas emissions, some accident costs and, arguably, the detrimental health effects of a too car-dependent lifestyle reducing physical exercise.[26] The costs associated with these detriments are significant. The Bureau of Transport and Regional Economics (BTRE) has estimated that the cost of congestion in major cities is $12.8 billion per year and the cost of the health effects of motor vehicle pollution is $2.6 billion per year (central estimate of total costs - the proportion which is an externality is not stated).[27]

8.29 Tailored road use charges are suggested as a way of reducing the external congestion cost. Motorists would be charged to use roads at the most congested times and places. This can be done by either a cordon charge in central areas (as in London and Stockholm) or by electronic tolling. Tolls can vary with the time of day. Those who value the use of the road less than the charge would adjust their behaviour by travelling less often, or at other times, or switching to public transport. Those who value the use more would have a less congested trip. The overall result for community welfare is positive.[28]

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25 Council of Australian Governments, communiqué 10 February 2006.

26 The external cost of an individual's ill health is publicly funded health care costs. A proportion of accident costs are internalised, and a proportion are funded by the public health system.

27 BTRE, *Urban Congestion - the Implications for Greenhouse Gas Emissions*, information sheet 16, 2000. *Health Impacts of Transport Emissions in Australia: Economic Costs*, working paper 63, 2005, pp 14-15.

28 To gain the economic benefit it is important that the charge is actually tailored to target only congested times and places. A flat rate city wide 'road use charge' is not a congestion charge. For further discussion see Productivity Commission, *The Private Cost Effectiveness of Improving Energy Efficiency*, 2005, p. 251ff.

8.30 According to the BTRE, among the possible types of road use charges, congestion charges have the best potential for reducing fuel consumption. The BTRE has estimated that levying optimal road user charges in major Australian cities could reduce peak hour travel by 20 per cent, overall travel time by 40 per cent, and total traffic fuel consumption by close to 30 per cent.[29]

8.31 While the economic case for congestion charging is strong, politically it has been very difficult to implement, because of the perception that it is 'yet another tax on motorists'.[30] One review of 25 examples around the world found that 'the common experience was that pricing was only acceptable if this objective could be seen as the solution to an already accepted problem, and a sufficiently widespread acceptance that other existing policies are not capable of solving it.' To win support for a proposal it was very important that the revenue was hypothecated to transport improvements. It was found that channelling revenue to public transport in particular increases public and political acceptance.[31]

8.32 The Australian Automobile Association supports congestion charging for the sake of the economic benefits, and supports using part of the revenue to improve public transport: 'In many instances… it would make the motorist better off if they had a viable public transport system.' The Royal Automobile Club of Queensland recently proposed a scheme for Brisbane.[32]

8.33 The Productivity Commission, in a recent report on energy efficiency, noted that congestion charging could deliver significant economic benefits, including improved fuel efficiency. It recommended further investigation of congestion charging. The Government response supported further investigation of congestion charging, noting that ‘effective congestion management requires a range of complementary measures.’ The Council of Australian Governments (COAG) is now investigating options for managing urban congestion.[33]

29 Bureau of Transport and Regional Economics, *Greenhouse Policy Options for Transport,* report 105, 2002, p. xv. Bureau of Transport and Communications Economics [predecessor of the BTRE], *Traffic Congestion and Road User Charges in Australian Capital Cities,* report 92, 1996.

30 For example, in response to a recent congestion charging proposal by the Royal Automobile Club of Queensland, the Queensland Transport and Main Roads Minister, Mr Lucas said, 'The Beattie government is not considering introducing congestion charging on Brisbane roads - it's a toll road by stealth.' www.theage.com.au 3 September 2006.

31 UK Commission for Integrated Transport, *CfIT's world review of road pricing phase 1 - lessons for the UK*, n.d. at http://www.cfit.gov.uk/docs/2006/wrrp1/index.htm

32 *Committee Hansard* 18 August 2006, p.78 (Mr J. Metcalfe). Willett K, (RACQ), *The Truth about Brisbane's Road: Stuck in Traffic and Stuck for Solutions,* 17 August 2006.

33 Productivity Commission, *The Private Cost-Effectiveness of Improving Energy Efficiency*, 2005, p. xlii, p. 257, recommendation 11.1. Government response, February 2006.

Comment

8.34 The object of a congestion charge is to reduce congestion. It is noteworthy that at least two peak motoring organisations now support this (Australian Automobile Association and RACQ). There are now a number of successful examples around the world to look to. The committee suggests that Australian governments should take a more active role in educating the public about the benefits of congestion charges. To make the idea more politically acceptable it is desirable to hypothecate the revenue to transport improvements. This should include improving public transport services, so that more motorists have alternatives to their cars.

Recommendation 7

8.35 The Committee recommends that Australian governments investigate the advantages and disadvantages of congestion charges, noting that the idea may be more politically acceptable if revenue is hypothecated to public transport improvements (as has been done in London, for example).[34]

Encouraging walking, cycling and public transport in cities

8.36 Many submissions argued for increased use of walking, cycling and public transport in cities, as a way of reducing transport fuel use, or at least restraining its growth.

Public transport

8.37 In Australian cities typically 75-90 per cent of all trips are by car, 5-10 per cent by public transport, and the rest by cycling or walking.[35] In the last 20 years public transport use has increased slowly, broadly in line with population growth, but public transport use as a proportion of all trips has been flat or declining slightly as car use increases faster.[36] A major reason for this is that as cities have grown outwards a greater proportion of people live in fringe areas that require more travel and are poorly designed for public transport. Other reasons are the declining share of commuting trips relative to other trips; rising incomes and the falling cost of car travel; more flexible working hours; and increased workforce participation by women with resulting increase in multi-purpose trips.[37]

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34 See Mayor of London's transport strategy, available at http://www.london.gov.uk/mayor/strategies/transport/index.jsp

35 The public transport share is usually somewhat higher in peak hours, and for travel to Central Business Districts.

36 Australasian Railway Association, personal communication, August 2006, based on research in progress.

37 Bureau of Transport and Regional Economics, *Greenhouse Policy Options for Transport,* report 105, 2002, p. xii.

8.38 Some increase in public transport use in the last year has been reported, presumably as a result of petrol price rises. However such increases are mostly quite small in percentage terms.[38] Another line of reporting stresses that most motorists have no alternative but to use their cars.

8.39 Ambitious goals for increasing the public transport mode share are commonly seen in official plans.[39] In some cities there has been significant investment in this: for example, Perth has electrified and extended its suburban rail network over the last 15 years, leading to a three-fold increase in use. The goals of these policies seem to be to control congestion and pollution, to give people more transport options, and to improve the opportunities of people without cars. Reducing oil dependency would be an additional benefit.

8.40 Many submissions urged the Commonwealth to be more involved in improving urban public transport infrastructure. They pointed out that there appears to be strong community support for more investment in public transport, and that in many other countries federal governments do contribute to urban public transport infrastructure. For example, in the USA the Federal Government is a significant provider of public transport funds and has recently announced an extension of its National Transportation Funding Program. Similarly, Canada has introduced a federal funding program for urban public transport infrastructure and in many parts of Europe (for example France and Germany) national governments are major financial contributors to public transport provision.[40]

8.41 The Bus Industry Confederation suggested that the Commonwealth should 'kick start' change by establishing a Sustainable Infrastructure Fund within Auslink programs. Grants to states and local government would require them to show that projects met sustainability objectives and were the outcome of an integrated landuse/transport planning process. Similarly the International Association of Public Transport proposed a Sustainable Transport Fund with a Commonwealth grant of $500 million per year initially and matching funds from state and local government.[41]

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38 For example, Hon. J. Watkins (NSW Minister for Transport), *Public bus patronage grows by 60,000 passengers a week*, media release 23 May 2006. This is a year on year increase of about 1.7 per cent.

39 For example, there are official goals to increase the public transport mode share from 7% to 10.5% in South East Queensland by 2011 *(Transport 2007);* from 9% to 20% of motorised trips (thus about 15% of all trips) in Melbourne by 2020 *(Melbourne 2030)*; to reduce car-as-driver trips in Perth by one third by 2029 (*Perth Metropolitan Transport Strategy 1995-2029*); and to increase the proportion of peak hour trips by public transport to 25% in Sydney (*A New Direction for NSW - State Plan*, 2006).

40 International Association of Public Transport, *Submission 32*, p. 31. Prof. P. Newman, *Committee Hansard,* 12 April 2006, p. 43. Municipal Association of Victoria, *Submission 124*, p. 6.

41 Bus Industry Confederation, *Submission 129*, p. 16. International Association of Public Transport, *Submission 32*, pp 24-5.

8.42 The Commonwealth's current policy is that public transport is the responsibility of the States.[42] However the Commonwealth, through the Greenhouse Gas Abatement Programme, has supported 'Travelsmart' projects, which aim to reduce car use by direct approach to targeted households (for example, to provide information about public transport services). Larger projects routinely show decreases in car use of 4-15 per cent, and increased walking, cycling and public transport use. The Queensland Government noted that Commonwealth funding for Travelsmart ends in mid 2007, and urged that it should continue.[43]

Cycling and walking

8.43 In Australian cities 30 per cent of car trips are less than 3km long, and half are less than 5km. The Bicycle Federation of Australia argued that many of these trips would be suitable for cycling, if the infrastructure was there to allow it to be done safely.[44] At present, although bicycle ownership is high (from 29 per 100 people in Sydney to 65 per 100 in Canberra), very few city people use a bicycle on an average day (from 1 per cent in Sydney to 4 per cent in Perth), and only 1-2 per cent of work trips are by bicycle.[45] It is estimated that currently about $100 million a year is spent on cycling infrastructure and promotion. This is about 2 per cent of the $5 billion a year that is spent on roads.[46]

8.44 The Australian National Cycling Strategy 2005 was developed by the Australian Bicycle Council (an association of relevant government agencies such as road and traffic authorities and other stakeholders). It aims to encourage cycling with policies such as:

- cycling should be an essential consideration in integrated land use and transport planning;
- suitable infrastructure and facilities should be provided; and
- cycling should be supported and promoted.

8.45 The strategy is an 'agreement to cooperate', and is not prescriptive. It leaves it to the member governments to decide what targets they will establish for increasing cycling.[47]

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42 Department of Transport and Regional Services, *Auslink White Paper*, 2004, p. 9.

43 Department of Environment and Heritage/ Australian Greenhouse Office, *Evaluation of Australian Travelsmart Projects,* 2005, p. 5. Queensland Government, *Submission 155,* p. 4. See also WA Department for Planning and Infrastructure, attachment.

44 Mr P. Strang (Bicycle Federation of Australia), *Committee Hansard,* 12 May 2006, p. 89. Mr E. Fishman (Institute for Sensible Transport), *Committee Hansard,* 12 May 2006, p. 93.

45 Australian Bicycle Council, *Australian Cycling - Bicycle Ownership, Use and Demographics*, 2004, pp 5-7.

46 Austroads, *The Australian National Cycling Strategy 2005-2010,* 2005, p. 3.

47 Austroads, *The Australian National Cycling Strategy 2005-2010,* 2005, p. 4 and pp 14-15.

8.46 It was argued that electric bikes would greatly improve the usefulness of cycling - the ASPO Australia Active Transport Working Group argued that these should be encouraged by setting a 300 watt limit for unregistered electric bikes, instead of the 200 watt limit which now applies.[48]

8.47 The Walking WA Committee argued that 'creating activity centres where employment, schools, recreation and shopping are within a short radius would reduce car use…'

> Government should put in more funding in the provision of a good pedestrian network system as local streets and paths have been identified as the most frequently used facilities. A similar program such as the "Black Spot" program for cars have been provided by the Federal Government, a program "Footpath black spot" program should be created to enable more footpaths to be built and maintained.[49]

Comment

8.48 Studies suggest that overall the potential fuel saved from promoting walking, cycling and public transport, with realistic assumptions about how much behavioural change could be achieved, is relatively small compared with the saving from improving the fuel efficiency of vehicles.[50] However more walking, cycling and public transport use is still a worthwhile goal for a number of reasons - for example to reduce congestion and pollution; to promote healthy lifestyles; and to reduce the disabilities suffered by people without cars (since more public transport use would make better services more viable). This applies regardless of predictions about the oil future. If there is a long term rise in the price of oil, it will be all the more necessary.

8.49 It is often said that it is too hard to get Australians out of their cars.[51] Others argue that the real problem is that people have no choice:

> There is no real relationship between wealth and car use. People use cars because they have to. Car dependence has become a dominant phenomenon. There is a lot of nonsense about how you will never get people out of their cars. You will not get them out of their cars unless you give them a better option, and then they will.[52]

8.50 The committee agrees that, whatever the reasons for people's travel behaviour, changing it is a challenging goal. However this does not mean it should not be

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48 ASPO Australia Active Transport Working Group, *Submission 136,* p. 8.

49 Walking WA Committee, *Submission 109,* p. 4.

50 Monash Energy Holdings, *Submission 58,* p. 17. Bureau of Transport and Regional Economics, *Greenhouse Policy Options for Transport,* report 105, p. 20. International Energy Agency, *World Energy Outlook 2006*, p. 224.

51 For example, Australian Automobile Association: 'Trying to get motorists out of their cars as an option for reducing transport fuel demand is unrealistic'. *Submission 151*, p. 7.

52 Prof. P. Newman, *Committee Hansard,* 12 April 2006, pp 50-51.

attempted. It a clearly a long term project. Change may be slow, but the important thing is to set the trend to reduce car-dependence into the long term.

8.51 Efficient transport investment requires better road pricing. This will probably mean significant new charges for using urban roads at the most congested times and places, as discussed above (paragraph 8.26ff). This is unlikely to be politically acceptable without serious improvement to public transport services, so that more motorists have other choices.

8.52 Serious improvements to public transport infrastructure - particularly rail extensions - are costly, tend to come in large, indivisible packages, and have very long payback periods. They are hard to program within state-sized budgets, and easy to shelve in favour of more incremental roadworks. However this outcome is not necessarily optimal in the long term.

8.53 The committee does not suggest that the Commonwealth should take over the states' basic responsibility to operate public transport services. However there may be a case for Commonwealth assistance to major projects such as rail extensions which are unlikely to happen, or unlikely to happen soon enough, without the involvement of the bigger budget which the Commonwealth commands.

8.54 The Committee recognises the need for more investment in mass transport and urges COAG to take this up as a national infrastructure priority.

8.55 The evaluation of Travelsmart projects suggests that they have significant benefits and can be a very cost-effective way of encouraging public transport use.

Recommendation 8

8.56 The committee recommends that Commonwealth support for Travelsmart projects be maintained beyond the currently planned termination date.

Integrating transport planning and land use planning to reduce car use

8.57 Car-dominated transport habits reflect patterns of urban development which make high car use necessary. Vast areas of post World War II suburbia have been designed on the assumption that most travel would be by car, and with the aim of making this easier. The effect has been to make travel in any other way harder, as activity centres disperse to sites distant from the public transport network, and the environment for pedestrians and cyclists is degraded by traffic.

8.58 In these areas existing public transport routes do not serve many travel needs, and services are poor. These services cannot attract people who have any other option: they mostly function as welfare for people without cars, with a very low proportion of total trips (less than 5 per cent).

8.59 The forces that drive high car use are still at work, in spite of the fact that urban plans now universally acknowledge the need to reduce it. According to Prof.

Newman, recent capital city strategic plans 'have recognized that there is a need to reduce automobile dependence and save on oil, [but] have not intervened in any radical way to stop oil-consuming behaviours.'[53] WSROC noted that 'In the last 20 years in western Sydney only 18 per cent of all new jobs have been located in centres.'[54] Wyndham Council in western Melbourne noted the targeted urban infill to restrain fringe development 'is simply not happening'.[55] The Public Transport Users Association criticised factory outlet developments approved by the Commonwealth on airport land, made possible by the fact that the land is exempt from normal planning controls:

> As you drive out to the airport I want you to just look at the discount or factory outlets at Essendon airport on Commonwealth land that are pretty much inaccessible by anything other than car or aeroplane.[56]

8.60 Development control is divided between State and local governments, and subject to the pressure of the property development industry representing market forces. This makes it difficult to follow through any strategic plan in the long term:

> Planners do not plan cities. Someone plans the subdivisions—usually the developers—somebody else plans the water supply, somebody else plans the electricity and, if you are lucky, somebody plans the transport. But they do not do it in concert; they do it independently. So industry develops where the land is cheap and where the services can be provided by somebody with very little cost to the developer… It goes in a circle and creates dysfunctional cities in the passenger transport area.[57]

8.61 Submissions stressed that turning around this situation requires better public transport services **and** planning policies to shape urban development so that public transport networks can work efficiently and attract more ‘choice’ customers:

> Travel behaviour and transport demand are directly linked to land use. Those planning for land use must consider how people using a particular space will travel around and through that space, as those decisions will affect how people choose to travel in future.[58]

8.62 Planning to reduce car-dependence means, for example:

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53 Prof. P. Newman, *Submission 11*, p. 5.

54 Mrs S. Fingland (Western Sydney Regional Organisation of Councils), *Committee Hansard,* 9 June 2006, p. 22.

55 Mr I. Robins (Wyndham City Council), *Committee Hansard,* 29 June 2006, p. 65.

56 Mr C. Tampion (Public Transport Users Association), *Committee Hansard,* 29 June 2006, p. 82.

57 Mr A. Honan (Railway Technical Society of Australia), *Committee Hansard,* 30 June 2006, p. 17.

58 Municipal Association of Victoria, *Submission 124*, p. 4.

- encouraging commerce and employment to locate at strongly planned regional centres, so that public transport networks have somewhere to focus on;
- reserving new corridors for fast public transport early in the planning of greenfields developments;
- new subdivisions and activity centres to be planned so that buses can be routed efficiently; and
- design principles to give high priority to a quality environment for pedestrians and cyclists.

8.63 Greenfields developments should be designed with high priority to creating an efficient public transport route network. Services should be provided from the outset, rather than being retrofitted years later, after the new residents have established car-dependent habits.

8.64 Similarly, design principles to encourage walking and cycling must be in place from the outset - for example, cycle-friendly road design, permeable street layouts which do not force circuitous trips, and suitably placed local and neighbourhood centres to promote walking and cycling for trips within the neighbourhood. Traffic calming and lowered speed limits on local roads can promote safe cycling in all areas at little cost.[59]

8.65 Transit-oriented development can improve public transport use. This refers to medium density mixed-use development around public transport nodes - this will usually mean rail stations, since rail best provides the visibility and permanence needed to attract this sort of development (high quality segregated busways may also serve).[60]

8.66 It should be stressed that transit oriented development is not the same as general 'urban consolidation'. This is usually taken to mean the attempt to increase population over wide areas of established suburbs by infill development or rezoning for denser development. Capital city strategic plans now commonly aim to house a significant proportion of future population growth within the existing urban footprint, to limit the amount of greenfields development at the fringe.[61] Undiscriminating urban consolidation usually arouses strong opposition from residents, and there is debate

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59 For related suggestions see Alan Parker Design, *Submission 12*, Appendix B. Residential Environments Study Team, *Submission 102,* p. 3.

60 For an overview of transit oriented development see for example http://www.patrec.org/conferences/TODJuly2005/TODJuly2005.html which is the papers of a 2005 conference by the Western Australia Planning and Transport Research Centre (PATREC).

61 For example, Sydney 2005 Metropolitan Strategy calls for 60-70 per cent of new housing to be in established areas. NSW Department of Planning, *City of Cities - a plan for Sydney's future - metropolitan strategy*, 2005, p. 133.

over whether the benefits are worth the costs.[62] The committee makes no comment on that debate here, but stresses that many other planning initiatives to promote walking, cycling and public transport, as noted above, can and should be done in any case, regardless of views about the best overall urban population density.

8.67 Urban strategic planning is the responsibility of State and Territory governments. The needed initiatives involve State and local government. Most of them require regional scale planning going beyond the boundaries of any one local government area. The right institutional arrangements and powers are needed to ensure that the planning and the execution are coherent.[63] The Municipal Association of Victoria suggested that 'urban development needs to be supported by a fully funded and integrated planning approach that involves the key agencies, including councils and the State Government'.[64] In Western Australia, transport, main roads and strategic land use planning have been rolled into one Department for Planning and Infrastructure.[65] The International Association of Public Transport suggested that achieving less car-dependent cities 'requires clear urban planning strategies which look more than one or two election cycles ahead…'

> There is a need to develop an urban strategy in each city and to stick to it. In our bipartisan political system, that means getting support from both sides of the political spectrum. It also means getting buy-in from the Commonwealth government which still seems to have little interest in the internal affairs of our cities notwithstanding that 85% of Australians live in them.[66]

Comment

8.68 Most public discussion of encouraging public transport focuses on the technicalities of improving the public transport service, and unfortunately gives little attention to the important land use planning connection. It should always be stressed that all land use planning is transport planning, as land use planning decisions have a dominating effect on people's travel habits. The best public transport service will not attract customers if the nature of urban development in the catchment area makes it impossible for the route to serve people's needs.

8.69 Governments who promote urban consolidation to reduce car use need also to remember that the planning policy is not enough: the improved public transport must

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62 For a leading Australian 'urban consolidation sceptic' see Patrick Troy, *The Perils of Urban Consolidation*, 1996. For an example of residents opposition see Save Our Suburbs at http://www.sos.org.au/new_home.html See discussion in House of Representatives Standing Committee on Environment and Heritage, *Sustainable Cities*, 2005, p. 43.

63 Municipal Association of Victoria, *Submission 124,* p. 4.

64 Municipal Association of Victoria, *Submission 124*, p. 4.

65 Department for Planning and Infrastructure, *Submission 172*, attachment.

66 International Association of Public Transport, *Submission 32*, p. 31.

also be provided. Denser population in areas where existing public transport is mediocre or overloaded, without improvement, will simply increase traffic congestion.

8.70 In all these matters, the aim of policy is to change people's travel behaviour at the margin. In the foreseeable future walking, cycling and public transport will continue to be unsuitable for many travel needs. The aim is to encourage them where they are suitable. A commonly stated goal is to increase the public transport mode share from 10 per cent to 20 per cent of trips.[67] On the positive side, because the present public transport share is so low, only a small behavioural change by motorists would be needed to greatly increase public transport use. This would make better services more viable.[68]

More use of rail for long distance freight

8.71 Many submissions argued for more use of railways for long distance freight. Trains use about one third the fuel of trucks per net tonne kilometre.[69]

8.72 At present road and rail have about equal shares of Australia's total freight transport task in tonne/kilometres (35% and 37% respectively, with 28% sea and 1% air). However the vast majority of the rail task (86%) is transporting bulk commodities such as coal and ore. Road performs about 75% of the non-bulk freight task. It is suggested that only about 15-20% of total freight is 'contestable' - realistically open to competition between road and rail.[70] This is primarily non-bulk freight over longer distances on the main intercity routes. The advantage of rail increases with distance, as the lower line haul cost begins to outweigh the cost of transhipping at the journey's beginning and end. The rail share of land freight on these routes ranges from 10-15% (Sydney-Melbourne) to 70-80% (eastern states-Perth).[71]

8.73 The Bureau of Transport and Regional Economics (BTRE) expects that on present trends, assuming no significant change in infrastructure, the long term decline

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67 For example, Bus Industry Confederation, *Submission 129*, p. 14.

68 For example, if car and public transport trips are now in the ratio 9 to 1, and 10 per cent of car trips become public transport trips, this would almost double public transport use.

69 Rail 0.0085, road 0.0265 litres per net tonne kilometre: Bureau of Transport Economics, *Competitive Neutrality Between Road and Rail*, working paper 40, 1999, p. 59. Figures are for non-bulk freight on an 'average' interstate corridor, and allow for typical load factors. Fuel efficiency of both road and rail has probably increased since then.

70 A larger proportion of freight would be on routes where rail service could theoretically be provided, but would not be viable because of the overwhelming natural advantages of road service on those routes.

71 Department of Transport and Regional Services, *Auslink White Paper*, 2004, p. 3. Australasian Railway Association, *Australian Rail Industry Report 2003,* p. 9. Mr S. St Clair (Australian Trucking Association), *Committee Hansard* 12 May 2006, p. 85. Bureau of Transport and Regional Economics, *Freight between Australian Cities, 1972 to 2001*, information sheet 22. BTRE, *Freight Measurement and Modelling in Australia*, report 112, 2006, p. xxiii.

in rail's mode share will continue on most routes. However if there was significant improvement to rail infrastructure the result might be different.[72]

8.74 This situation has arisen partly because of the competitive advantage of road in speed and reliability (qualities which have become more important in the age of 'just in time' logistics); partly because of a history of poor rail management by former public authority owners; and partly because of past government policies to invest heavily in improving roads and comparatively little in improving railways. For example, over the last 30 years the Hume Highway has been almost entirely rebuilt and duplicated.[73] The Sydney-Melbourne railway remains on the alignment built in the 1870s, with many speed-limiting curves and gradients.[74]

8.75 Commonwealth policy recognises that the rail system has been underfunded in the past and has the potential to increase its share of the freight task if there are improvements to infrastructure and modernisation of operating practices.[75] The Commonwealth has committed $2.4 billion to rail improvements over the 5 years to 2008-9, mostly for the Melbourne-Sydney-Brisbane corridor.[76] In the longer term, Auslink 'corridor strategies' promise a balanced assessment of the road and rail infrastructure needs of key corridors for the sake of the most efficient overall outcome.[77]

8.76 The Australian Trucking Association (ATA) supports the need for investment in railways, but is concerned that the road freight industry should not 'have imposts put on our business simply to make rail more competitive.' The ATA also argued that heavier trucks should be permitted for the sake of their greater fuel efficiency.[78]

Comment

8.77 Fuel efficiency or possible oil depletion do not figure particularly in the 2004 Auslink White Paper (Commonwealth government transport policy). The Auslink policies and first five year program are based on goals of general economic efficiency,

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72 BTRE, *Freight Measurement and Modelling in Australia*, report 112, 2006, p. xxiii.

73 113km of the Hume Highway remains unduplicated: Department of Transport and Regional Services, *Sydney-Melbourne Corridor Strategy* [2006], p. 4.

74 Dr P. Laird, *Committee Hansard,* 30 June 2006, p. 81. In fact the current Sydney-Melbourne rail alignment is *worse* than as built in the 1870s. In the 1910s many deviations were made to obtain easier grades at the cost of sharper curves and longer overall distance. For today's faster, more powerful trains it would be better if the deviations had not been made.

75 Department of Transport and Regional Services, *Auslink White Paper*, June 2004, p. 62.

76 This is a combination of grants under Auslink funding programs; direct grants to the Australian Rail Track Corporation, which controls the main interstate routes; and the ARTC's own investment (the ARTC is Commonwealth owned).

77 Australian Government, *Auslink White Paper*, 2004.

78 Mr S. St Clair (Australian Trucking Association), *Proof Committee Hansard,* 12 May 2006, p. 85. ATA, *Submission 131*, p. 23.

considering the predicted strong growth of freight transport over the next 20 years.[79] However it may be expected that if there is a long term rise in the price of fuel, this will favour rail because fuel is a greater proportion of costs for road transport. This may suggest a need to increase the pace of catchup investment in rail infrastructure. Auslink corridor strategies ought to allow for this.

Recommendation 9

8.78 The committee recommends that corridor strategy planning take into account the goal of reducing oil dependence as noted in recommendation 2. Existing Auslink corridor strategies should be reviewed accordingly.

8.79 Competitively neutral pricing of access to road and rail infrastructure is an essential prerequisite to economically sound decision-making about investment priorities. This has long been controversial - rail interests argue that heavy trucks do not pay enough for the use of roads, while trucking interests argue that they do. The Productivity Commission has recently investigated this, but at the time of writing, the report had not yet been released.[80]

8.80 The committee agrees with the Australian Trucking Association that there is no case to hamper the road freight industry by regulation or by excessive charges, merely in order to improve the competitive position of rail. Once economically rational investment priorities and competitively neutral access charges are assured, road and rail should be able to compete on their merits. If there is a long term rise in the price of fuel, this will show itself in changing their competitive position.

8.81 The committee comments on the Australian Trucking Association's suggestion that bigger trucks should be allowed for the sake of their fuel efficiency: this idea should be approached with caution. The overall effect needs more detailed study. Bigger trucks will cause greater road wear and accident costs. They will also tend to be concentrated on the routes which compete most directly with rail. If they take traffic from rail, given that rail is more fuel efficient still, the net result in terms of fuel efficiency could be counterproductive.

Other matters: fringe benefits taxation of employer-provided cars

8.82 Many submissions argued that the concessionary tax treatment of cars as a fringe benefit should be abolished. They argued that the concession encourages the

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79 The 2004 Auslink White Paper in a few words flags the possible issue of 'depletion of fossil fuel supplies before alternative energy sources are developed' (pp 21 and 115), but makes no further comment.

80 Productivity Commission, *Road and Rail Infrastructure Pricing*, discussion draft September 2006. It is also argued that rail access charges may not recover long term asset replacement costs: BTRE, *Land Transport Infrastructure Pricing: an Introduction*, working paper 57, 2004, p. x.

use of cars for commuting and is contrary to widely held government policy goals to promote public transport and restrain urban traffic congestion.

8.83 Private use of employer-provided cars is taxed by recording actual business and private use (the operating costs method), or by deeming certain proportions of business and private use using a statutory formula. About 90 per cent of car fringe benefits tax is calculated by the statutory method. The statutory formula deems that the taxable fringe benefit is the base value of the car times a percentage which varies according to how far the car is driven in the year. The taxable fringe benefit is less if the car is driven further. The rationale for this seems to be an assumption that if the car travels further, it is likely that a smaller proportion of its use is private.

km travelled during the FBT year	statutory percentage
less than 15,000	26
15,000 to 24,999	20
25,000 to 40,000	11
over 40,000	7

8.84 The tax is concessionary because the statutory formula overestimates the amount of business use; thus some private use is untaxed.

8.85 The concession was worth about $1.1 billion in 2004-5.[81] The tax forgone is about 43 per cent of the tax that would be collected if the taxable fringe benefit was calculated accurately. The concession is worth, on average, about $2,300 per vehicle.[82]

8.86 The statutory formula method of calculating the tax liability, which creates the concessionary aspect, was adopted to minimise compliance costs and to support the Australian car industry, which at the time (1986) attracted significant government support and provided nearly 85 per cent of car sales.

8.87 The Institute of Chartered Accountants in Australia (the ICAA) argues that the concessionary treatment should be ended, since:

- it undesirably distorts economic behaviour; and
- as a way of assisting the Australian car industry it is poorly targeted, as now only 29 per cent of new cars are Australian-made.

8.88 The ICAA points out that the question of minimising compliance costs is distinct from the question of whether the tax should be concessionary. A statutory

81 Treasury, *Tax Expenditures Statement 2005*, p. 125.

82 Based on about 463,000 affected vehicles in 1999-2000, the last year for which figures are available. The Institute of Chartered Accountants in Australia, *Fringe Benefits Tax - Decision Time,* 2006, p. 19.

formula method could be maintained for the sake of easy compliance, while the concessionary aspect could be removed by adjusting the rates.[83]

8.89 The concessionary treatment of FBT on cars encourages car use and contributes to urban congestion. It is suggested that in Sydney 50 per cent of cars on the road in peak hours enjoy the concession.[84] As well, it is often noted that the sliding scale encourages people to drive further merely to reach the threshold distance that earns a lower fringe benefits tax.

8.90 Some submissions also suggested that public transport tickets should be given a tax concession in some way - for example, in Canada 15.25 per cent of the cost of a monthly or longer transit pass can be claimed as a rebate of tax.[85] At present in Australia employers are free to offer public transport tickets as a fringe benefit but, by contrast with an employer-provided car, there would be no tax advantage in doing so. On the other hand, Treasury argued that a tax benefit for public transport use would seem to be contrary to fundamental principles of the tax system:

> If you were to start using the fringe benefits tax regime to provide an incentive for people to use public transport, you would run into an issue about effectively providing a tax deduction for private expenditure.[86]

Comment

8.91 The committee notes that the Council of Australian Governments (COAG) in February 2006 resolved to investigate options for managing urban traffic congestion consistent with jurisdictional responsibilities.[87] The committee suggests that this include the Commonwealth reconsidering the policy behind the concessionary treatment of the fringe benefits tax on cars. The policy encourages car use for peak hour commuting, and now seems to serve little of its original purpose.

8.92 The committee notes suggestions that public transport tickets should earn a tax concession in some way as a 'levelling the playing field' measure. In relation to this, it should be noted again that the car FBT regime is concessionary because of the construction of the statutory formula, not because the trip to and from work is tax-free. The trip to and from work is not tax-free - as a general rule it is regarded as private use, just as a public transport trip is.[88]

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83 The Institute of Chartered Accountants in Australia, *Fringe Benefits Tax - Decision Time,* 2006, p. 19.

84 House of Representatives Standing Committee on Environment and Heritage, *Sustainable Cities*, 2005, paragraph 5.75.

85 See http://www.cra-arc.gc.ca/whatsnew/items/transit-e.html

86 Mr M. Jacobs (Department of the Treasury), *Committee Hansard,* 18 August 2006, p. 30.

87 COAG communiqué, 10 February 2006.

88 Australian Taxation Office, *Reportable Fringe Benefits - Facts for Employees*, p. 3.

8.93 If the concessionary aspect of car FBT related specifically to the trip to work, there might be logic in suggesting a corresponding concession for a public transport fare. But this is not the case. The best 'levelling the playing field' measure would seem to be to end the concessionary aspect of the car FBT, not to create an ad hoc new concession for public transport fares which is contrary to the fundamental logic of distinguishing private and work related expenses in the tax system.[89]

Recommendation 10

8.94 The Committee recommends that the government review the statutory formula in relation to fringe benefits taxation of employer-provided cars to address perverse incentives for more car use.

8.95 It should be stressed again that the question of whether the tax should be concessionary is different from the question of minimising compliance costs. A statutory formula method can be retained for the sake of easy compliance, while the concessionary aspect can be removed by adjusting the rates.

General comment on demand management measures

8.96 When government considers the range of policies needed to reduce oil dependence, and the level of government intervention or support that they deserve, the costs and benefits of demand side measures versus supply side measures should be compared. A litre of oil saved through a fuel efficiency measure, or by turning a car trip into a bicycle trip, is just as real as a litre of oil found by new exploration or produced in a coal to liquids plant.

89 A tax rebate for public transport fares might also be regressive as it would not be available to those who pay no tax.

8.97 It should be remembered that measures to reduce demand for oil-fuelled transport also have other benefits - reducing greenhouse gas emissions; promoting the environmental and social benefits of less car-dependent cities - which the alternative fuels do not have, or have to a lesser degree. In the cost/benefit comparison these extra benefits should count to the credit of the demand management measures.

Senator the Hon. Bill Heffernan
Chair

Appendix One

List of Submissions

1. Mr Eriks Velins
2. Mr Allan Heasman
3. Mr Martin Olmos
4. The National Committee on Transport, Engineers Australia
5. Mr Pat Naughtin
6. Mr Alan Kleidon
7. Ms Janet Marsh
8. Mr Loris Erik Kent Hemlof
9. The Chartered Institute of Logistics & Transport
10. ASPO Ireland
11. Professor Peter Newman
12. Alan Parker Design
13. Mr Adam Butler
14. Mr John Schindler
15. Mr Peter Robertson
16. Mr Chris Shaw
17. Mr Mervyn Couper
18. Mr Mark Robson
19. City of Wanneroo
20. Mr Robin Collin
21. China University of Petroleum
22. CONFIDENTIAL
23. Mr Ray Dowsett

24. ASPO – Australia Biofuels Working Group

25. Dr Jeremy Wilkinson

26. Mr David Rice

27. Mr James Ward

27A Confidential

28. Mr Stephen Kovacs

29. Mr David Bell

30. Mr Llewellyn Wishart

31. Engineers Australia

32. The International Association of Public Transport (Australia/NewZealand)

33. Mr David Green

34. Mr Don Durrett

35. Mr Paul Pollard

36. Australian Cane Growers' Council Ltd

37. Mr David Finlay

38. Western Australian Cycling Committee

39. Cecile Storrie

40. Dr David Bennett

41. Mr David Yap

42. Mr Phil Connor

43. Western Sydney Regional Organisation of Councils Ltd

44. The Understandascope, The Monash Science Centre

45. Sustainable Transport Coalition WA

46. Mr Paul Eistis

47. Mr David Huck

48. ASPO-Australia Indigenous Working Group

49. ASPO-Australia Agriculture, Fisheries and Food Working Group

50. Advanced Fuels Technology Pty Ltd

51. Mr Peter Flanagan

52. Mr John Evans

53. Murray Goulburn Co-operative Company Limited

54. Sasol Chevron Consulting Ltd

55. Livestock Feed Grain Users Group

56. City of Wanneroo

57. Mr David Allen

58. Monash Energy Holdings Limited

59. Mr Keith Skipper

60. Office of Industry and Innovation
University of Western Australia

61. Mr David Wanless

62. Southern Metropolitan Regional Council

63. Mr Aaron Nielsen

64. Motive Energy Pty Ltd

65. Mr Michael Dwyer

66. Mr Lionel Orford

67. ASPO-Italia

68. Biodiesel Association of Australia

69. Mr Matt Mushalik

70. Ms Caroline Le Couteur

71. Mr Peter Nattrass

72. Mr Alex Roberts

73. Advanced Engine Components Limited

74. Mr Brian Fleay

74A Mr Brian Fleay

74B Mr Brian Fleay

74C Mr Brian Fleay

75. Asia-Pacific Natural Gas Vehicles Association

76. Mr Michael Gutteridge

77. Mr John Harland

78. Mr John Bowman

79. ASPO-Australia Finance and Economics Sector Working Group

80. Torquay Landcare Inc.

81. Sydney South West Area Health Service

82. Mr Peter Bartlett

83. Mr Harry Lewis

84. Cummins Inc. (Australia)

85. Bioenergy Australia

86. Mr Svargo Freitag

87. WA Farmers Federation

88. Australian Medical Association

89. Council of Social Service of New South Wales

90. Mr Greg Smith

91. Australian Liquefied Petroleum Gas Association Ltd t/a LPG Australia

92. Microbiogen Pty Ltd

93. Enecon Pty Ltd

94. Climate Change Australia (Manning Branch)

95. Natural Fuels Australia Ltd

96. Mr Donald Coventry

97. City of Whitehorse

98. Wesfarmers Kleenheat Gas Pty Ltd

99. The City of Newcastle

100. Public Transport Users Association Inc. & Environment Victoria

101. CONFIDENTIAL

102. RESIDential Environments Project Team

103. Cr Chris Aubrey, City of Whitehorse

104. Research Institute for Sustainable Energy

105. Envestra Limited

106. Boral Transport Limited

107. The Pedestrian and Bicycle Transport Institute of Australasia

108. Mr Paul Johnson

109. Walking WA Committee, Western Australia

110. Greenfleet Australia

111. Mr Les Chandra

112. Brunswick Bicycle User's Group

113. The Solar Shop

114. Ms Philippa Clarkson

115. Bendigo Bicycle Users Group

116. ACT Peak Oil

117. Emergent Futures

118. Sustainable Population Australia inc

119. The Natural Gas Vehicles Group Pty Ltd

120. Queensland Farmers Federation

121. Holmgren Design Services

122. Dr Melanie Fitzpatrick

123. Mr Noel Child, Mr Oliver Clark AM & Mr Simon Humphries

124. Municipal Association of Victoria

125. Mr Lex Creemers

126. Mr Stephen Gloor

127. Geoscience Australia

128. CSIRO

129. Bus Industry Confederation

130. Cyclists' Action Group

131. Australian Trucking Association

132. ASPO-Australian Oil & Gas Industry Working Group

133. ASPO-Australia Working Group on Urban and Transport Planning

134. ASPO-Australia Social Services Sector Working Group

135. ASPO-Australia

135A ASPO- Australia

135B ASPO Australia

135C ASPO Australia

136 ASPO-Australia Active Transport Working Group

137 ASPO-Australia Construction Industry Working Group

138 ASPO-Australia Health Sector Working Group

138A ASPO-Australia Health Sector Working Group

139 Mr John Caley

140 Dr Philip Laird, University of Wollongong

140A Dr Philip Laird, University of Wollongong

141 Dr Colin Endean

142 Ms Catherine Beck

143 Hydro Tasmania

144 Cycle-Safe, Armidale

145 Australian Fodder Industry Association Inc.

146 ASPO-USA

147 Ms Mary Sweetapple

148 CSR Limited

149 ASPO-International

150 Mr Daniel Boon

151 Australian Automobile Association

152 Australian Conservation Foundation

153 Centre for Low Emission Technology

154 Australian Academy of Technological Sciences and Engineering

155 Queensland Government

156 Tathra Street

157 Wyndham City Council

158 Western Transport Alliance

159 Gecko – Gold Coast and Hinterland Environment Council

160 Railway Technical Society of Australasia

161 Bicycle Federation of Australia & Cycling Promotion Fund

162 Society for Underwater Technology

163 Public Health Association

164 Mr Brian Merchant

165 Urban Research Program

166 Australian Bureau of Agriculture and Resource Economics

167 Ford Motor Company of Australia Limited

168 Maritime Union of Australia

168A Maritime Union of Australia

169 Pacific National

170 Mr Ben Rose

171 Department of the Environment and Heritage

172 Department for Planning and Infrastructure
Government of Western Australia

173 BP Australia Pty Ltd

174 CONFIDENTIAL

175 Mrs Kim Bax

175A Mrs Kim Bax

176 Australian Petroleum Production & Exploration Association

177 Capt. Peter Ireland

178 Australian Institute of Petroleum Ltd

179 Dr Hongwei Wu & Dr Mike Ewing

180 Dr Ross Kingwell

181 Shell Australia

182 QRNational

183 Australian ITER Forum

184 Mr Dennis Keith

185 Gardner Smith (Holdings) Pty Ltd

186 Mr Frank Crichlow

187 Dr Darren Phillips

188 DUT Pty Ltd

189 Mr Cy d’Oliveira

190 Renewable Fuels Australia

191 Waste and Fleet Services

192 Mr Donald Coventry

193 ASPO-Australia Defence & Security Working Group

194 Sustainable Energy Australia, University of South Australia

195 Government of South Australia

Appendix Two

Witnesses who appeared before the Committee at the Public Hearings

Tuesday, 11 April 2006
Legislative Council Committee Office
PERTH

Sustainable Transport Coalition
Dr David Bennett, Founder
Dr David Worth, Convenor

Office of Industry and Innovation, University of Western Australia
Mr Andrew Beveridge, Project Manger Commercialisation

Department of Agriculture and Food, Western Australia
Dr David Bowran, Grains Industry Development Director

Mr Brian Fleay, Private capacity

Research Institute for Sustainable Energy
Professor David Harries, Director

Department of Planning and Infrastructure, Western Australia
Mr Glen Head, Director, Perth Fuel Cell Bus Trial and Transport Sustainability

Wesfarmers Energy and LPG Australia
Mr Gary Ireson, Director, Gas and Power Wesfarmers Energy and President, LPG Australia

Department for Planning and Infrastructure
Mr David Rice, Principal Network Planning Office

ASPO Australia
Mr Bruce Robinson, Convenor

Sustainable Energy Association, Western Australia
Mr Matthew Rosser, Chair

Royal Automobile Club, Western Australia
Mr Michael Upton, Manager, Vehicle Policy

Public Transport Authority
Mr Tim Woolerson, Bus Fleet Manager

Wednesday, 12 April 2006
Commonwealth Parliament Offices
PERTH

Australian Association for the Study of Peak Oil and Gas
Mr Bruce Robinson, Convenor

Mr Brian Fleay, private capacity

Sasol Chevron Consulting Pty Ltd
Mr Anthony Pytte, Australia Country Manager

Office of Industry and Innovation, University of Western Australia
Mr Andrew Beveridge, Project Manager, Commercialisation

Research Institute for Sustainable Energy, Murdoch University
Professor David Harries, Director

Sustainable Transport Coalition
Dr David Bennett, Founder
Dr David Worth, Convenor

Institute for Sustainability and Technology Policy, Murdoch University
Professor Peter Newman, Director

Commonwealth Scientific and Industrial Research Organisation
Dr Beverly Ronalds, Chief, CSIRO Petroleum
Dr Cedric Griffiths, Theme Leader, Maintaining Australian Oil Self Sufficiency, CSIRO Petroleum

Advanced Engine Components Ltd
Mr Antony Middleton, Managing Director

Department for Planning and Infrastructure, Western Australia
Mr Glen Head, Director, Perth Fuel Cell Bus Trial and Transport Sustainability
Mr Iqbal Samnakay, Policy Officer

Mr Alexander Creemers, Private capacity

Western Australian Farmers Federation
Mr Trevor DeLandgrafft, President
Mr Ross Hardwick, Executive Officer

School of Science and Engineering, Murdoch University
Dr August Schlapfer, Lecturer, Energy Studies

Natural Fuels Australia Ltd
Mr Richard Selwood, Chief Executive Officer

Friday, 12 May 2006
Parliament House
CANBERRA

GeoScience Australia
Dr Clinton Foster, Chief, Petroleum and Marine Division
Mr Denis Wright, Chief Petroleum Engineer
Mr Stephen Le Poidevin, Senior Reservoir Engineer

Australian Bureau of Agricultural and Resource Economics
Dr Brian Fisher, Executive Director
Ms Karen Schneider, Acting Deputy Executive Director
Mr Graham Love, Manager, Energy Projections and Analysis Section, Energy and Minerals Branch
Dr Jammie Penm, Senior Analyst

Commonwealth Scientific and Industrial Research Organisation
Dr David Brockway, Chief, Division of Energy Technology

Engineers Australia
Mr Andre Kaspura, Policy Analyst

International Association of Public Transport
Mr Peter Moore, Executive Director

Livestock Feed Grain Users Group
Mr Kevin Roberts, Vice-President

ACT Peak Oil
Mr Alexander Pollard, Convenor, Chair and Submission Editor
Mr Leigh Kite, Treasurer and Public Awareness Campaign Manager

Australian Trucking Association
Mr Stuart St Clair, Chief Executive

Bicycle Federation of Australia
Mr Peter Strang, Executive Director
Mr Elliot Fishman, Director, Institute for Sensible Transport

Friday, 9 June 2006
Parliament House, Macquarie St
SYDNEY

CSR Ethanol Ltd
Mr Martin Jones, General Manager, Government Relations
Mr Gavin Hughes, General Manager

Western Sydney Regional Organisation of Councils Ltd
Councillor Anthony Hay, President
Mr Alexander Gooding, Executive Director
Ms Sharon Fingland, Assistant Director

Chartered Institute of Logistics and Transport Australia
Mr Leonard Harper, National Chairman & Executive Director

Biodiesel Association of Australia
Mr Adrian Lake, President
Dr Len Humphreys, Board Member
Mr Christopher Mapstone, Bowral–Marketing Manager–Biofuel, Gardner Smith Pty Ltd

Australian Liquefied Petroleum Gas Association Ltd
Mr Raymond North, General Manager
Mr Warring Neilsen, Chairman, Government Relations

Bioenergy Australia
Dr Stephen Schuck, Manager

Boral Ltd
Mr Mervyn Rowlands, Fleet Engineering Manager, Boral Transport
Mr Ian McKimm, Consultant

The Natural Gas Vehicles Group
Mr Kevin Black, Managing Director

Thursday, 29 June 2006
Joint Committees Administration Office
Melbourne

Monash Energy Holdings Ltd
Mr Jeffrey Gordon, Chief Executive Officer
Mr David Lea, Executive Adviser
Mr Stuart Lund, Chief Financial Officer

Advanced Fuels Technology Pty Ltd
Mr Sean Blythe, Chief Executive

Cummins Engine Company Pty Ltd
Mr John Bortolussi, Director

ASPO Australia
Mr Richard Campbell, Convenor, Finance Group
Dr Sheridan Mayo, Deputy Convenor

BP Australia Pty Ltd
Mr Ian Fliedner, Director, Communications and External Affairs
Mr William Frilay, Manager, Government Relations

Shell Australia
Mr Russell Caplan, Chairman
Mr Peter Scott, General Manager, External Affairs, Downstream

Western Transport Alliance & City of Wyndham
Mr Ian Robins, Chair, Steering Committee and Chief Executive Officer, Wyndham City Council
Mr Timothy Cottrell, Senior Traffic Engineer, Wyndham City Council

City of Whitehorse
Mr Keith Loveridge, Energy and Water Officer

Public Transport Users Association
Mr Timothy Long, Committee Member
Mr Cameron Tampion

Environment Victoria
Ms Louise Sales, Transport Campaigner

Friday, 30 June 2006
Jubilee Room, Parliament House
Sydney

Pacific National
Mr Gregory Green

Rail Technical Society of Australasia
Mr Andrew Honan, Chair, Government Relations Subcommittee
Mr Maxwell Michell, Member, Government Relations Subcommittee

Australian Cane Growers Council
Mr Bernard Milford, Senior Manager, Policy

Centre for Low Emission Technology
Dr Kelly Thambimuthu, Chief Executive Officer
Dr Graham Reed,Program Manager

Hydro Tasmania
Mr John Titchen, Manager, Technology and Commercialisation
Mr Lachlan Tait, Graduate Policy Analyst

Council of Social Service of NSW
Mr Dinesh Wadiwel, Senior Policy Officer

Dr Philip Laird, Private capacity

Microbiogen Pty Ltd
Dr Philip Bell, Manager, Research Innovation

Tuesday, 11 July 2006
Jubilee Room, Parliament House
Sydney

Dr Ali Samsam Bakhtiari, Private capacity

ASPO Australia Working Group on Urban Planning and Transport
Mr David Kilsby, Convenor

Griffith University
Dr Neil Sipe, Head of School, School of Environmental Planning
Dr Jago Dodson, Research Fellow Fellow, Urban Research Program, Griffith University

Friday, 11 August 2006
Parliament House
Canberra

Australian Petroleum Production and Exploration Association
Ms Belinda Robinson, Chief Executive
Mr Noel Mullen, Deputy Chief Executive
Mr Ranga Parimala, Director, Exploration and Access

Cooperative Research Centre for Greenhouse Gas Technologies
Mr Barry Hooper, Capture Program Manager

Ford Motor Company of Australia Ltd
Mr Russell Scoular, Government Affairs Manager

Industries, Communities and Energy Division,Australian Greenhouse Office
Mr Barry Sterland, First Assistant Secretary
Mr Gene McGlynn, Assist Secretary, Energy Efficiency and Community Branch
Ms Lynden Ayliffe, Assistant Secretary, Environment Standards Branch
Mr Michael Ward, Acting Director, Clean Fuels and Vehicles
Mr Chris Baker, Director, Fuels and Technology
Mr Paul Kesby, Director, Air Quality Section

Australian Institute of Petroleum
Dr John Tilley, Executive Director
Mr Paul Barrett, Deputy Executive Director
Mr Nathan Dickens, General Manager, Policy

Queensland Department of State Development, Trade and Innovation
Mr Phil Jardie, Manager, Processed Foods and Renewable Fuels Unit
Ms Siobhán Ahern, Principal Policy Officer, Processed Foods and Renewable Fuels Unit
Mr Bruce Harrison, Principal Policy Officer, Processed Foods and Renewable Fuels Unit

Friday, 18 August 2006
Parliament House
Canberra

Department of Transport and Regional Services (including BTRE)
Mr Mike Mrdak, Deputy Secretary
Mr Stewart Jones, General Manager, Transport Integration and Reform
Mr Phil Potterton, Director, Bureau of Transport and Regional Economics
Mr Peter Robertson, General Manager, Vehicle Safety Standards
Dr David Gargett, Research Leader, Bureau of Transport and Regional Economics
Mrs Lyn Martin, Senior Economist, Bureau of Transport and Regional Economics

Department of the Treasury
Dr Steven Kennedy, General Manager, Domestic Economy Division
Mr Patrick Colmer, General Manager, Indirect Tax Division
Mr Mark O'Connor, General Manager, Individuals and Exempt Tax Division
Mr John Hawkins, Manager, Commodities, External and Business Unit, Domestic Economy Division
Mr Martin Jacobs, Manager, Individuals Non-Business Unit, Individuals and Exempt Tax Division

Department of Industry, Tourism and Resources
Mr Bob Pegler, General Manager, Offshore Resources Branch
Mr Jeff Beeston, General Manager, Automotive, TCF and Engineering Branch, Manufacturing, Engineering and Construction Division
Dr Naomi Ashurst, Manager, Alternative Fuels and Fuel Supply Section

Mr Martin Squire, Manager, Petroleum Refining and Retail Section
Mr William Crawshaw, Manager, Resources Taxation Section, Safety, Taxation and Projects Branch, Resources Division
Mr Jonathan Chamarette, Resources Taxation Section
Mr Chris Lloyd, Manager, Major Projects Section, Safety, Taxation and Projects Branch, Resources Division

Geoscience Australia
Dr Clinton Foster, Chief of Petroleum and Marine Division
Mr Denis Wright, Chief Petroleum Engineer
Mr Stephen LePoidevin, Senior Reservoir Engineer

Australian Bureau of Agricultural and Resource Economics
Ms Karen Schneider, Deputy Executive Director
Dr Don Gunasekera, Branch Manager, International Branch
Mr Paul Ross, Brach Manager, Energy and Minerals Branch
Mr Graham Love, Section Head, Energy Projections and Analysis
Dr Jammie Penm, Acting Chief Commodity Analyst

Australian Automobile Association
Mr Lauchlan McIntosh, Executive Director
Mr John Metcalfe, Director, Research and Policy

Appendix Three

CSIRO response to question on notice on 12 May 2006

CSIRO

CSIRO Government Relations
CSIRO Corporate Centre
PO Box 225, Dickson ACT 2602
Telephone: (02) 6276 6368 Facsimile: (02) 6276 6304
www.csiro.au
ABN 41 687 119 230

Our Ref: 06-239 future oil supply

Ms Roxane Le Guen
Committee Secretary
Senate Rural and Regional Affairs and Transport Committee
Department of the Senate
PO Box 6100
Parliament House
Canberra ACT 2600

Tuesday, 27 June 2006

Dear Ms Le Guen,

During the hearing on 12 May as part of the inquiry into Australia's future oil supplies and alternative transport fuels, the following question was asked of CSIRO, which was taken on notice at the time:

> **CHAIR**-I asked a question of ABARE before and I think someone said to try asking CSIRO. ABARE was saying it was $40 a tonne for CO_2. Do you know how much that converts to per barrel?

We have consulted with a number of our experts on this issue and CSIRO provides the following answer to the Committee:

It should be noted first of all that the question is not straightforward and that the calculation depends on the type of fuel generating the CO_2 and through what production process.

The following table shows the barrel of oil equivalents (BOE) of a tonne of different fuels:

tonne of	**Equals BOE**
Liquefied Natural Gas (LNG)	8.7
Liquefied Petroleum Gas (LPG)	8.458
oil	7.9
condensate	9.04
coal	~3 to 5

This allows us to assume an average of 8 barrels (bbl) per tonne of liquids. Looking then at the different types of liquids production the following numbers result:

Tonne CO_2 / Tonne HC from TIGAS / coal	**Tonne CO_2 / Tonne HC from TIGAS / natural gas**	**Tonne CO_2 / Tonne HC from Fischer Tropsch**
3.9	0.67	1.2

(Note: HC means hydrocarbons. TIGAS is one of the more efficient ways of making synthesis gas, which is then recombined to make synthetic fuel. Fischer Tropsch is the conventional means of recombining the synthesis gas to make mainly diesel)
Based on an average of 8 bbl/Tonne of liquids, we arrive at the following amounts of CO_2 per barrel of HC:

Tonne CO_2 / bbl HC	0.48	0.08	0.15

Working on the assumption of a carbon tax of AUD40 per tonne CO_2, this equates to:

AUD equivalent / bbl HC	AUD19.30	AUD3.20	AUD6.00

To really understand the costs per barrel, it is necessary to put taxation costs in context. We have summarised the costs of the different CO_2 options per barrel of HC from different sources (figures taken from the Stanford University economics of CO_2 sequestration):

	AUD – from TIGAS/coal	**AUD from TIGAS/ natural gas**	**AUD Fischer Tropsch from natural gas**
Cost per bbl HC in AUD of capturing CO_2	33	7	14
Plus one of:			
Cost per bbl HC in AUD of underground sequestration of CO_2	46	9	18
Cost per bbl HC in AUD of using CO_2 for Enhanced oil recovery	7	1.5	3
Cost per bbl HC in AUD of using CO_2 for enhanced coal-bed-methane production	23	4	8

A recent paper by Allinson *et al* (2003) estimated the cost of capture and storage of CO_2 in Australia to be USD 13-45 per tonne (AUD 17-60) (Allinson, W.G., Nguyen, D.N. and Bradshaw, J. 2003. The economics of geological storage of CO_2 in Australia. *APPEA Journal* **43** (1), pp623-636.)

We trust that the above provides sufficient information in response to the question. Should the Committee have any further questions regarding the information provided in this letter, please do not hesitate to contact me.

Yours sincerely

Sheila Lunter
Senior Adviser Government Relations

Appendix Four

Documents Tabled at Public Hearings

Wednesday, 12 April 2006

Date	Lodged By	Title/Subject	No of Pages
12/4/06	Mr Bruce Robinson, ASPO	Page of graphs relating to NYMEX Futures and ABARE oil price forecasts	1
12/4/06	Sustainable Transport Coalition (WA)	▪ Article titled *Russia to supply less oil than expected*, C Hoyos and K Morrison, Financial Times, 11 April 2006 ▪ Brochure titled *Sustainable Transport Coalition Policy Statement: Bicycle* ▪ Brochure titled *Sustainable Transport Coalition Policy Statement: Walking* ▪ Series of graphs: • World oil production Jan 2002-Feb 2006 – plateau for 18 months at 84.5 mill bpd • Saudi and Russian increase in oil production – 50% of world increase • World oil production 1995-2006 – plateaus in 1998-99 (75mbpd) and 2001-02 (78mbpd) • US EIA projection of oil price 2003-05 - <US$30pb • US EIA projection of oil price 2006-08 – US $60pb • World oil spare production capacity – drop 2002-06 from 5 mbpd to 1mbpd • OPEC oil production March 2006 – only Saudi has spare capacity • Non-OPEC supply growth 2005-07 – only US and Angola big jumps	1 16 4 10

Friday, 12 May 2006

Date	Lodged By	Title/Subject	No of Pages
12/5/06	Geoscience Australia	Visual material relating to the submission by Geoscience Australia to the Rural and Regional Affairs and Transport Committee Inquiry into Australia's Future Oil Supply and Alternative Transport Fuels – Dr Clinton Foster, Chief, Petroleum and Marine Division	17
12/5/06	ABARE	Graph: *Crude Oil Prices since 1970*	1
12/5/06	Engineers Australia	Article from MSNBC Website: *Boost for natural cars: Home fueling: Honda, partner will sell unit in 2005, starting with California*	4
12/5/06	International Association of Public Transport	Brochure titled: *Energy Crisis? Climate Change? – Breathe Easy: How a properly-balanced transport system can help preserve and improve our urban environment: a UITPANZ Policy Statement*, IAPT, Canberra	6
12/5/06	Australian Lot Feeders Association	*Australia's future oil supply and alternative transport fuels: Paper for Senate Inquiry,* supported by Australian Lot Feeders Association and Meat and Livestock Australia, Centre for International Economics, May 2006	36

Friday, 9 June 2006

Date	Lodged By	Title/Subject	No of Pages
9/6/06	Western Sydney Regional Organisation of Councils	Maps: ▪ ABS Index of Relative Socio-Economic Disadvantage, Sydney Urban Suburbs 2001 (Source: Urban Frontiers Program UWS) ▪ Oil Vulnerability in Sydney (Source: Jago Dodson and Neil Sipe, Urban Research Program, Griffith University	1 1
9/6/06	Biodiesel Association of Australia	▪ Letter to President of BAA from Australian Oilseeds Federation, dated 8 June 2006 ▪ Letter to President of BAA from Gardner Smith (Holdings) Pty Ltd, dated 9 June 2006 ▪ List of Biodiesel Plants in Australia ▪ List of Comparative Diesel vs Biodiesel Prices Pre and Post 1 July 2006	2 1 1 1
9/6/06	Bioenergy Australia	▪ Presentation Notes: *Biomass Based Transportation Fuels: Rural and Regional Affairs and Transport Committee, 9 June 2006,* Dr Stephen Schuck, Manager, Bioenergy Australia ▪ Booklet titled: *Wood for Alcohol Fuels: Using farm forestry for bioenergy,* JVAP Research Update Series No. 7, RIRDC, Canberra ▪ Publication titled: *Biomass energy production in Australia: status, costs and opportunities for major technologies,* C. Stucley, S, Schuck, R. Sims, P. Larsen, N. Turvey and B. Marino, RIRDC Publication No. 04/031, RIRDC Project No. EPL-1A, February 2004 ▪ Brochure: Vaxjo Varnamo Biomass Gasification Centre, Sweden ▪ IEA Bioenergy Annual Report 2005 ▪ Publication titled: *Biomass: Green*	17 16 251 6 118

		Energy for Europe, European Commission, Brussels ▪ Book titled: *Biofuels for Transport: An International Perspective*, International Energy Agency, Paris	46 210

Thursday, 29 June 2006

Date	**Lodged By**	**Title/Subject**	**No of Page s**
29/6/06	ASPO Australia Finance and Economics Sector Working Group	Document titled: *Measuring Oil Vulnerability*, including diagram showing spatial plot of oil vulnerability in Melbourne measured using the VIPER model	1
29/6/06	Wyndham City Council	Copy of presentation prepared by Wyndham City Council for public hearing – Thursday 29 June 2006	26
29/6/06	Public Transport Users Association	Document titled: *Choosing the Right Options: Response to the VCEC's Draft Report on Managing Transport Congestion from the Public Transport Users Association*, Public Transport Users Association Inc., 2006	63

Friday, 11 August 2006

Date	**Lodged By**	**Title/Subject**	**No of Page s**
11/8/06	Australian Institute of Petroleum	Report: *Downstream Petroleum 2005,* Australian Institute of Petroleum, Canberra	23
11/8/05	Queensland Government, Department of State Development, Trade	▪ Report: *Inquiry into petrol pricing in Queensland*, Impact of Pricing Select Committee, Legislative Assembly of Queensland, April 2006 ▪ *Queensland Government Response to the*	197 16

	and Innovation Industry Development and Small Business	*Impact of Petrol Pricing Select Committee*, June 2006 ▪ Package of information sheets and brochures: *E+ ethanol powered by nature,* Queensland Government	

Friday, 18 August 2006

Date	**Lodged By**	**Title/Subject**	**No of Pages**
18/8/06	Department of Transport and Regional Services	• Report: *Alternative Fuels in Australian Transport*, Bureau of Transport and Communications Economics, Information Paper 39, AGPA, 1994 • Report: *Australian Trends to 2020*, Bureau of Transport and Regional Economics, 2002	325 254

Appendix Five

Index of Documents Provided During Inquiry

Date	Provided by	Title/Subject	No of Pages
27/6/06	Sheila Lunter, Senior Adviser, Government Relations, CSIRO	Answer to question taken on notice during 12 May 2006 public hearing – cost of CO2	3
28/6/06	Rob Howse, Australian Trucking Association	Answer to question asked by Senator Milne during 12 May 2006 hearing – via email	1
3/7/06	Railway Technical Society of Australasia	Report provided at request of committee during 30 June 2006 hearing – *Engineers Australia: RTSA: Study Tour – Branch Lines of NSW 22-25 March 2005, Study Tour Notes*	69
14/7/06	Shell Australia	Document provided at request of committee during 29 June 2006 hearing – *APPEA Issues Paper: Australia's upstream oil and gas industry: a platform for prosperity*, May 2006 (2 copies provided)	59
11/8/06	Dinesh Wadiwel, Council of Social Service of NSW	Information provided at the request of committee regarding Council of Social Service NSW submission – email attaching web addresses	1
11/8/06	Carmel Anderson, Communication Manager, CO2CRC	Additional information provided at the request of the committee following 11 August 2006 hearing: ▪ Extra information packages ▪ Extracts from IPCC Carbon Dioxide	

		Capture and Storage Summary for Policy Makers ▪ Confirmation of numbers for coal-to-liquids add-on ▪ Slide showing comparative costs of carbon dioxide capture technologies	
25/8/06	Nathan Dickens, Australian Institute of Petroleum	Answer to question asked by committee at 11 August 2006 hearing. *Australian Petroleum Statistics*, Issue No. 119, Department of Industry and Tourism, June 2006	32
1/9/06	Graham Love, ABARE	Answer to question taken on notice by Dr Fisher at 12 May 2006 hearing – carbon tax	5
4/9/06	Mr Jeff Beeston, Department of Industry, Tourism and Resources	Correction of evidence provided at 18 August 2006 hearing – estimate of number of vehicles expected to attract LPG subsidy	2
12/9/06	Mr Bob Pegler, Department of Industry, Tourism and Resources	Answers to questions taken on notice at 18 August 2006 hearing	5
21/9/06	Dr Stephen Schuck, Bioenergy Australia	Answer to question taken on notice at 9 June 2006 regarding biofuels use in Australia as a percentage of total fuel use	1
22/9/06	Mr Barry Hooper, CO2CRC	Email regarding confirmation of figures provided at hearing	2
25/9/06	Mr Martin Jones, CSR Limited	Response to request for answers to questions taken on notice at 9 June 2006 hearing – Brazil ethanol exports	2
26/9/06	Mr Tim Wyatt, Department for Planning and Infrastructure, WA	Answer to question asked as a follow-up in relation to WA department's work in oil vulnerability mapping with attached Relative Transport Vulnerability Map	2

1/10/06	Mr Daniel Bowen, Public Transport Users Association	Information provided in response to questions taken on notice, including: ▪ Article titled *Ethanol as Fuel: Energy, Carbon Dioxide Balances and Ecological Footprint,* De Oliveira, Vaughan and Rykiel, Biocience, Vol. 55, No. 7, July 2005 ▪ Document titled *Five years closer to 2020: A plan to get transport back on track,* Public Transport Users Association, Melbourne, November 2005	24
4/10/06	Ms Victoria Crapper, Australian Greenhouse Office, Department of Environment and Heritage	Responses to questions taken on notice at 11 August 2006 public hearing by officers of the Department of Environment and Heritage (with attachments)	69
5/10/06	Russell Scoular, Ford Motor Company of Australia Limited	Answers to questions taken on notice by Russell Scoular at 11 August 2006 hearing.	2
5/10/06	Rob Howse, Australian Trucking Association	Answer to question in relation to road and rail freight – email	1
6/10/06	Mr Oscar Pearse, Australian Lot Feeders Association	Answers to questions asked of Mr Kevin Roberts during hearing with attached report: *Australia's future oil supply and alternative transport fuels: Paper for Senate Inquiry,* Centre for International Economics, May 2006	60
6/10/06	Mr Peter Strang, Bicycle Federation of Australia	Response to information requested by the committee at 12 May 2006 hearing with attachments	241

10/10/06	Ms Rebecca Russell, Queensland Transport	Answers to questions taken on notice at 11 August 2006 hearing relating to TravelSmart	4
11/10/06	Mr John Titchen, Hydro Tasmania	Answers to questions taken on notice at 30 June 2006 hearing	6
20/10/06	Peter Robertson, Department of Transport and Regional Services	Documents requested by the committee (Senator Milne) at 18 August 2006 hearing.	22