Australia's future oil supply and alternative transport fuels

Submission to Senate Inquiry into Australia's future oil supply and alternative transport fuels

From

The National Committee on Transport, Engineers Australia

1. Who we are

Engineers Australia was formerly known as the Institution of Engineers, Australia.

The National Committee on Transport (NCTR) of Engineers Australia is a committee of practicing transport engineers who serve the body of professional transport engineers in Australia by, among other things :

- promoting excellence in transport systems, analysis techniques in education;
- providing expert guidance on transport issues to Institution members and others; and
- encouraging informed debate on transport issues.

The Committee members are not employed by Engineers Australia and this submission represents the view of the Committee, not that of Engineers Australia as an institution.

The principal author of this submission is the current Chairman of the Transport Panel of the Sydney Division and is a member of NCTR.

2. Overview

As part of its mission to encourage informed debate on transport issues, NCTR has prepared a number of discussion papers on transport issues. One of these [1] covered energy futures for Australian transport, and it was published in "Transport Engineering in Australia", the transport journal of the institution. This discussion paper is appended (**Appendix A**), because it forms the basis for the argument of this paper that global oil production will not be able to continue rising for much longer, while demand for oil is increasing. This will bring major problems for whole economies, but particularly for transport. Implementation of the recommendations of the 1998 Sustainable Energy Transport Taskforce of

Engineers Australia ([2]) would at least buy a little more time to consider the options more thoroughly. These recommendations are repeated in **Appendix B**.

In slightly more detail:

- sooner or later global oil production will reach a plateau and then start declining, because oil is a finite resource;
- the uncertainty is not whether this will happen but when;
- available data is extremely rubbery and the point when this peak is past will probably only be detectable with hindsight;
- nevertheless it is uncomfortably close, probably within ten years from now;
- all the projections for global energy demand are rising – it will not be possible to satisfy these from oil production growth as it has in the past;
- the world will not run out of oil for a long time but it may run out of cheap oil very soon;
- the implications of restricted oil availability and higher oil price are many but irrespective of what happens in other sectors, the transport sector will be badly affected because of transport's high dependence on oil at present;
- this is an issue of national importance which is not taken into account in national or most state strategies yet;
- there will probably be a conflict between metropolitan and rural/regional demands for oil in Australia, when there is less of it available and demand for both continues to rise;
- there will be a long lead time for actions to be effective; and
- Engineers Australia have been aware of this issue for many years. A 1998 report of the Sustainable Energy Transport Taskforce made a number of recommendations to government (**Appendix B**). NCTR does not believe that these would be sufficient to avoid the coming problem, but their implementation would at least buy some time to examine the further options more thoroughly.

Appendix C is a press release recently issued (December 2005) by the Sydney Division of Engineers Australia, following the publication of the NSW State Government's strategy for managing the growth of Sydney over the next 25 years.

3. The Australian Transport Task

Transport currently accounts for 41% of Australia's final energy consumption, and is forecast to grow (provided fuel is available) by 2.4 per cent per annum over the next 20 years [3].

The AusLink White Paper ([4], P 3) gave the information shown in **Table 1** for the domestic freight task.

Table 1: The domestic freight task 1999-2000 broken down by mode
Source : DOTARS [4]
]

Domestic freight 1999-2000	Tonnes	Tonne-kilometres (375.3 billion)
Air	<1%	<1%
Road	72%	37%
Rail	28%	35%
Sea	2%	28%

For passenger transport the White Paper offered a little less information. DOTARS quoted an estimate of passenger-kilometres in 1999-2000 as 311 billion:

- of which the car accounted for over 80% of kilometers travelled and was the strongly preferred mode for trips of up to 400 km;
- private road vehicles accounted for 93% of urban passenger transport;
- air travel became significant for journeys of more than 400 km and was the dominant mode for journeys of more than 1200 km;.
- the non-urban passenger task had grown slightly more strongly than the urban over the last 20 years, at 2.7 and 2.5 per cent per annum respectively; and .
- urban passenger-kilometres were forecast to increase by 1.3 per cent per annum over the next 20 years and non-urban by 1.8 percent – although most of the non-urban increase is in air travel not car travel.

These percentages exclude non-motorised trips. Data for Sydney in 2002 [5] showed that walking and cycling accounted for over 17% of trips by Sydney residents over a 24 hour day, while public transport (train, bus, ferry, taxi, other) accounted for up to 13%. Private vehicles accounted for 70% of person movement, or 84% of weekday urban motorized passenger trips. The figure for Sydney would probably be the lowest of anywhere in Australia, At weekends in Sydney the percentage of person trips in private vehicles rises to 77%. With the average length of an urban trip in Sydney being nearly 9.5 km, clearly walking and cycling do not have a similar impact on the breakdown of travel as they do on the breakdown of trips. (Indicative calculations have shown [6] that while a transfer of short trips from car to non-motorised power would have little effect on fuel consumption, combination of such a transfer with a move to shorten trips by land use changes could have a dramatic effect).

The AusLink White Paper observed ([4], p4) that “in regional and rural areas, low population densities tend to preclude alternatives to the use of cars for business and personal travel”.

The White Paper also clearly stated ([4], p9) the Australian Government’s position on public transport – that this was primarily a State or Territory government responsibility. The absence of any significant Commonwealth involvement in urban public transport will make it difficult to introduce any future

national policy that seeks to reduce oil demand more than pro rata in metropolitan areas (where alternatives can be provided) and less in regional and rural areas (where they cannot).

4. The Future of Oil

The mode likely to be worst affected by a decrease in availability of oil, or an increase in its price, or both, is aviation. This is because there is no feasible alternative in sight for oil-based fuel for aircraft. Tourism is a non-transport sector that is heavily dependent on transport (road transport as well as aviation) and hence oil. The forecast growth in aviation demand cannot occur if planes cannot be fuelled at roughly today's prices. If road transport becomes more problematical, the rural and regional businesses that depend on caravanners for their trade will suffer. The fruit-picking industry tends to rely on itinerant back-packers who need cheap transport to get around: therefore higher fuel prices could hit farm production not only through higher costs to distribute the produce but also through less access to labour.

Road transport would also be heavily affected. All urban freight, most rural freight, and most person movement in both types of area takes place on roads. Most of the fuel now consumed by cars is required to move the vehicle rather than its payload, the person or people in it. The average age of a vehicle in the Australian fleet is 10.2 years, with 27% registered in 2005 manufactured before 1991 [7], and so it will take a long time for engine efficiencies to best-practice standards to impact on the performance of the average vehicle. Consumers can react to more efficient engines by driving further or driving heavier vehicles rather than by consuming less fuel to do the same transport task as before, and so the fuel savings implicit in the better engine economy are not captured.

The year 2006 saw a record number of sales of new cars and trucks in Australia, up 3.5% on 2004, but compared with 2004 small car sales were up by 18.6% while demand for large cars fell by 15.7%.

The future for road transport seems to point to even more vehicles than today, but not so dominated by petrol or diesel fuelled vehicles as today.

In the long term rail transport is less vulnerable to a disruption in the supply or higher price for oil, because a railway locomotive is effectively a power plant on rails and can be designed to make use of whatever fuel is most economical at the time. However practically everywhere has a road connection, while connections to the rail network are very limited. Moreover many individuals and individual businesses are required to provide their own road vehicles, but this is not the case for the rail network.

Sea transport is the least vulnerable mode, because most ships contain their own power plants, size is not a significant constraint and, as with rail, ships can be

designed to utilize whatever power source is most economical. But the connections (ports) to sea routes are even more limited than for the rail network and only serve coastal or international destinations.

As the Commonwealth Government showed in its 2004 Energy White Paper ([8] **-** the relevant figure is reproduced as Figure 2 in Appendix A) road transport and aviation accounted for most of the transport energy demand in 2000 and their energy requirements are expected to grow much faster than those for rail, sea or pipeline transport over the next 20 years.

The date of the peak of global oil production is something no two experts in the field agree on, and the shape of the graph of global production over time (see Figure 1 in Appendix A) is such that the peak of the curve is flattish for a long period and hence fresh discoveries or technological breakthroughs have the potential to shift the technical peak by quite a few years. Nevertheless the basic shape of the graph remains as shown. While there are extreme pessimists (who think we have already passed the peak) and extreme optimists (who put the peak thirty years or more into the future), much of the debate centres on whether the peak will occur in the next five years or the five after that. This is too close for complacency.

5. Alternative fuels

Transport, because of its distributed nature, requires a decentralised source of energy. This requires reticulation of energy (like the overhead electricity to power urban trains) , a portable source (like petrol for cars), or a widely available renewable energy supply (like wind, in days gone by, for sailing ships, or human muscle power for urban cycling).

Most of the R&D funding for technological development in alternative fuels comes not from national governments but from the energy or automotive interests, whose objectives are to sell us more energy (not necessarily oil-based) or more cars (not necessarily oil-powered). Both are therefore likely to promote supply-side options: reducing demand for their product is not in their interest, although it is highly relevant from a public policy viewpoint..

Major advances are being made in the fuel efficiency of new engines and/or vehicles. This is a mixed blessing. On the one hand less fuel is required to move a given mass a given distance; on the other, consumers currently have the freedom to respond by buying larger vehicles or by driving more or both, and in either case more fuel-efficient cars are probably more technologically sophisticated and hence more expensive cars.

Table 2 shows BTRE estimates [9] of the change in new and average car fuel intensities, in the size of the car fleet and the amount of car travel, and in the fuel consumed by cars and commercial vehicles between 1971 and 2001. Their data

shows that while the fuel intensity of new cars dropped considerably over that time, the fuel intensity of the average car in the fleet did not; the size of the car fleet, the volume of travel and the fuel consumed all increased by around 130%; and the rise in fuel consumed by the commercial vehicle fleet was much higher.

Table 2: Energy characteristics of Australian vehicle fleets 1971 and 2001
Source: BTRE [9]

	Units	1971	2001 (estimate)	% change
Fuel intensity – new car	l/100 km	12.60	9.63	-24%
Fuel intensity – average car in fleet	l/100 km	12.28	12.08	-2%
Passenger car numbers	thousands	3,997	9,454	+136%
Passenger car vehicle kilometers	billions	63.8	146.5	+130%
Energy consumed – cars	petajoules	268	605	+126%
Energy consumed – light commercials	petajoules	39.6	179.3	+353%
Energy consumed – rigid trucks	petajoules	45.8	78.5	+71%
Energy consumed – articulated trucks	petajoules	29.6	101.3	+242%

Our understanding of energy issues is rudimentary, as our expertise lies in the use made of energy by transport rather than the generation of that energy. Nevertheless the impending transport fuel crisis has fiorced us to look into such matters and the following comments summarise our understanding:

Renewable energy

Renewable sources: – solar energy, wind energy, tidal energy, geothermal energy may have potential for stationary power generation and as a power source in remote areas but for the major transport modes for aviation and road transport it does not appear to have much potential because the energy is produced in the wrong places, it is not portable and it cannot be easily stored.

Biofuels

The expectation that biofuels – ethanol, biodiesel – will meet all Australia's future transport needs is misplaced. Even if the technical difficulties of adapting engines to use this fuel without damage could be managed – and they do not seem insuperable – the scale of the requirement would defeat this as a solution. For ethanol it has been calculated [10] that If we wanted to keep our sugar production at current levels, we would have to triple sugar cane land just to run Sydney's cars. It would take at least 15 years to convert our car fleet to cars suitable to run on an 85% ethanol/petrol blend (E85). In order to produce all that ethanol, we need an unending supply of gas (8 GJ per hectare p.a.) for nitrogen fertilizer production plus energy for the distillation process and other inputs and,

of course, sufficient, regular rains or irrigation water. While biofuels might make a difference at the margin, they will not appreciably affect the problem caused by Australia's oil dependency.

Conventional oil

The major fields are maturing and, outside the Middle East, most producing countries have passed the peak of their production. Hence the future of the world's energy supply will be even more bound up with Middle Eastern geopolitics than it is already. New discoveries of oil tend to be in relatively unexplored areas where extraction is difficult and expensive, eg in deep water or polar regions.

Hybrid vehicles have the potential to increase fuel economy dramatically but Australian-made cars are still of the large "family car" variety. Hybrid cars require expensive technology to function, however, and the current import concessions on four-wheel-drives could be more appropriately applied to less oil-dependent vehicles.

Diesel, unleaded petrol and fuels for aviation and marine use are all refined petroleum products. Government revenue is derived from all these products and the Government is faced with the challenge of maintaining its income stream. Nevertheless the Government policy on the use of diesel seems to be sending mixed messages. On the one hand Australia cannot produce much diesel from its predominantly light crude oil and imports most of it, and it costs more at the pump than petrol (unlike in Europe); on the other its use is encouraged by fuel subsidies to farmers and fleet operators like the State Transit Authority in Sydney, who changed an order for 150 gas-powered buses to one for 150 diesel-powered vehicles in June 2004, on commercial grounds. "Because of price, and policy changes, we have to rethink our approach to gas" said the STA Chief Executive at the time. NCTR feels that the Government really needs to make up its mind whether diesel use is something to be encouraged or discouraged, and act consistently.

Unconventional oil

The world – especially Canada - has plenty of "unconventional oil" in shale or tar fields, which is included sometimes (notably by IEA) in the global oil reserves figure. However the extraction of the oil would be hugely expensive and environmentally damaging, as ore must be mined, crushed, boiled and washed. To date the energy requirements to do this exceed the energy that would be available from the end product, and so it does not seem worth doing with existing technology even if a high price of oil in future made it financially viable.

Natural gas

Natural gas is a finite resource. Australia is well endowed with the raw material for energy. The Commonwealth Government White Paper on Energy Futures estimated ([8], Figure 2) that Australia has enough demonstrated oil resources for 15 years, enough natural gas for 70 years, enough uranium for 130 years and enough black coal for 110 years (and brown coal for 560 years) – although this clearly depends on the rate of consumption. This is seen as a source of income for Australia, but uranium and coal are not energy sources suitable for transport. Instead of trying to wean our heavy vehicle fleet off imported diesel and onto natural gas as soon as possible, we are selling our natural gas heritage overseas to generate export dollars without considering whether we might need it ourselves in future. Once the oil and the natural gas are gone, there will be no readily available source of energy suitable for our transport. An analysis of our future domestic energy requirements for transport would be a prudent step.

Coal

Australia has plenty of coal, but this cannot be used directly for transport. Moreover, burning coal to extract the energy contained in it produces copious volumes of CO_2. NCTR is not competent to assess the options for dealing with this, for instance geosequestration, but it would observe that any attempt to utilize the energy on coal for transport, for instance by gasification, that did not also address the greenhouse emissions produced as a by-product of the process could not be considered as a complete option.

Nuclear energy

Nuclear power has not featured on an Australian agenda so far, because of intractable waste disposal issues. Nuclear power stations also have high cost and limited life, though the energy itself can be produced cheaply once this investment is made. However when the energy needed to construct the plant in the first place and then dispose of it after the end of its working life are included (as shown in outline in Figure 1), nuclear power as a source seems to be a bad idea. We consider the sort of whole-of-life energy analysis for infrastructure projects shown in Figure 1 to be essential and it forms recommendation 9 of our position on Transport, the Environment and Health [11] (“A holistic systems view when planning would need to consider energy requirements as well as financial requirements.”).

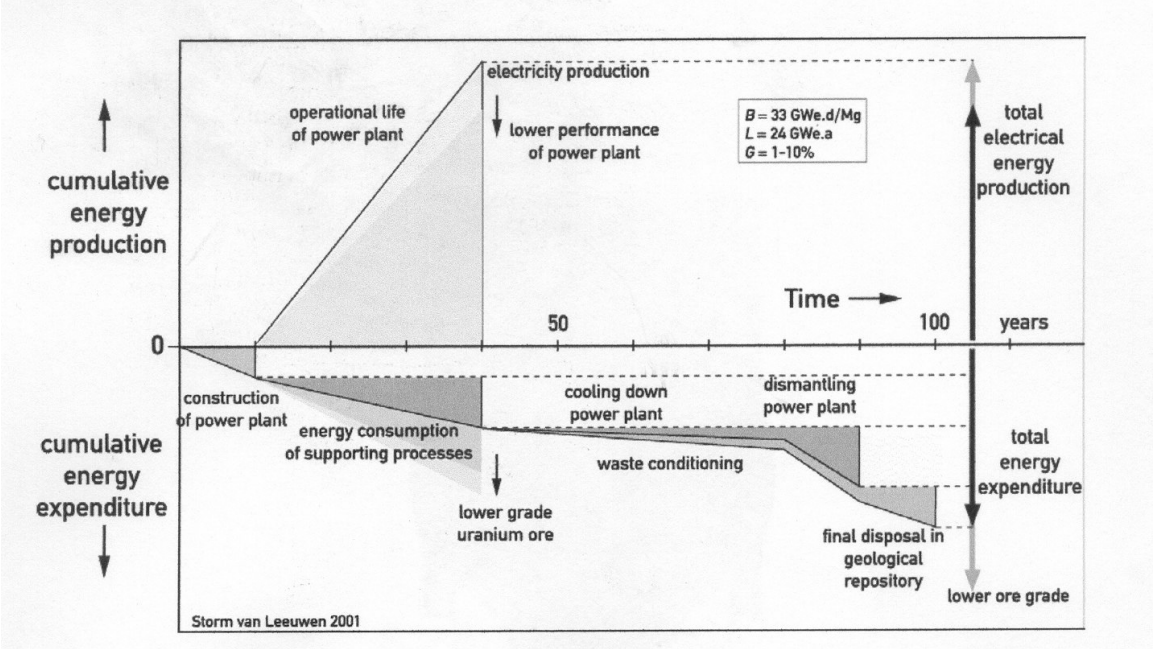

Figure 1: Schematic representation of the energy production and energy costs if nuclear power set out roughly as a function of time.
Source: van Leeuwen [12]

In the absence of planning for any alternative, greater use of nuclear power to produce hydrogen may well seem a default option for transportation energy. The United States is already following this direction. If a nation was truly desperate for alternative energy sources, nuclear waste disposal issues might be deferred for later generations to sort out.

The Sydney Branch of the Australian Institute of Energy held a symposium in June 2005 entitled *Nuclear Energy for Australia: Irrelevant or Inevitable?* [13]. The summary said, among other things: “To the extent that it is possible to draw any single conclusion, it is that given the need to gain public acceptance, pass the necessary enabling legislation, select a suitable location, and secure all planning and other approvals, short of some unforeseeable emergency it will take so long for a nuclear power station to be commissioned in Australia (2025 or thereabouts) that it is largely irrelevant to our short- and medium-term energy requirements.”

Hydrogen

The energy inherent in hydrogen is carried by it, like electricity, rather than a source in its own right. Hydrogen only occurs naturally in combination with other elements (eg in coal, oil, natural gas or water) and the process of separating it is an energy-intensive one. The “hydrogen economy” appears to be a pipedream with out an effective way of producing – and then distributing – the hydrogen. Fuel cell road vehicles may be decades away from commercial production [14].

The United States has embraced the concept of a hydrogen car and is supporting it with federal R & D funds – with the hydrogen probably being created by nuclear energy – but this seems to be mainly so that its citizens can retain their present unsustainable lifestyles without heavy future reliance on Middle Eastern oil.

6. Specific points

projections of supply & demand & implications for availability/price

Figure 1 in Appendix A summarises the issue. Of course the supply and demand curves cannot diverge as shown in practice. The laws of economics dictate that there will be some demand for oil that cannot be met, and the price of oil will rise; and the laws of physics dictate that remaining sources of oil will require more energy to extract.

At the same time, a higher oil price may make it economic for some known sources of oil to be further exploited (for conventional fields, oil production does not extract all the oil-in-place. The East Texas Oilfield is an exceptionally high-yielding one and is expected to yield 82 percent of its original oil-in-place, but this degree of recovery is highly unusual [15], with 35 percent being a more usual limit without recourse to enhanced recovery procedures) but if the effect is to open up some known reserves for production rather earlier than planned then the reserves will be consumed even faster and the eventual decline in the availability of oil will be accelerated.

With oil costing more, there will be a financial incentive to develop oil extraction technologies further and to develop alternative sources which may become more viable if the price of the main alternative (oil) rises, but in neither case will a return to the age of cheap energy be possible.

For the last six months of 2005 the average price of a barrel of crude oil on the New York Mercantile Exchange was over $US61.50, Evidence of a change in consumption or other behaviour may or may not be evident in data collected during this period. It will be instructive to see analysis of such data.

potential of new sources and alternative fuels to meet demand

Only the discovery of new oil provinces with plentiful reserves would make this possible. There is clearly some oil as yet undiscovered, and the oil industry devotes substantial and sophisticated resources to finding it – but the finds to date have either been of a small size compared to consumption rates or in locations very expensive to get at (eg polar regions, deep water) or both. The rate of discovery has been falling for decades while the global rate of

consumption has been increasing, and currently the latter is about four times higher than the former [16].

flow-on economic and social impacts

Our expertise does not cover areas other than transport, so we will leave this for others with more relevant expertise to comment on. However it is evident that many of the long-term forecasts for the demand for oil from transport are incompatible with the amounts that can be produced. The demand and supply curves cannot diverge – you cannot use what is not there. One consequence for transport will be greater prioritization of trips, with the distribution of food presumably being of high priority. Similarly, many discretionary urban car trips will be seen as of low priority. It is not possible to treat urban transport and rural/regional transport as different issues when they both make demands on the same fuel resource.

Pedestrian, bicycle and public transport networks in our cities will come to be seen as an essential element in urban design rather than the "optional extra" that they are often treated as now. The issue will be particularly keenly felt in outer metropolitan areas and regional areas, where few alternatives to car use exist. **Table 3** shows that nearly 60% of Australians lived in the five capital cities in 2001, with nearly 80% of us living in settlements of over 25,000 people.

Table 3: Australian population disaggregated by settlement size (000)
Source: CSIRO[17]

Settlement size	2001 est.	%	2011 est.	%
>1 million	11,517	59.7%	13,002	61.9%
80,000-1 million	2,601	13.5%	2,915	13.9%
25,000-80,000	1,282	6.6%	1,349	6.4%
Subtotal	15,400	79.8%	17,266	82.2%
Other	3,897	20.2%	3,751	17.8%
Australia total[1]	19,297	100.0%	21,017	100.0%

[1] National total calculated by different method from settlement size totals

options for reducing fuel demand

Different pricing of transport energy is a policy option usually not considered. It has been shown that, at least for NSW, that rural and regional traffic does not produce enough revenue t o fund its infrastructure requirements while urban traffic does not contribute fully towards its externality costs ([18]). This under-pricing of transport leads to its over-consumption. The effects on the transport sector of a higher oil price could be beneficial if lower demand for oil resulted, but offset against this would be the effects of a higher-cost transport industry on other sectors of the economy.

It is in urban areas that most alternatives to car use can be developed, because distances are shorter and densities are higher. This would mean that some urban trips (those for which feasible alternatives could be developed) are perhaps of lower priority than regional and rural trips (those for which they cannot). The absence of interest in transport in our metropolitan areas by the Commonwealth government is a little hard to understand.

Voluntary travel behaviour change programs are an area where Australia has world-class expertise and, while some scepticism exists about the ability of such schemes to maintain early results, it is strange that this is not recognized as an energy-saving measure by the Federal Energy White Paper ([8], p170).

All the demand drivers for transport energy are forecast to increase (eg [4] figures 4 to 9 inclusive), and this is used as a reason to invest in infrastructure which facilitates this increase (especially for freight). The relationship between the underlying factors of these increases (principally, globalisation of markets for freight and lifestyle changes for person movement) and sustainability has not been explored to the Committee's knowledge.

6.Conclusions

- Transport currently accounts for 41% of Australia's final energy consumption, and is forecast to grow (provided fuel is available) by 2.4 per cent per annum over the next 20 years.

- Complacency because Australia has plenty of coal is inappropriate. Transport does not run on coal.

- The peak of global oil production will soon be passed. Although the world will not run out of oil, the age of cheap oil will soon be only a memory.

- Although the price and availability of oil-based fuel is a long-term transport problem, there is short-term urgency in addressing it.

- The Commonwealth should take an interest in urban transport, because of its complementary nature with rural/regional transport in relation to fuel.

7. Recommendation

There is no easy solution. The policy response from Government should cover all available measures, including :

    - Application of conventional planning and regulatory measures to a greater extent than has been thought politically feasible so far

- Development of technological improvements to vehicles, fuels, infrastructure, system management etc.

- Use of economic measures including pricing. The market is the most appropriate mechanism for this, but where market forces fail to deliver environmental and social objectives government should intervene.

- Pursuit of demand management options and behaviour change programs. A prerequisite for this is public acceptance of the problem. Government should take a lead in developing public awareness. There is more scope for changing behaviour in urban areas than in regional or rural ones.

The recommendations of the Engineers Australia Transport Taskforce on Sustainable Energy remain as valid now as in 1998 when they were first put forward (see **Appendix B**). They may not be the answer to issues of lower oil availability and higher oil price, but they indicate directions that will help postpone the potential moment when more draconian measures become required.

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Appendix A Energy futures for Australia's transport

Energy Futures for Australian Transport

David Kilsby
Director, Kilsby Australia
Chairman 2003-04, National Committee on Transport, Engineers Australia

Introduction

At the 27th Australasian Transport Research Forum (ATRF) Conference in Adelaide in 2004, two papers were presented relating to oil futures.

Lyn Martin, an economist with the Bureau of Transport and Regional Economics (BTRE), reviewed the evidence for and against the proposition that the world was running out of oil (Martin 2004). While she did not attempt a conclusion one way or the other she asserted that the key issue was not the outcome of the debate regarding future oil supplies, but the appropriate Government policy response.

> *From a policy perspective the main issue is ... the efficient operation of the oil market ..*

She pointed out that although the cost of motoring is a politically sensitive issue in Australia, the price of oil and the cost of motoring are not the same thing.

> *A doubling of world oil prices (from $20 to $40 a barrel) increases the variable costs of motoring by less than 20 percent.*

(At the time of writing in early August 2005, the price of oil is around $60 per barrel).

Bruce Robinson, on the other hand, with a scientific background, was more pessimistic and suggested that the finite nature of oil resources invalidated the normal assumptions of economics. He presented the case not that the world was running out of oil but that the world was running out of cheap oil (Robinson, 2004). He concluded by asserting that

> *Transport planners who take notice of the oil storms now appearing on the radar screens will be far better equipped to help the community survive the large changes that are likely to sweep through Australia in the near future.*

That this issue is not yet on the radar of many authorities was amply demonstrated in November 2004 when the NSW Department of Energy, Utilities and Sustainability (DEUS) published an Energy Green Paper (DEUS, 2004) for the state. It referred virtually exclusively to power stations and electricity generation, despite a convincing estimate (ABARE, 2004) that transport accounts for about 44 percent of final energy use in NSW now.

The National Committee on Transport (NCTR) of Engineers Australia has been concerned about energy futures for transport for some time. The warning voices have been loud for many years. In 1998 the Chartered Institute of Transport (as it then was – it has now evolved into CILTA) mounted a National Symposium ("Beyond Oil") to examine this question, and after the symposium took the unusual step of issuing an unambiguous Outcomes Statement (CITIA, 1998) much of which we reproduce here.

> *We are at the climax of the fossil fuel age. The Chartered Institute of Transport in Australia draws attention to this fact following its 1998 national symposium "Beyond Oil: Transport and Fuel for the Future". Unlimited use of our greatest ever source of cheap energy may soon contract and the "Petroleum Age" in which we live can now be seen to be approaching an eventual end.*
>
> *The symposium heard that a clear consensus is emerging that cheap oil production outside the Middle East will begin permanent decline around the year 2000, to be followed by permanent world decline within 15 years.*
>
> *We have reached a crucial stage in the development of our local, national and international transport services. Our present path is leading us into potentially serious economic, social and environmental problems. New directions are needed for our future transport fuels and vehicles. "More of the same" in our current transport plans and ways of thinking is no longer tenable.*
>
> *The unlimited use of cheap oil that has characterised this century will end and we will be faced with one of the greatest transformations of human affairs. The signs are already there. Risk of chaos, disorder and conflict will arise unless we face up to this great challenge and make the difficult decisions essential to the future well being of us all. These decisions must be based on the care of people and of the environment if we are to proceed down the path of constructive change.*
>
> *Congestion, pollution and diminishing oil supplies are the central drivers of this change. Communities across the world are increasingly going to be faced with the need to revise their transport systems in response to these drivers. Congestion and pollution are already major factors in some cities - the diminishing fuel supplies will increasingly become apparent as the next century progresses.*
>
> *Should self interest predominate, we could become locked in conflict, unable to adapt and with the likelihood that we will dissipate unproductively the scarce high quality petroleum fuels so essential to a safe transformation to a world "beyond oil".*

CITIA – or CILTA, as it is now known (the Chartered Institute of Logistics and Transport in Australia) – is a very conservative body not known for extreme views. If it was sufficiently concerned to call (CITIA, 1998) for

> *the development of greater understanding and awareness of these crucial issues and for their consideration attention in all policy formulation and decision making relative to the future of transport and fuel in Australia*

then we should now be extremely concerned, because little has happened between 1998 when that was written and 2005.

In this paper, on behalf of NCTR, I review the available evidence on both supply and demand. A longer version of this paper is available in the Kilsby Australia website (Kilsby 2004). My conclusion is that transport is heading for a crisis within ten years unless urgent steps are taken now. In the long run the economists would probably be right - if we had that long, but we don't.

Analysis

General : Why is Peak Oil important?

Figure 1 encapsulates the issue.

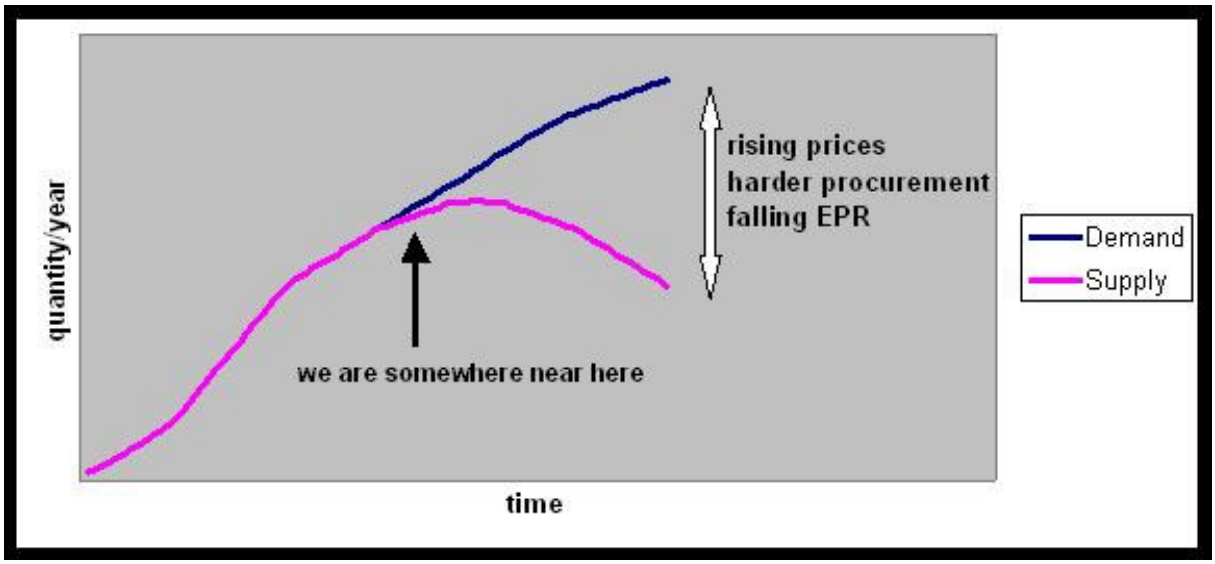

Figure 1: Peak Oil

The world is in no danger if running out of oil soon. However it is likely that the peak of oil production is close.

For all of the last century, the supply of oil kept pace with the rise in demand. It was therefore a buyer's market.

Once at or past the peak, however, the further supply of oil will not rise and sellers will become more dominant than buyers.

A gap will open up between supply trends and demand trends. Economists are of course quite right that this will not happen – the price mechanism ensures that it will not. It will not be possible to consume more than is produced. The price of what is consumed will rise, and this in turn will be a spur to technological development to extract more of what

has already been produced and to commercial increases in production from known reserves. However the world's endowment of oil is finite, and increases in production now will lead to earlier depletion than would otherwise be the case. And another predicted effect, that of encouragement of the development of alternatives to oil, is unlikely to happen because of oil's unique suitability as a transport fuel, and even if it did we would lack the production and distribution infrastructure which has evolved over the last hundred years or so to service transport.

Not only will the price of oil rise and its procurement become harder, but increasing amounts of energy will need to be devoted to extracting the dwindling amounts of oil left in the oil fields. The energy "yield" will therefore drop (the EPR, Energy Profit Ratio, or equivalently the EROEI, Energy Return on Energy Invested).

There is also the possibility that the financial measures which drive the developed world's economic growth will be much reduced in effectiveness because they depend on continuation of future growth, which in turn depends on future increases in energy use. If energy use was constrained in future, at least for transport, then economic development would be choked and the assumptions on which our global financial markets are based would no longer be so applicable.

Supply Issues

The factors that will make oil less cheap are:

- The plateau-ing of supply, as some known fields become depleted or exhausted and insufficient new discoveries are made to replace them.
- The continuing increase in demand for transport energy, giving rise to a growing gap between supply and demand unless the price changes.

Not only will the prices rise and procurement become more difficult, as a growing number of potential users chases a steady or declining supply of oil, but it will become physically harder to maintain present levels of supply. This is because it requires more energy to extract a given amount of oil from a field which has past its production peak than it does to extract the same amount of energy when the field is new.

The federal government recently issued an Energy White Paper "Securing Australia's Energy Future" (Department of Prime Minister and Cabinet, 2004). This clearly showed that transport, already the dominant user of energy in the year 2000, is expected to increase this dominance over the next twenty years. And, of course, while reticulated electricity is the power source for some urban rail systems, the major power source for transport has to be portable. It is oil.

A rather misleading graphic (Figure 2) showed domestic flows of oil in Australia. When the scale is taken into account, this shows that the majority of crude oil (60%) produced domestically in Australia is actually exported, while the majority of crude feedstock for Australian refineries (67%) is imported. In addition to crude oil refined in Australia, net

imports of imported products add a further 22% to our petroleum products. Transport consumes about 75% of all petroleum products in Australia.

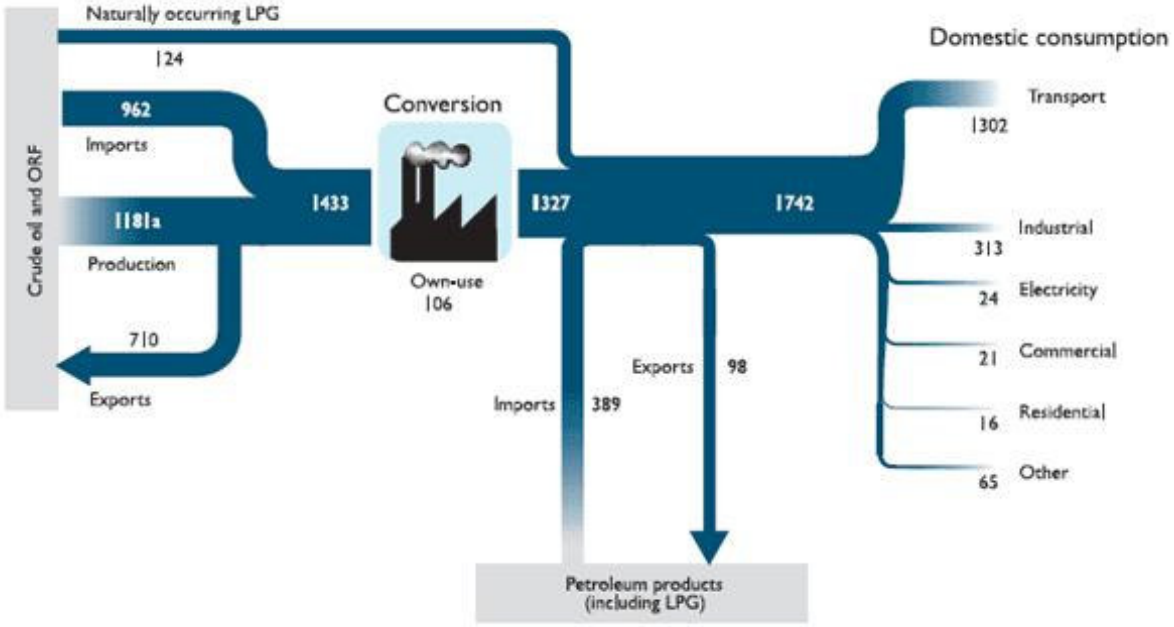

Figure 2: Petroleum flows in petajoules in Australia 2004-05 (Source: Department of Prime Minister & Cabinet 2004, based on analysis by ABARE)

ASPO (the Association for the Study of Peak Oil, a European think-tank) has estimated past and future global production of oil as shown in Figure 3.

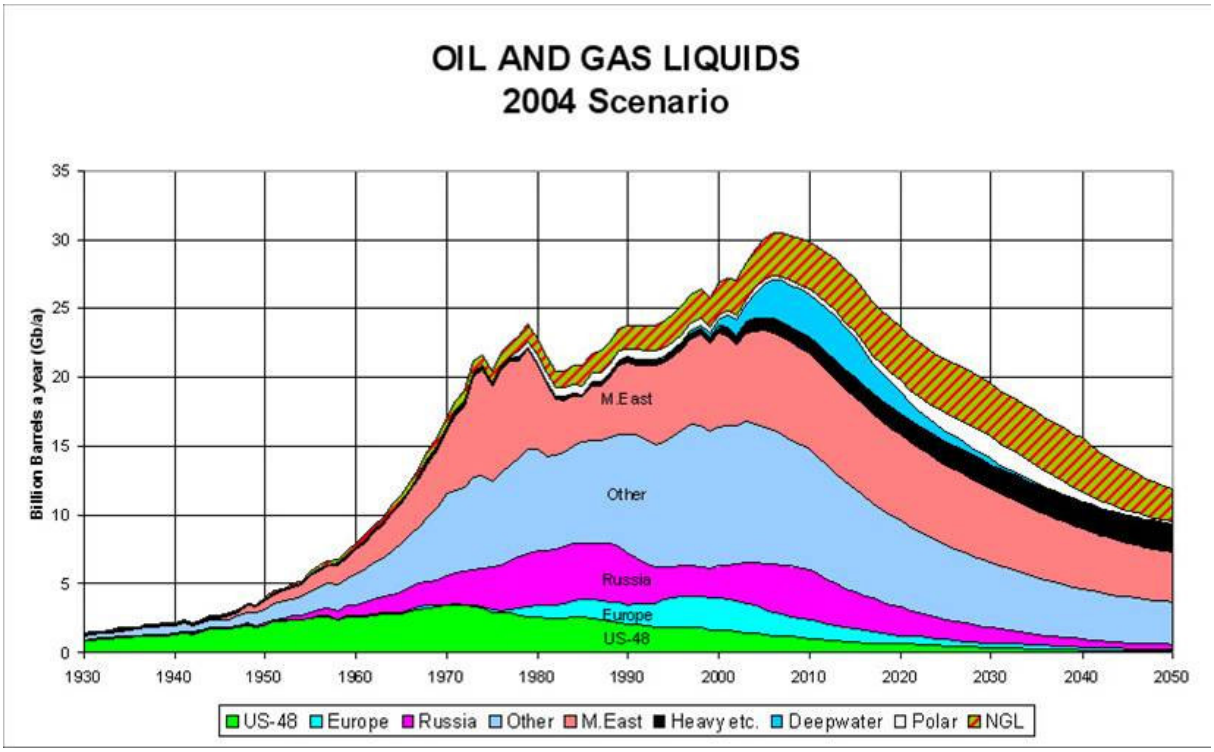

Figure 3: Estimated production of oil to 2050 (source: ASPO 2004-05)

It is now well established that the production profile of an individual oil field is a bell-shaped curve over time, with the second half of the oil more difficult to extract than the first half. World oil production is the sum of a lot of such individual profiles, and is itself bell-shaped, as shown.

The figure suggests that while it is not easy to assess when the peak is (except with hindsight), it is not far off. On the other hand, the timescale for the commercial development of alternative energy sources for transport can be measured in decades (World Business Council for Sustainable Development, 2004).

Demand Issues

There is little doubt that the demand for transport energy will continue to rise.

Figure 4 shows the predictions for final energy demand for transport in Australia over the next 20 years, taken from the 2004 Energy White Paper. Projections in the Auslink White Paper on transport infrastructure, released at around the same time (Department of Transport and Regional Services, 2004) show all principal sources of transport demand

(freight, aviation passengers, urban car traffic) rising over the next twenty years, in some cases by dramatic amounts.

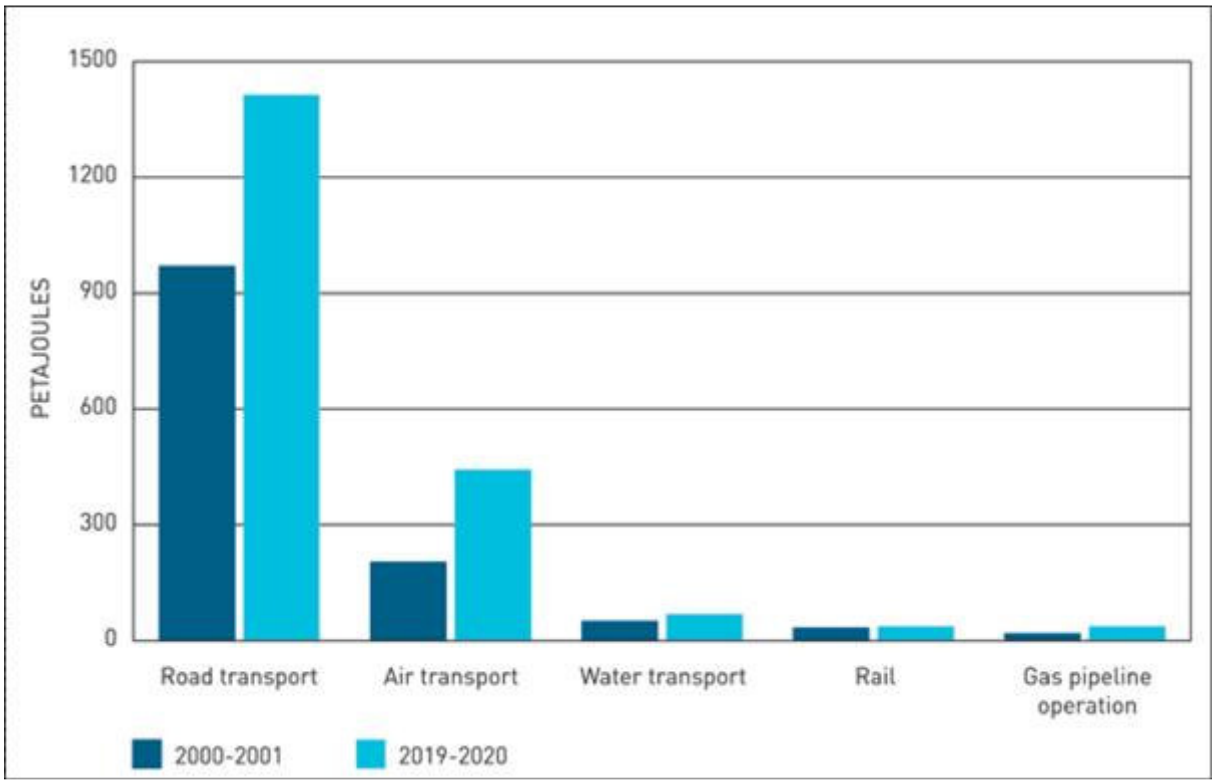

Figure 4: Forecast transport energy needs for Australia 2020 (Source: Dept of Prime Minister & Cabinet, 2004)

The largest absolute demand is exoected to be from road transport, which is almost entirely dependent on oil. Road transport displays the largest absolute growth as well.

The next largest absolute demand is from aviation, which is also almost entirely dependent on oil and also with fewer potential alternatives than road transport. This sector also shows the second largest absolute growth.

In comparison, rail transport, sea transport and transport by pipeline do not have significant growth in energy requirements.

Demand from other countries is also rising, especially from developing countries (and particularly from China).

Evaluation

Depletion: We're fast using up what we have.

There is considerable professional disagreement about the world's oil reserves.

At one extreme is the US Geological Survey, which is extremely optimistic and suggests a figure of around three trillion barrels (3,000 gigabarrels).

More soberly, ASPO relies mainly on scientific data produced by experienced geologists and suggests the world's reserves of conventional oil are under 1 trillion barrels.

This degree of variation in professional estimates is staggering, given its importance to the global economy.

Figure 5 shows some recent estimates of the global amount of oil ultimately recoverable. Definitional niceties are important: there is no agreement about reporting conventions (and the available data is very rubbery). While ASPO is at the "pessimistic" end of the range of estimates, they appear (to the NCTR) to be also at the more credible end of the spectrum. They estimate that the total world supplies of conventional oil once amounted to 1.85 trillion barrels. Of that, we have discovered 92% of it, with another 8% still to be found somewhere (this is obviously an estimate). More worryingly, we have already used half of all the oil there probably is, or 54% of what we have discovered.

Source	Year of Estimate	Global oil reserves (Gb)	Status of estimate	Past production
ASPO[1]	2004	760	Estimated production from known fields to 2010: excludes "yet to find" 145 Gb	945 Gb
EnergyFiles[2]	2004	1,004	Excludes "yet to find" 270 Gb	990 Gb
BP[3]	2003	1,150	"proved reserves"	Not given

[1] ASPO 2004-5
[2] (EnergyFiles are consultants to the energy industry) World Oil Resources & Peak Oil Production 2004
[3] BP 2004

Figure 5: Some estimates of global oil reserves

In 2003 Dr Michael Smith of Energyfiles estimated that of 99 countries in the world that produced oil, have produced it or potentially will produce oil in the future, 60 countries

are already at or past their peak and a further 12 are very near to it (Californian Energy Commission, 2003).

The current rate of discovery of further sources globally is far less than the current global rate of consumption.

When "unconventional oil" is added to the picture (oil from coal, shale, bitumen, heavy oil, deepwater oil, polar oil and gasfield liquids – any of which may more trouble to extract than it is worth) ASPO's estimate of ultimately recoverable reserves rises to 2.4 trillion barrels (or the equivalent thereof), of which about 43% has already been consumed.

World production of conventional oil is estimated by ASPO to peak this year, 2005, and the world market will increasingly come to rely on the giant middle eastern oilfields for its sources of oil as alternatives become exhausted.

Historical perspective of "the Age of Petroleum".

With a short-term view, the world has plenty of oil and the forecast is not that it will run out but that growth in the production rate will cease and eventually go into reverse.

One commentator has taken an extremely long-term view of this, in which oil consumption appears as a mere blip in the timeline of human history. Oil was discovered, it was mostly used up in a short space of time, and then we stopped using it because we had none left.

What will happen afterwards?

The conclusion is that the end of the age of cheap oil on which transport (and agriculture, and defence, and many other activities) depends is not far off.

The addition of energy from gas to the picture will extend the duration of the blip slightly but that too is finite and when the gas is mostly used as well as the oil, the earth's geological legacy of fossil fuels (except coal) will be all spent.

The global consequences of oil depletion will be:

- Rising oil prices
- Harder oil procurement, leading to prioritisation of uses between and within sectors
- Need to devote greater amount of energy to extracting last of oil
- Increased tension between developed and developing nations
- Greater power to Middle East producers
- Greater geopolitical tension
- Need for a transition to a world "beyond oil"

There is considerable disagreement amongst informed sources about when the problems will be encountered, but not whether.

The prevailing view held by the energy and automotive industries, economists and governments is that problems are at least twenty years away. The prevailing view among environmentalists and scientists is that the problems will be felt within ten years, probably sooner and are possibly starting to impinge already.

The onus should be on those who believe that cheap oil will last for a long time yet to substantiate their views, rather than asserting that there is nothing to worry about because the opposite case has not been proven beyond doubt (this is surely the precautionary principle of ESD).

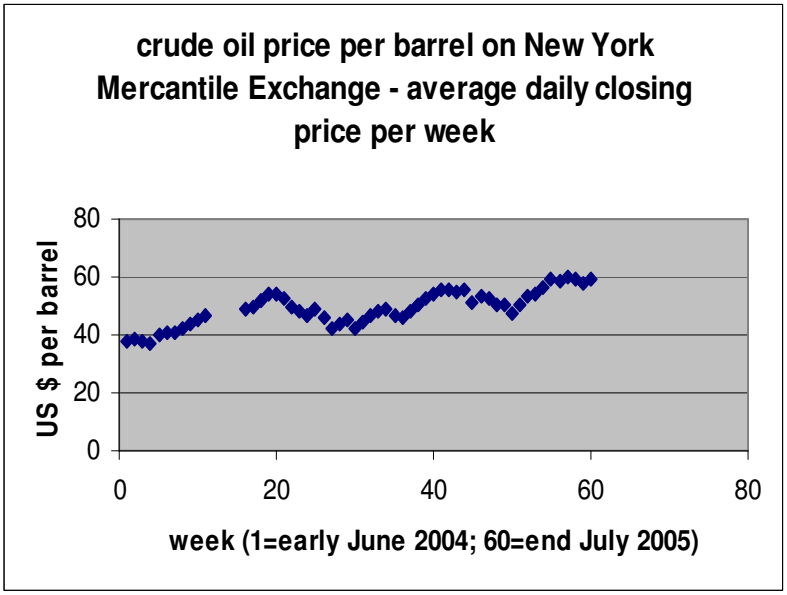

Figure 6: Movement in price of crude oil start June 2004 to end July 2005.

It is instructive to consider movement of the price of crude oil per barrel on the New York Mercantile Exchange between June 04 and July 05 (Figure 6). The price goes up and the price goes down, but somehow it never seems to go down by quite as much as it goes up, with associated angst in the media every time it breaks through a new "psychological barrier" for the first time. This has happened at $30, $40, $50 and recently at $60. Figure 6 only displays the average weekly market variation – the price also varies within each week and indeed within each day. This evidence is quite compatible with a scenario of a steadily rising price as global production reaches its peak, but not with the scenario anticipated by some of an oil price spike followed by a return to the sort of prices we have been used to in the past.

Implications for Australian transport

The potential consequences for Australian transport in particular will be:

- Less and more expensive diesel and petrol
- Higher priority for road freight relative to personal transport
- Impact to hit road freight first because of national lack of heavy oil
- Car-dependent suburbs, eg in outer Sydney, to experience major difficulties
- Need to develop alternatives to car travel for many personal journeys
- Lower returns to investors in private road infrastructure
- Need for higher fuel efficiency in car and truck fleets
- Possible constraints on air travel – consequent impact on tourism industry
- Growing importance of public transport, bicycle and pedestrian networks
- Potential civil unrest as limits appear on personal mobility

What can our planners do to mitigate the consequences?

- Do nothing. This should be rejected as an option.
- Business as usual ("BAU") – application of BAU policies to greater degree than has been contemplated so far. Land use/transport integration, development of better public transport, pedestrian and low-energy networks (eg cycle paths), etc. The Warren Centre at Sydney University conducted an extensive inquiry into "Sustainable Transport in Sustainable Cities" in the period 2000-2002, and concluded that simultaneous action on six fronts was needed to develop more sustainable systems. This is probably as good an indicator as any of what "business as usual" would lead to in future, although it also impinges to some extent on the other approaches considered below. The six fronts were (Warren Centre, 2003):
    - engaging the community
    - monitoring and reporting on transport performance
    - optimising the performance of what we have
    - modifying the shape of the city
    - introducing better planning, pricing, funding, new technology and infrastructure
    - lowering barriers to change
- Technological development – alternative fuels, more fuel-efficient automobiles, intelligent transport systems, promotion of hydrogen and electricity in transport, etc.
- Economic instruments – reliance on market forces, government intervention via taxation and other pricing policies where necessary. Optimists (eg the Economist, 2005) point out that the same depletion fears had been raised in the past about finite global supplies of minerals, which are now cheaper and in more abundant supply than ever thanks to new discoveries, more advanced extraction technology, more efficient usage and the development of substitutes. If these factors apply to finite global oil supplies as well, there would be little need for intervention – but

for the reasons outlined in this paper, they are unlikely to apply to transport energy.
- Behavioural change – public education and awareness campaigns, behaviour change programs, encouragement of individual responsibility.

Several years ago the Institution of Engineers Australia convened a Transport Task Force to consider the role transport might play in contributing to a more sustainable energy culture in Australia (Engineers Australia, 1999). As well as making a number of recommendations on issues where the Institution or individual engineers could make a difference, the Task Force made a number of recommendations to government that encompass these four areas:

- Taxation and fiscal policy instruments should encourage sustainable transport (economic instruments)
- There was a strong case for increased investment in transport infrastructure that offered the opportunity to develop a transport system that was integrated, more sustainable and less greenhouse gas intensive (business as usual).
- The market was the appropriate mechanism to allocate resources between individual transport modes, but where market forces fail to deliver environmental and social objectives governments should intervene (economic instruments).
- More holistic approaches that integrate environmental considerations into transport policy, planning and investment decisions were needed. They should go beyond current Commonwealth and State and Territory environmental impact evaluations in order to examine wider impacts on health, sustainability and greenhouse gas emissions (business as usual).
- There was a need for industry, innovation and research and development policies and commitments to support the development of cleaner transport fuels and technologies (technological development).
- Additionally, there was a need for research into transport pricing, economics and demand-management technologies (economic instruments, behavioural change).

While there has been a little progress on some of these recommendations, it is disappointing to reflect that much the same could be said today, six years on.

Conclusions and recommendations

The availability and price of oil will deteriorate quite soon (probably starting within ten years).

National government energy policy places priority on coal-related technologies, which will aid power generation sector but will not aid transport. Transport, particularly road transport and aviation, is highly dependent on oil rather than coal. The social, economic and environmental consequences for Sydney of reaching and passing the global peak of oil production are immense. Our present forward planning processes do not recognise this as an impending problem.

The possible consequences of reaching the peak of global oil production are so far-reaching that they cannot be ignored in transport planning processes. Precautionary planning against future oil constraints should be an essential part of the management of risks.

There are perhaps five options, of which the first ("Do Nothing") will lead to an undesirable future and should be rejected. The others are not mutually exclusive and should all be strongly supported. The options are:

- Do nothing.
- Business as usual ("BAU") – application of BAU policies to greater degree than has been contemplated so far. Land use/transport integration, development of better public transport, pedestrian and low-energy networks (eg cycle paths), etc
- Technological development – alternative fuels, more fuel-efficient automobiles, intelligent transport systems, promotion of hydrogen and electricity in transport, etc.
- Economic instruments – reliance on market forces, government intervention via taxation and other pricing policies where necessary.
- Behavioural change – public education and awareness campaigns, behaviour change programs, encouragement of individual responsibility.

All the available options (except "do nothing") should be deployed.

In particular, the following actions should be given high priority:

- The Australian Transport Council should become better informed about Peak Oil issues and implications.

- All appropriate jurisdictions that are not already doing so should take the initiative to build knowledge of peak oil issues and develop a precautionary strategy.

- For our major capital cities, urban transport corridors should be defined and a multi-modal strategy for each one developed. Plans that boost travel conditions for one mode and do little or nothing to improve others in the same corridor should be unacceptable except in the context of the prior planning strategy for the corridor.

- A Taskforce should be established to revise the evaluation procedures for multi-modal options, in particular requiring a constrained energy position to be included in the future scenarios used for assessing options, and the energy costs and benefits of planning options to be included in the evaluation of alternatives.

- The shortening of trip lengths by the fostering of local centres with surrounding residential consolidation, and the provision of better alternatives to car use, to be encouraged.

- Alternatives to car use, for instance in inner and middle Sydney, should be encouraged. Strategic bus planning skills for major conurbations are very important and should be strengthened.

- Alternative fuels and distribution infrastructure should be supported. More fuel-efficient vehicles should be supported via regulation and standards and transport infrastructure (eg use of more Intelligent Transport System technology). Support for lighter vehicles, including powered bicycles, could be implemented through differentiation in licensing charges,

- Pressure should be continued in searching for ways of internalising externality costs in transport pricing.

- Public awareness programs should be implemented to gain acceptance of the nature of the problem. This is the "pre-contemplation" stage of the classic five stages which change behaviour. The five stages, as used in health programs and Travelsmart programs, are: pre-contemplation (needs information); contemplation (needs options); preparation (needs plans); action (needs public support); and maintenance (needs long-term commitment).

- Outside metropolitan areas, the prioritisation of food production and distribution over other types of non-metropolitan travel should be prepared for.

- The conversion of rural and regional vehicles to run on gas or other alternative fuels rather than petrol or diesel, should be encouraged by arguing for Commonwealth revision of pricing differentials and by State support for distribution infrastructure for alternative fuels.

The strategic directions emerging for most major Australian capital cities (centres, densification, encouragement of alternatives to car use etc) are appropriate and would be even more necessary if the worst fears regarding peak oil were to be realised. Urban areas that are built around the use of the private motor vehicle (for instance all of Canberra) would face major changes.

There is considerable uncertainty over what the future holds but the possibility that these directions will turn out to be inescapable rather than precautionary is very real indeed.

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Appendix B Recommendations of 1998 Transport Taskforce on Sustainable Energy

From Chapter 3 of “Sustainable Transport: Responding to the Challenges”
Sustainable Energy Transport Taskforce Report November 1999
Institution of Engineers, Australia

3.2 Recommendations to government

1 Taxation and fiscal policy instruments should encourage sustainable transport.

(with five sub-recommendations)

2a There is a strong case for increased investment in transport infrastructure that offers the opportunity to develop a transport system that is integrated, more sustainable and less greenhouse gas intensive.

2b The market is the appropriate mechanism to allocate resources between individual transport modes, but where market forces fail to deliver environmental and social objectives governments should intervene.

(with six sub-recommendations)

3 More holistic approaches that integrate environmental considerations into transport policy, planning and investment decisions are needed. They should go beyond current Commonwealth and State and Territory environmental impact evaluations in order to examine wider impacts on health, sustainability and greenhouse gas emissions.

(with four sub-recommendations)

4a There is a need for industry, innovation, and research and development policies and commitments to support the development of cleaner transport fuels and technologies.

4b Additionally, there is a need for research into transport pricing, economics and demand-management technologies.

(with seven sub-recommendations)

Appendix C Sydney Division press release 15/12/2005
PRESS RELEASE

For immediate release

ENGINEERS AUSTRALIA

Sydney Division

Peak Oil and the Sydney Metropolitan Strategy

Global oil production is going to peak soon – a phenomenon known as Peak Oil. Though the world will still have plenty of oil left, the 'Age of Cheap Oil' will effectively be over.

In August we saw the reaction of world markets when Hurricane Katrina devastated New Orleans and destroyed much US refinery capacity.

The mainstream debate is no longer about whether Peak Oil will occur, but when. At the most pessimistic end of the spectrum, some commentators think we are already there, but at the most optimistic, other commentators think it is thirty years away. No reliable data exists.

The implications of Peak Oil for the world economy are drastic but the National Committee on Transport of Engineers Australia is very concerned about the impact this will have on transport in particular.

David Kilsby, Chairman, Transport Panel for Engineers Australia, Sydney Division says, "Much argument focuses on whether Peak Oil will occur in the next five years, or the five after that. This is too close for comfort. Transport is very heavily dependent on oil, especially aviation and also road transport."

The NSW Government released its draft metropolitan strategy for Sydney on December 4 2005, and Engineers Australia cautiously welcomes this strategy.

Most (but not all) of the elements of the Metro Strategy would be appropriate to mitigate the effects of Peak Oil, if they were effective in time.

Kilsby continues, "Our main criticism of the Metro Strategy is not that it does the wrong things, but that it does not do the right things with enough urgency. "The same as always" will not be an option if affordable oil is not available. The Metropolitan Strategy expects that the ground rules for urban planning will stay largely unchanged over the currency of the Strategy. The strategy is intended to guide urban growth for the next 25 years at least."

"This stability is unlikely to occur, and the Sydney Division Transport Panel considers that the Metropolitan Strategy is deficient in not even providing contingency measures in case the fears surrounding Peak Oil turn out to be real, as we believe they are. The Transport Panel of Sydney Division thinks that the transport component of the Metropolitan Strategy fails to deal with the Peak Oil issue. It is not optimistic that "something will turn up" to save the day for Sydney's urban transport," Kilsby concludes.

- ENDS -

For further information, contact Michelle Crowshaw, Public Relations & Events, Engineers Australia, Sydney Division P: (02) 8923 7118 F: (02) 9956 7670 mcrowshaw@engineersaustralia.org.au

Or see:

http://www.sydneypeakoil.com for a compendium of information about the phenomenon of peak oil and the likely effect on Sydney;

http://www.nctr.org.au for the NCTR's discussion paper about energy futures for Australian transport;

http://www.metrostrategy.nsw.gov.au for the Metropolitan Strategy documentation and a description of the process.