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Paper title: **Oil depletion: the crucial factor in transport planning**

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Abstract (200 words):
As a result of steeply declining domestic oil production and forecasts of dwindling world supplies, Australia is very vulnerable to temporary and permanent oil shocks in the short, medium and long term. Transport planning priorities (both large scale planning and road design) must be changed dramatically to minimise the impacts of the coming oil shortages. The current reluctance of decision-makers even to consider oil depletion will rank high on the list of missed opportunities and 'intelligence failures'. There is a great deal that can be done to prepare for the likelihood of future oil shocks and hence to ameliorate the effects when (or if) they hit us. Current transport infrastructure projects, with only a few exceptions, are planned without any consideration for the effects on our oil dependence. A much more precautionary approach should be adopted now to reduce our vulnerability when oil supplies become limited, as appears to be almost certain within the service lifetime of most transport infrastructure projects. Many of the policy options to reduce fuel usage will in addition lead to healthier, happier and more equitable communities and improve local and global pollution levels. They will also require substantial changes in the way that transport is viewed by planners, engineers, politicians and the general public.

Introduction

Perhaps the most compelling (but still largely unrecognised) evidence of the lack of even short-term transport sustainability in Australia is our very serious dependence on rapidly declining petroleum sources. Petroleum is currently essential for agriculture and most facets of Australia's community life and economic systems as well as for transport. Most transport decision-makers have assumed, wrongly, that medium and short-term supplies are assured. There is rapidly mounting evidence from the oil industry itself that this complacency about future oil supplies may well be very misplaced , for example Akehurst (2002).

Almost 80% of Australia's petroleum use is in transport. 55% of road transport fuel is petrol, 39% diesel and 6% is LPG, and Australia uses about 45,000 megalitres of petroleum each year.

Compared to other regions, Australia has a good level of understanding of practical demand management strategies (especially from successful and long-standing water conservation measures). This knowledge coupled with our existing still unallocated reserves of natural gas provides an encouraging opportunity for us both to forecast and to weather the coming oil shortage storms better than many other regions. It is particularly important that the issues are tackled seriously and urgently by decision-makers.

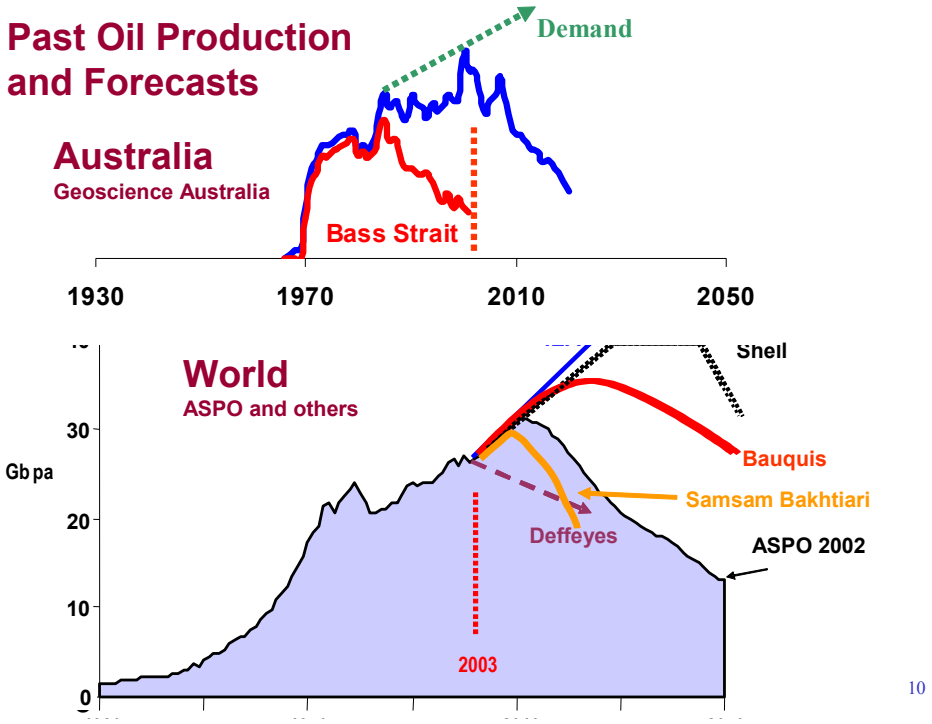

Figure 1: Australia's vulnerability to oil depletion is shown in these diagrams of past Australian and world oil production and future decline predictions. [Australian data and forecasts from APPEA (2004). Global predictions after Bauquis (2004). IEA is the International Energy Agency; ASPO is the Association for the Study of Peak Oil & Gas. A majority of estimates of the peak of world oil production cluster between the present and 2020 (Andrews and Udall (2003)]

Australian oil production decline

Australia has been shielded from past oil shocks by our domestic oil production from Bass Strait. Hence, as a nation we have not learnt as much about oil conservation and transport planning as European countries, especially the Netherlands which radically changed its transport planning policy to reduce its oil dependence after the 1973 oil crisis.

However, Bass Strait production has been declining since 1985 and until now other fields have filled the production gap. Reliable recent predictions by Geoscience Australia and Woodside indicate that Australia's oil and condensate production will fall substantially in the next decade (Akehurst (2002), APPEA (2004)).

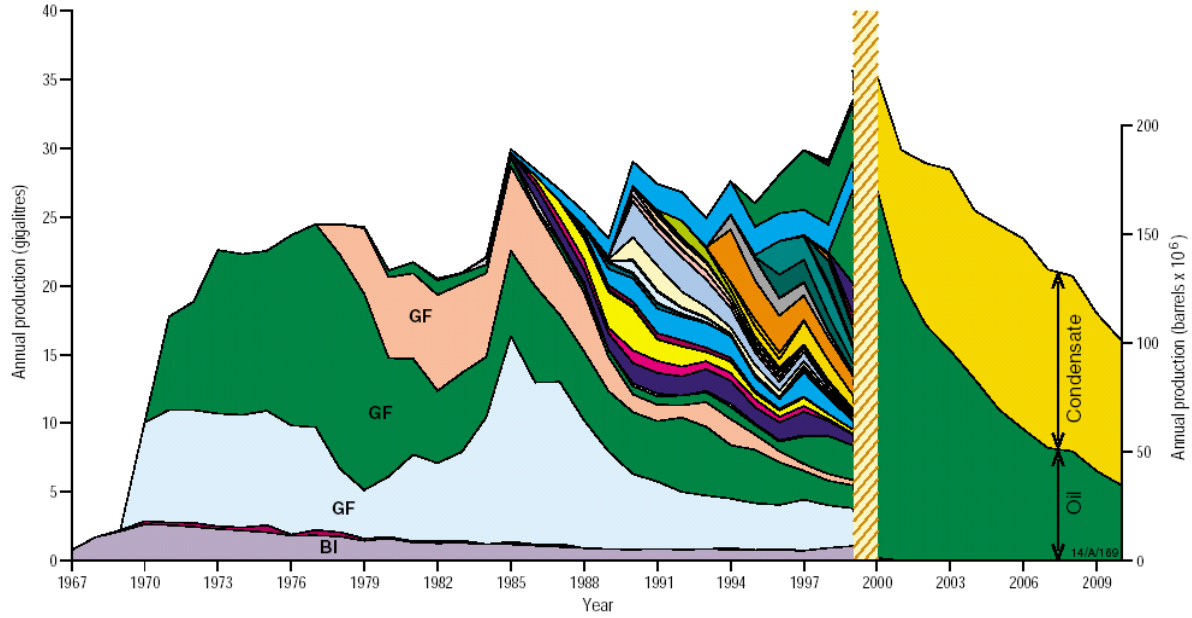

Figure 2. Oil and condensate production profiles of individual Australian fields, and the forecast cumulative production at 50% probability derived from industry data [Powell (2001), Akehurst (2002). BI denotes Barrow Island; GF denotes giant Gippsland Basin Fields]

The dominance of a few large fields, shown in Figure 2, is typical of oil regions. The giant fields are normally found first. An increasing discovery rate of usually progressively smaller fields is needed to keep production relatively constant as the giant fields decline. Then inability to keep finding adequate volumes in ever-smaller fields leads to an overall decline. Australia is now using three times as much oil as is being discovered, and this will lead to the forecast production decline as shown in the graph (Akehurst, 2002).

Australia's rapid domestic oil production decline is taking place not long before it is predicted that the overall world oil production will also commence to decline. As a result, Australia is becoming increasingly vulnerable to serious oil shortages, in the short term (within a year), in the medium term (within 5 years) and in the long term (within one or at most two decades). Self-sufficiency is expected to decline from an average of 80-90% over the past decade to about 20% by 2020 (APPEA, 2004).

World oil production decline predictions

A world-renown US Geological Survey petroleum geologist, Les Magoon, visited Australia in November 2001 as the Distinguished Visiting Lecturer of the Petroleum Exploration Society of Australia. He gave talks around Australia entitled 'Are We Running Out of Oil'. As reported (Australian Energy News (2001), Magoon (2001)), he describes the 'Big Rollover' as the change from the current world oil buyers'-market to a world sellers'-market when global production starts to decline. Various forecasts have put the 'Big Rollover' date at sometime around 2003, 2007, 2010 or by 2020 (Andrews and Udall (2003)). *'At BP, our best estimate of when global oil shortages will begin to bite deeply is between 20 and 40 years'*, Greg Bourne, Regional President of BP Australasia, told the 5th Energy in WA conference in Perth in March 2003.

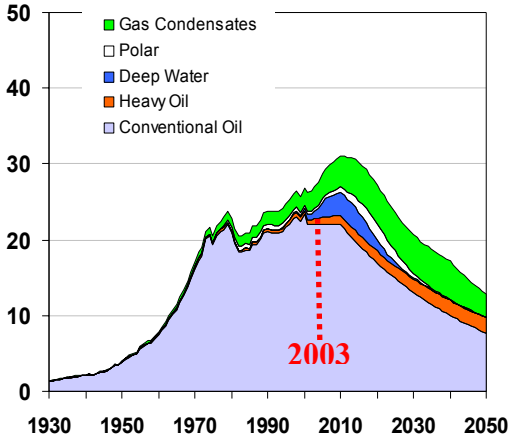

Figure 3a: Current forecast of future world oil production, including non-conventional oil. [(ASPO (2002)). Scale is in gigabarrels of oil-equivalent per year. The peak of the curve is the 'Big Rollover']

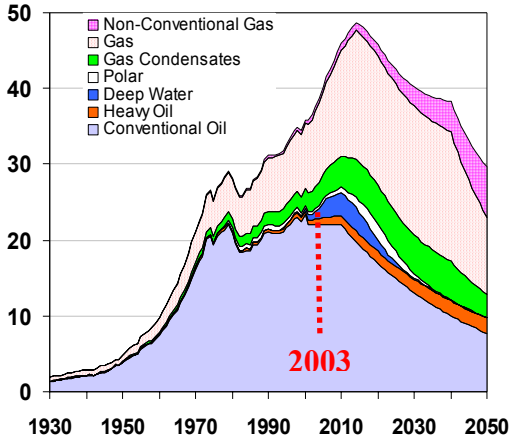

Figure 3b: Current forecast of future world oil and gas production, [ASPO (2002)). The inclusion of gas does not change the shape of the global hydrocarbon depletion curve substantially]

Prof. Pierre-René Bauquis of the French Institute of Petroleum told a combined meeting of the Society of Petroleum Engineers and the Petroleum Exploration Society of Australia in Perth that he expected global oil production to start its terminal decline in about 16 years (Bauquis (2004)). He does not see any significant renewable energy substitutes for petroleum over the next 20-50 years. He was also dismissive of hydrogen as a transport energy carrier and foresaw the use of nuclear energy to help manufacture synthetic hydrocarbon fuels

As can be seen in Figure 1, there are some considerably more optimistic forecasts of future oil supplies. The most optimistic ones are driven by economic and political perspectives, rather than by geology and engineering constraints, for example see Lynch (2002). There are very considerable grounds on which to doubt the forecasts published by the International Energy Agency. The IEA takes without question the oil reserve data provided by all the national governments. Many of these estimates are clearly misleading as they either increase dramatically without any matching exploration success, or they remain constant for years in spite of substantial production which must reduce the actual oil reserves. Conflicting definitions and national and political priorities make the IEA figures as dubious, for example,

as similar audited and glowing accounts of the financial strength of HIH and Enron just before their catastrophic corporate crashes.

Shell has recently revised its 'proven reserves' downward by 23%, showing that oil-company reserve claims are subject to uncertainties and mistakes. The scope for analogous errors and misrepresentation at the national level is very substantial. Mexico has twice halved its claimed reserves since the mid 1990s. Recent presentations by Matthew Simmons (Simmons (2004), (2004a)) cast considerable doubt on the reliability of the claimed Saudi oil reserve figures. Similar doubts about OPEC's overall reserves are also raised by Salameh (2004). In the case of Saudi Arabia, any substantial errors in reported reserve estimates are of very serious global significance. There is of course the complementary but lower probability that some reserves may have been understated, but most concern has been expressed about over-optimism.

International Workshops on Oil Depletion.

Annual International Workshops on Oil Depletion are held in Europe by the Association for the Study of Peak Oil and Gas, ASPO. The most recent, and by far the largest and most prominent, was hosted in Berlin by the German Geological Survey, BGR in May 2004. Unfortunately, there has been no attendance at all from anyone from Australia professionally involved in transport, government or the oil industry. However, the Sustainable Transport Coalition has been represented at all three held so far. Papers and presentations are available at www.PeakOil.net. Oil depletion experts from the US, Europe, Russia and the Middle East gather to discuss the growing body of evidence that world oil production will reach a peak then decline relatively sharply within a decade or at most two. At the first workshop APSO also released the first edition of its 'Statistical Review of World Oil and Gas', a nation-by-nation evaluation of reserves and production rates, based on the most reliable technical data available. The ASPO data differ substantially from those published in oil trade journals and by the IEA which have very serious commercial and political biases and inconsistencies. Evaluation of non-conventional oil is now included in the current predictions shown in Figure 3a. Non-conventional oil includes heavy oil (which needs to be heated to flow adequately), oil from deep water (>500 metres) and from polar regions and condensates from natural gas. These sources will in part offset the rate of decline of conventional oil after the 'Big Rollover'

Presenters at the International Oil Depletion Workshops included Matthew Simmons, a prominent energy-sector investment banker from Houston who advises President Bush.

> Simmons said, *'I have studied the depletion issue intensely for too long now to have any remaining doubts as to the severity of the issue. But I am still amazed at the limited knowledge that exists, even in the U.S. or within our major oil and gas company's senior management about this topic and its dire consequences',* (Simmons (2002))
>
> *'Most serious scientists worry that the world oil supplies will peak* [and then decline]. *Peaking of oil can not be predicted accurately, but the event will occur. Peaking turns out to only be clear through a 'rear-view mirror'. By then, an alternative or solution is too late. My analysis leads me to worry that peaking is at hand, not years away. If I am right, the unforeseen consequences are devastating. The facts are too serious to ignore.'* (Simmons (2003))

Dr Samsam Bakhtiari, of the National Iranian Oil Company, provided a pessimistic view of future oil supply decline and of its effects: -

'Seen from a Middle Eastern perspective, the present global oil situation can be summarised within five major and inescapable trends:

- *The world's super giant and giant oil fields are dying off;*
- *There are no more major frontier regions left to explore besides the earth's poles;*
- *Production of non-conventional crude oil has been initiated at great costs --- in Venezuela's Orinoco belt, Canada's Athabasca tar sands and ultra-deep waters;*
- *Even OPEC's oil production has its limits;*
- *No major primary energy rival can possibly take over from oil and gas in the medium term.*

Adding up these five trends, one can envision a global oil crunch at the horizon --- most probably within the present decade … .It would take a number of miracles to thwart such a rational scenario. Now, a single miracle is always a possibility, but a series of simultaneous miracles is not --- for there are limits even to God Almighty's mercifulness'. (Samsam Bakhtiari, 2002)

Samsam Bakhtiari has also since published simulations of the World Oil Production Capacity (Wocap) model which suggest that global oil production will peak at a point near 81 million barrels per day well before the end of the decade, likely by 2006-07 (Samsam Bakhtiari (2004)). Dr Samsam Bakhtiari visited Australia recently, presenting seminars in four cities. He also briefed the WA Cabinet about oil depletion risks on August 9th 2004.

A paper in December 2002 by Exxon Mobil Vice President, Harry J. Longwell (Longwell (2002)) contains the world oil discovery decline curve (Figure 4) which agrees well with those published in Aleklett and Campbell (2002). Declining past oil and gas discovery success rates foreshadow future production decline rates, and acknowledgment of this by a major oil company is very significant. There is an often-overlooked truism that oil production can only follow oil discoveries. Longwell also showed a peak of global gas discovery in about 1970 with a sharp decline in natural gas discovery rates since then.

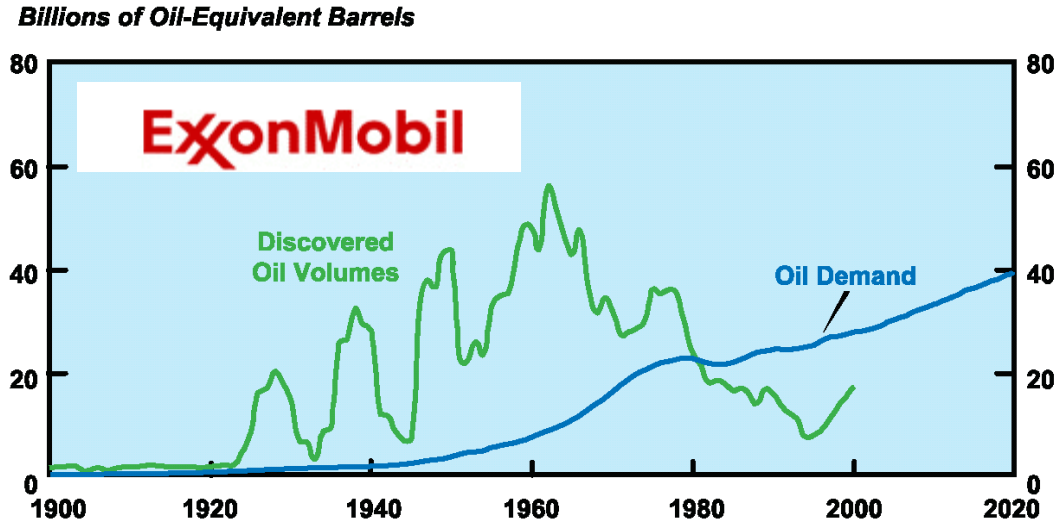

Figure 4: World oil discovery rates have been declining since the early 1960s as now acknowledged by Exxon Mobil. [Longwell (2002)]

More recently, there has been an increasing level of coverage of oil depletion issues in the scientific and general media. Some examples follow.

New Scientist ran a cover story (2nd August 2003). 'Crisis looms – When demand for oil outstrips supply'

> *'... we could be in for a big shock: we are going to run out of cheap oil. That's not oil per se, but we're approaching the point when global demand for oil will outstrip supply. It is not clear when we will reach this tipping point. The economists say we have about 35 years before oil production peaks, while geologists think we have only a decade. At present the geologists' argument is in the ascendant, having won the backing of some investment banks and oil consultants.'*

Oil & Gas Journal editorial (18th August 2003)

> *'...can a peak in production be anything other than imminent? That question breeds others. How rapidly will production decline after the peak?*

The Guardian (2nd December 2003) 'Bottom of the barrel – The world is running out of oil - so why do politicians refuse to talk about it?'

> *'Every generation has its taboo, and ours is this: that the resource upon which our lives have been built is running out. We don't talk about it because we cannot imagine it. This is a civilisation in denial.'*

Richard Miller, BP Exploration UK, wrote in a letter to the Oil & Gas Journal (12th January 2004) sharply refuting a statement from an extreme economic optimist (Maugeri, O&GJ, Dec 15th 2003) who had claimed *'.. just as the Stone Age did not end because of the scarcity of stones, the Oil Age will not end because of the scarcity of oil. Rather oil will inevitably be surpassed in convenience by a new source of energy in the future'.*

> Miller stated *'This is the classical economist's view: something will turn up, when the price of oil is high enough, because something always does. But there isn't anything conceivable that could replace conventional oil, in the same quantities or energy densities, at any meaningful price. We can't mine the oil sands in sufficient quantity because there isn't enough water to process them. We can't grow bio-fuels because there would be no land left to grow food. Solar, hydro, wind, and geothermal don't yield enough energy, hydrogen (from water) takes more energy to make than it can yield, and nuclear fission and fusion are presently off most political agenda. The oil consumed directly and indirectly by the average American is equivalent to the work output of 135 slaves, unfed, unclothed, unhoused, and paid $2 a day between them. When oil gets too expensive, surviving Americans will still obtain energy from alternative sources, but in much smaller amounts and at much higher prices. Westerners will have to live with only a handful of slaves.*

Christian Science Monitor, 29th January 2004 'Has Global Oil Production Peaked?',.

> *The question now making the rounds in energy circles: Has production already peaked?*

West Australian, March 10th 2004 'End looms for the days of cheap oil'

> *'Oil companies are now raising their doubts. They voice it softly, but clearly they are starting to feel if they don't raise any doubts, the public will be hostile to them'.*

This well-researched long article was taken from an international newswire service. The fact that the West Australian was probably the only newspaper in Australia which ran the story may illustrate the reality of the community taboo against discussing oil depletion.

As production outside the Persian Gulf declines, the balance of oil power will shift more and more towards OPEC and the Middle East. Substantial short-term disruptions, for instance from a revolution in Saudi Arabia (Bauquis (2004)) and large market-force pressures in the medium-term are quite possible. The permanent decline phase will start once the Middle East production starts falling as forecast, possibly in about 2010 or so. Physical constraints in addition to market forces and geopolitical factors will then limit oil availability. Rising world demand, for instance from China and India, will add enormous pressures to the oil market. The past oil shocks have been predicted to be mere ripples compared to the changes which will probably occur in the next decade or two.

These reliable forecasts of declining domestic production and uncertain world supplies indicate that Australia is very vulnerable to 'Oil Shocks' in the short term (2 months), medium term (2 years) and long term (within 1-2 decades).

The declines in Australian and world oil availability are likely to be much faster than any alternatives can be brought on stream in significant volume and much faster than the necessary structural and efficiency improvements can be made, unless extraordinary measures are taken very soon.

Preparation for probable oil shocks

There is a great deal that can be done to prepare for the likelihood of future oil shocks and hence to ameliorate the effects when (or if) they hit us. Many possible precautions will be 'no-regrets' options already justified on equity, environment, health, social or economic grounds. Australia's existing reserves of uncommitted natural gas coupled with local understanding of demand management (especially in water use efficiency and TravelSmart individualised marketing) provide an encouraging opportunity for the nation to both forecast and to weather the coming storms better than many other regions. It is particularly important that the issues be tackled seriously and urgently at all levels in the community. WA Planning and Infrastructure Minister, Alannah MacTiernan (2004) said, in opening the 'Oil: Living with Less' conference *'It is also certain that the cost of preparing too early is nowhere near the cost of not being ready on time.'*

Communication about potential solutions and their limitations:

It will be crucially important that there be open and informed discussion about oil depletion. Broad consideration of the various strategies for reducing our oil vulnerability; especially their limitations and the input energy needed, the time required and the costs needed to implement them are essential precursors to effective decision-making.

Contrary to many common predictions, it is highly unlikely there will ever be a single 'Magic Bullet' panacea for our oil vulnerability**.** A major aim should be to reduce our very high levels of automobile dependency. Some of the possible oil-use reduction and replacement strategies are outlined in Figure 5.

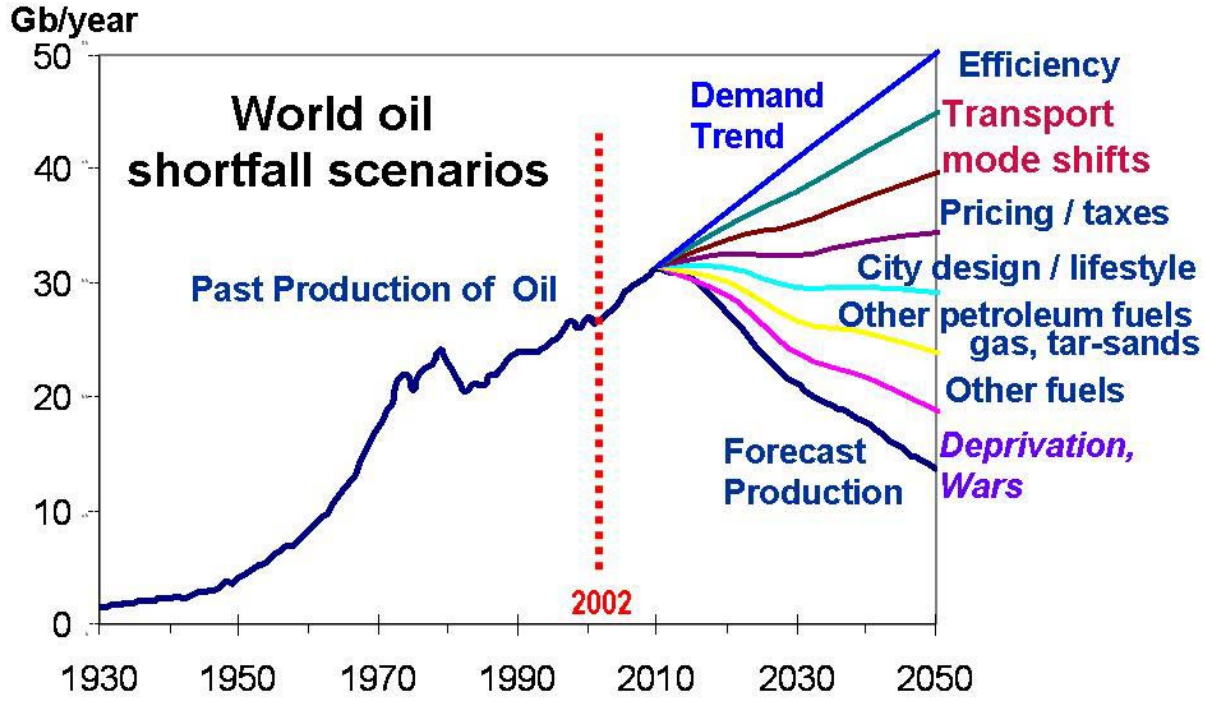

Figure 5. An adaptation of the scenario outlined by Swenson (1998) of the various mechanisms of bridging the coming gulf between growing current world demand for oil and the forecast decline in the production of conventional oil [Robinson (2002)]

Travel mode shifts: Individualised Marketing

Very substantial changes have already been triggered in existing urban travel patterns when people are given personalised information about the travel choices available to them. Empowering people in this way has resulted in sustained decreases of 8% to 19% in car-kms travelled. The oil saved by these voluntary travel pattern changes is very significant, and shows that reducing car-travel demand is more cost-effective than exploring for more oil.

Australia leads the world in the application of Individualised Marketing to make very significant reductions in car travel rates. Programmes have been completed or are underway in several states. WA has the most extensive record with a number of very successful and well documented programmes. The average reduction in car-kms travelled in the completed WA projects is 13% at a benefit:cost ratio of 30:1, far higher than those of most transport projects. Similar results have been obtained in Europe and the US, (Robinson (2004), Socialdata (2004)).

The TravelSmart Individualised Marketing programmes in WA have covered suburbs with some 158,000 people to date, and have resulted in the annual saving of some 115 million car-kms, or 11 million litres of petrol (John (2004), MacTiernan (2004)). Extrapolated to Australia's urban population, this would equate to about a thousand megalitres of oil saved each year. Globally, this level of travel reduction and mode shift would save each year oil amounting roughly to the annual production of Iraq, as an example.

Alternative Fuels

All alternative fuels to replace petrol and diesel have severe constraints to their introduction. Enormous volumes are required to replace a sizeable proportion of our current liquid fuel usage, and the timescale for their provision in these volumes is very short. For instance, diverting Australia's entire wheat crop to produce ethanol would replace less than 10% of our oil usage. Hydrogen is an energy carrier, not an energy source. It requires large amounts of energy for its manufacture and for its distribution. For the foreseeable future, the vast bulk of the world's hydrogen will continue to be made from oil and gas. The 'Hydrogen Economy' may well turn out to be just a pipe-dream like fusion power. Concentration on hydrogen diverts attention and resources from practical and immediate fuel conservation options. The most likely alternative for our current cheap plentiful oil will also be oil, but much more expensive and less plentiful oil.

Technological changes

It will be very risky indeed to rely on unproven technologies becoming available on such enormous scales within a decade or so, which is the timeframe likely to be required if the Big Rollover forecasts are accurate. There are around 14 million motor vehicles in Australia, and at only $25,000 each, a fleet replacement exercise to change them to other technologies or other fuels would need the outlay of $350,000 million, which would be diverted from other community and Government needs. Currently half the registered motor vehicles are more than ten years old, and 20% more than 20 years old. Normal fleet changeover rates are actually very slow. Half of today's new cars will still be on the roads in 20 years (BTRE (2002))

For instance, it has taken Australia almost two decades since 1985 to switch from leaded to unleaded petrol (Figure 6), a very much simpler technological change indeed than a conversion to fuel-cell cars, for instance. This change was mandatory for all new cars purchased from 1st January 1986.

Suggested Oil Dependence Reduction Measures

Australia is very wasteful of energy in general, and of petroleum fuels in particular, and there are a great many measures which can reduce this wastage while either improving or not diminishing our quality of life. Changes to the built environment can substantially improve transport energy efficiency if our automobile-dependent perspective is cast aside. Sadly, all too many planners and transport decision-makers give an impression of having a windscreen-shaped view of the world. There is great scope for simple and cost-effective steps to make our cities and towns far less automobile dependent and much friendlier and more efficient for walking and bicycle transport.

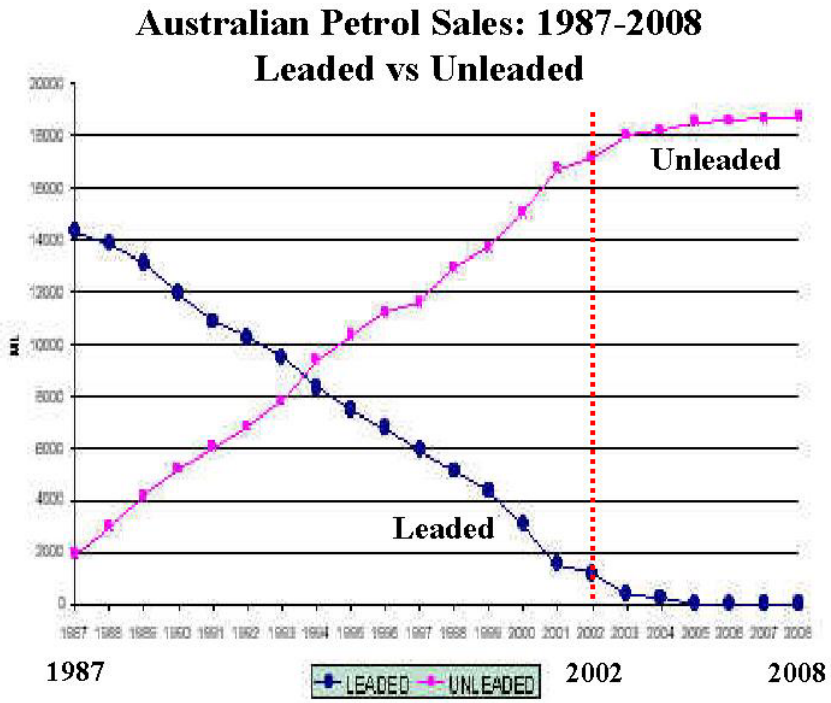

Figure 6. Example of the inevitably slow rate of introduction of new technology into Australia's vehicle fleet. [Unleaded and leaded (or LRP) petrol sales, Australia, from 1987 and extrapolated to 2008, (Australian Institute of Petroleum at www.aip.com.au), following mandatory introduction of emission-control engines in new cars in 1986. The introduction of hybrid vehicles and fuel cells is likely to be much slower as the technological differences are much greate]

In its submission to the COAG Energy Markets review, BP recommended :-

> *'Achieve a step change in energy efficiency –*
> *BP knows from its own experience that significant cost savings are available through greater energy efficiency. Better energy efficiency is the 'low hanging fruit' of the energy challenge.'* (BP (2002))

There is a wide range of oil consumption reduction measures outlined by Denniss (2003), in Robinson (2002) and (2003) and by the Sustainable Transport Coalition (2004). A crucial first step would to review and remove the inequitable perverse subsidies which fund and encourage excessive private motor vehicle use in our cities and towns.
'Perverse policies, that is policies which actually reduce the sustainability and efficiency of the transport sector, continue to be implemented, and continue to receive the support of various levels of government in Australia' (Denniss, 2003).

These include 10% Federal tariff subsidies to fuel-inefficient urban 4WD vehicles; FBT regimes which reward heavy car use and penalise modest usage; and the GST which increased the price of public transport while leaving that of petrol unchanged. There are massive Federal funds to build freeways, but no specific allocation at all to build cycleways. State Governments have high fixed 'vehicle ownership' charges rather than 'vehicle use' charges (especially for third party injury insurance). These mean that those frugal with car use are forced to subsidise the profligate users. Local Government ratepayers are forced to pay more for planning and engineering staff who live long distances away (because of high company car package costs) than they do for local staff who are of more value to residents because of

their better local knowledge. The provision of salary-packaged vehicles mean that most decision-makers do not pay directly for their petrol and hence tend to have an automobile-dominated outlook. Even supermarket chains like Coles and Woolworths now force shoppers who use cars rarely to subsidise the gas-guzzlers due to the inequitable petrol discount schemes, funded by increased supermarket food prices.

Like BP, the authors recommend starting with the low-hanging fruit, of simple good engineering and urban planning to end the addiction to continual expansion of facilities for motor vehicles. For example, the overall disjointed and low standard facilities for pedestrians and bicycle transport users are an indictment of past and current planning and engineering practices throughout Australia.

Transport researchers must look now towards evaluating the oil shortage scenarios outlined, so there is much more information on which to base the crucial decisions which must be made soon. The current National Oil Supply Emergency Committee rationing plans are just one minor example. These need a rigorous review and a much broader community input to make them far more equitable and suitable for long-lasting shortages. Making decisions by default, using the current business-as-usual forecasts will prove extremely costly to nations, communities and individuals.

There is enormous scope for economic gains and for the avoidance of serious losses if the community, the professions and governments can turn away from car-dominated thinking. 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 very likely to sweep through Australia in the near future.

Acknowledgment

The authors would like to express special appreciation to Brian Fleay for his pioneering interest in oil depletion (eg Fleay (1995) (1998)). This paper is derived in part from the background paper prepared for the WA State Sustainability Strategy (Robinson, (2002)). The efforts and encouragement of Prof Peter Newman in this area amongst others should be recognised. Inspiration and assistance from members of the Sustainable Transport Coalition is also gratefully acknowledged.

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