

Peak Oil – What Australians need to know

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1 Introduction - no longer a theory

UK Energy Institute researcher and editor of the Petroleum Review Chris Skrebowski kicked off a presentation in Cape Town, South Africa (Energy Bulletin, 2008a), by outlining three stages of how an unpopular idea becomes a dominant belief: initially, proponents are portrayed as being insane; then comes the begrudging possibility that their theories may be right (with the proviso that they are not particularly important); and lastly, the former sceptics project the attitude that they “knew it all along”. Peak Oil certainly is one such idea. In September 2007 former US Energy Secretary Dr James Schlesinger told the annual conference of the Association for the Study of Peak Oil and Gas (ASPO) that “we are all peakists now” (Energy Bulletin, 2007).

In this paper the author – formerly the inaugural co-ordinator of ASPO Australia activities in Sydney - reviews the current state of the world’s oil situation to answer the question “what is meant by Peak Oil”. Emphatically it does not mean the world is running out of oil, but equally emphatically it means that the age of cheap oil is over. There is currently a debate in the peak oil community about whether the term “Peak Oil” is so misunderstood – particularly by newspaper editors – that it should be dropped, but Irishman Colin Campbell, a prominent advocate of Peak Oil, has helpfully defined it as being the situation that unfolds when production from new fields fails to offset the natural decline of old fields. (Campbell, 2008).

Oil is a commodity unlike any other. Our prosperity – and indeed our whole way of life – depends on energy being available cheaply. Some 75-80% of oil in Australia (Department of Prime Minister and Cabinet, 2004) is used for transport, and there is no substitute available commercially now or likely to be developed soon. Considerable faith is placed in the ability of engineers to come up with technological alternatives when confronted by appropriate price signals - but what if they do not?

2 Peak Oil

Figure 1 shows the essence of the peak oil dilemma. So far supply growth has kept pace with demand growth, but demand continues to grow at about 2% annually, driven mainly by demand from the Indians and the Chinese, while the global supply of oil is starting to flatten out, prior to a fall. The “super-giant” fields of Burgan (Kuwait) and Cantarell (Mexico) are already in decline, while the largest of them all, Ghawar (Saudi Arabia) has its status treated as a state secret. It has been in production since 1954, and currently supplies about 6% of the world’s oil.

When the time profile of the amount of oil extracted (“supply”) and the amount required (“demand”) - several things will happen. The price of oil will rise, it will become scarcer and harder to obtain, and the amount of energy required to extract oil remaining underground (the denominator of the EPR, or Energy Profit Ratio) will increase. This last effect is a function of the physics of oil extraction – it is always more difficult to extract the oil in a half-depleted field than from a fresh one, because of the need to maintain pressure, separate the oil from the water content etc..

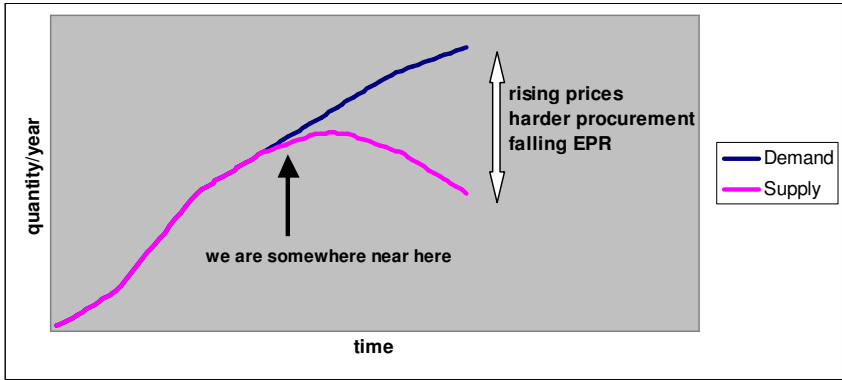


Figure 1 Peak Oil

3 Peak Profile

Clearly the credibility of the peak oil argument rests on the existence of a peak, leading to a post-peak decline. Campbell observed

“It [Peak Oil] is sometimes dismissively referred to as a theory, when in reality it is based on the simple observation that the consumption of any finite resource must start and end, passing a peak in between, as every beer-drinker observes as he drains his glass... It can apply equally well to an individual well, an oilfield, a region, a country or the world as a whole.” (Campbell 2008)

For example, Figure 2 shows the profile of Norwegian production, using data from the Energy Information Agency (EIA), an organisation which is part of the US Department of Energy. The profile of all non-OPEC producers is similar. In April 2008 the Russian Oil Minister announced that his country’s production could not be increased (Financial Times, 2008b). Thus Russia joined the United States (whose domestic production peaked in 1971) and many other oil producing nations in passing its peak. Those with an economic background might argue that high oil prices will bring forth both more oil and technological alternatives, but this assumes that the world’s endowment of oil is infinite and the world has the time to wait while the alternatives are commercialised. The amount of oil left as global

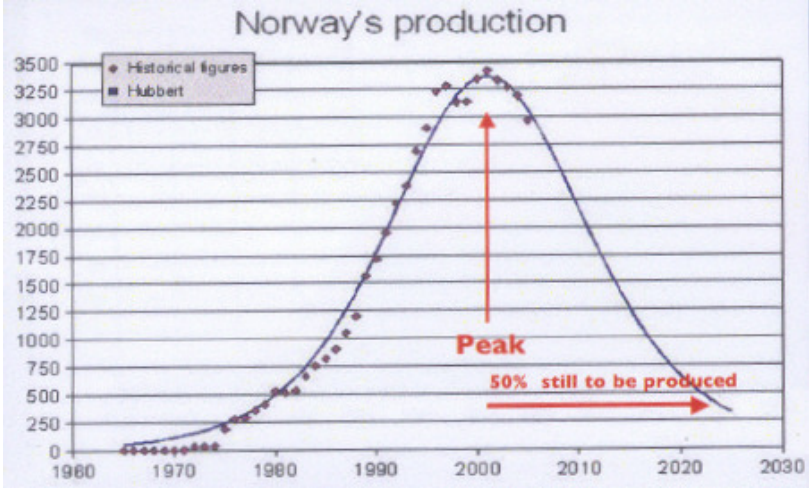


Figure 2 Norway’s Oil Production Profile

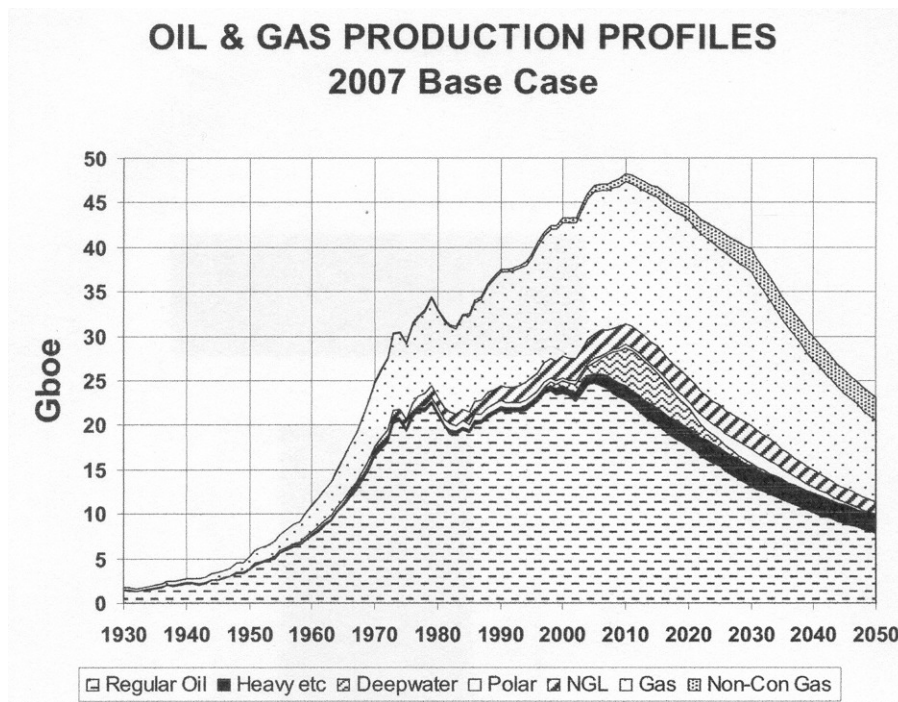


Fig 3 World oil & gas production (source: ASPO)

reserves is no guide to the amount that will be available on the international market, either, as oil exporting countries are facing rising domestic demand for oil and are directing their production to satisfy this component of demand first. Oil exports will peak before oil production does.

In late April King Abdullah of Saudi Arabia announced (Energy Bulletin 2008b) that Saudi oil production would not rise, citing the need to keep national resources to meet future national demand. According to one commentator, investment banker Matt Simmons, it is anyway impossible for the Saudis to raise production significantly, since they are relying for most of their oil exports on the world's largest oil field, Ghawar., which as already noted has been in production since 1954, In Simmons (2005), despite the undoubted engineering expertise of Saudi Aramco and the secrecy surrounding Ghawar, he showed that the technical indications are that it is close to the end of its life.

4 Production and price

The late Dr Ali Samsam Baktiari, an ex-senior adviser to the Iranian National Oil Company, gave independent evidence (Hansard 2006) to the Senate Inquiry into Australia's oil future and alternative transport fuels (described later). Among other things, he was asked "what are the key indicators that [the giant oilfields] are past peak production?" He answered that there were only two indicators to watch – the production and the price. Figure 3 shows ASPO's estimate of the imminence of the peak of production, based on geology rather than economics. The price over the last four years (Figure 4) has gone up and it has gone down, depending on what is happening in the world, but the underlying trend is unmistakably upwards - and it is accelerating. The US dollar price of a barrel of crude has doubled from February 07 to April 08 on the New York Mercantile Exchange (NYMEX). While this is not evidence that the oil price will continue to accelerate, or even continue to rise in the short to medium term future, it does illustrate the extreme volatility of the price and recent movement, in which the trend is upwards , (driven by the scarcity value of oil).

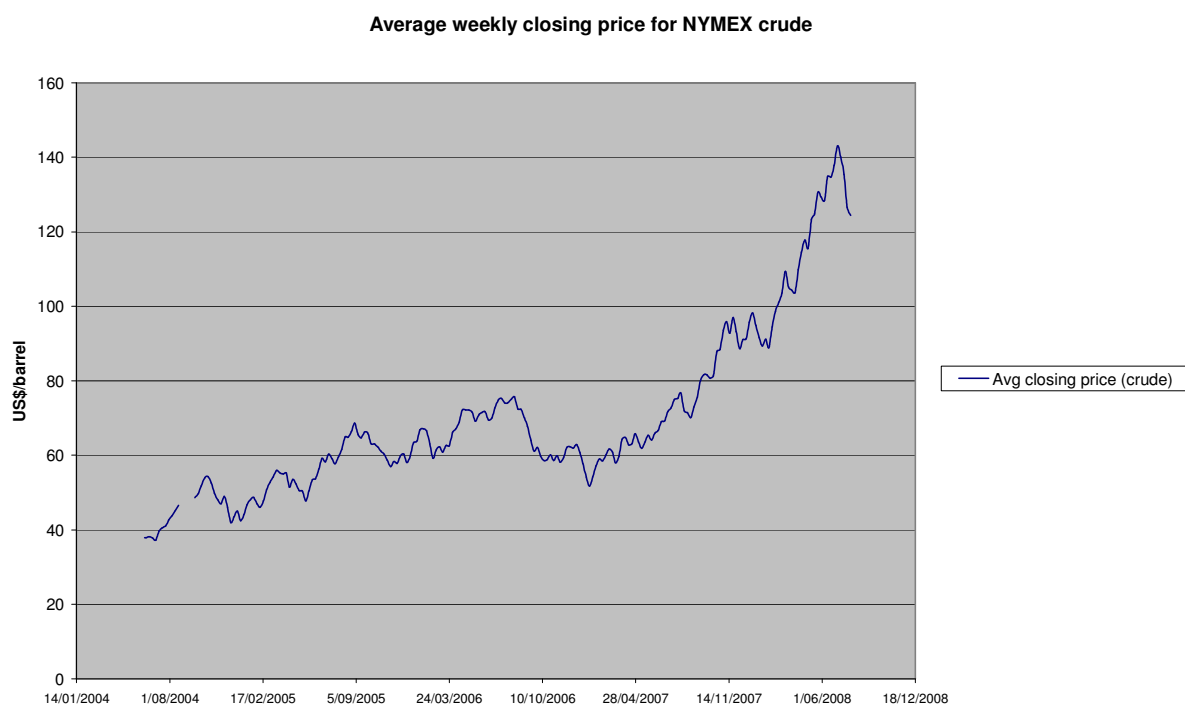


Figure 4 Weekly movement in NYMEX price of a barrel of crude oil 2004-2008

5 Lack of consensus as to timing

So the peak is coming, When? There have been a variety of studies, which have not agreed at all. Table 1 shows the range. The estimate of the Macnamara Report (Queensland Government, 2007) is a statistical average of the other studies, and if - as this paper argues they should - the long-term forecasts are disregarded, the average comes down from 2013 to 2011 – uncomfortably close to now. Even 2013 is close, compared to the time needed to prepare.

Do experts agree?

Unfortunately, no. There is a paucity of reliable data regarding the extent of oil reserves. The International Oil Companies tend to regard the amount of reserves on their books as

Table 1 Various published estimates of timing of oil peak

Based on data in Queensland Government (2007)..NB Macnamara estimate is statistical average of others

Category	Researcher	Country	Timing of Peak
Past	Deffeyes	USA	2005
	Baktiari	Iran	2006-07
	Simmons	USA	2006-07
Imminent (2008-2012)	Skrebowski	UK	2010 (+/-)/
	Campbell	Ireland	2010
	Goodstein	USA	Before 2010
	World Energy Council Weng	- China	After 2010 2012
Short-term (2013-2019)	Macnamara	Australia	2013 ± 7
	Westwood	UK	2016
Medium- or long-term	CERA	-	After 2020
Beyond 2020	Bull	USA	2030 or later

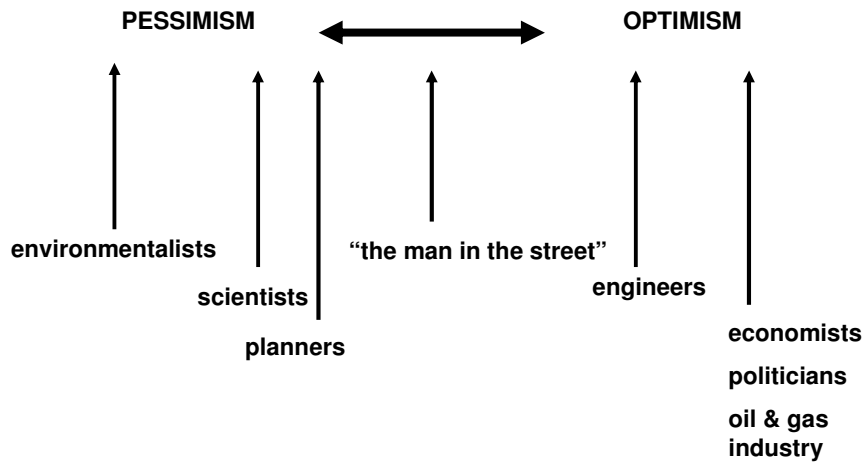


Figure 5 – Peak Oil mindsets

(Source: D Kilsby seminar presentation 28.5.08)

commercially sensitive, and the US stock market reporting rules give them every incentive to under-report, while the opposite is true of the National Oil Companies which are increasingly dominating the scene (CRS 2007). With OPEC production quotas (and hence state revenue) dependent on the extent of national reserves, there is an incentive to over-report (and plenty of evidence that both practices exist).

With no reliable data, one's view of the imminence or otherwise of the peak tends to reflect one's basic beliefs, which vary (Figure 5). Figure 5 divides the spectrum of opinion into the pessimistic (the peak is imminent) and the optimistic (the peak is a long way off or there is no peak). Which will turn out to be right, we have no way of knowing but the science is not encouraging..

As a caricature, the extreme end of the pessimistic spectrum is occupied by environmentalists, while the extreme end of the positive spectrum is occupied, for different reasons, by economists, oil & gas industry executives, and politicians (or, to be more accurate, by politicians in government, Politicians in opposition tend to take a "wait-and-see" middle approach.) Economists look at the numbers, and are trained to ignore the basic physical systems they are modelling with their economic theory, so they apply no concept of limits imposed by those physical systems. Ergo crop yields will always go up, oil prices will always go down, and growth will continue forever... Oil and gas industry executives tend to believe that there is plenty of oil and gas "out there", waiting to be discovered - if only exploration budgets could be increased. And government politicians tend to deny that there is any problem at all, for who would vote for a self-admitted struggler at the next election?

Also positive, but less extreme, are engineers, with their faith in their ability to find a technological solution to our difficulties, while the corresponding position on the pessimistic side is occupied by planners, who recognise that there is a major transition ahead but have faith in their ability to plan for it. Slightly more pessimistic than the planners, but less so than environmentalists, are the physical scientists (principally geologists) who look at the physical realities.

The economists at the Australian Bureau of Agricultural and Resource Economics (ABARE), in particular, have a woeful record of forecasting the price of oil, as Figure 6 shows. Unfortunately the Australian government needs this advice. ABARE has consistently predicted a fall in the price, when in fact it has continued to rise (it is approaching US\$120 per barrel at the time of writing, though there are other factors at play as well (like the falling value of the US dollar). Nor is this economic aberration confined to ABARE. Nobel Economics Prizewinner Vernon Smith is on record as predicting, in November 2005, that the price would fall to US \$15 a barrel “in the near future”. It rose to US \$145 a barrel by July 2005.

On 28 April, OPEC's president warned that crude oil prices could hit \$200 a barrel. (Financial Times, 2008b). Now that prices are falling again, some analysts are predicting that the price could go “as low as” \$100 a barrel. (1 barrel contains 159 litres of crude oil)

It is no wonder that the apocryphal “man in the street”, when confronted by this degree of disagreement between “experts”, sees no reason to change his (or her) behaviour yet. What will happen in future is unknowable – there **could** be a major new oil find, in defiance of trends (see below), or a technological breakthrough, but it is equally possible that the price will continue rising and shortages will develop, as the scientists predict, In my opinion. what is likely is that the extreme positions will disappear. The extreme optimists will have to acknowledge the reality that there are no more major oil provinces to be found - only the polar regions remain relatively unexplored – that physical limits do matter, and that governments do have a problem, but it is not as bad as once feared by environmentalists. The positive aspects of peak oil will be covered later. What is clear is that the role of the engineer will be critical – a promising breakthrough, be it in clean coal technology, fuel cell vehicles, biofuels or whatever – would give rise to the hope that “something will turn up” is (apparently) fulfilled, with no need to abandon familiar behaviour,

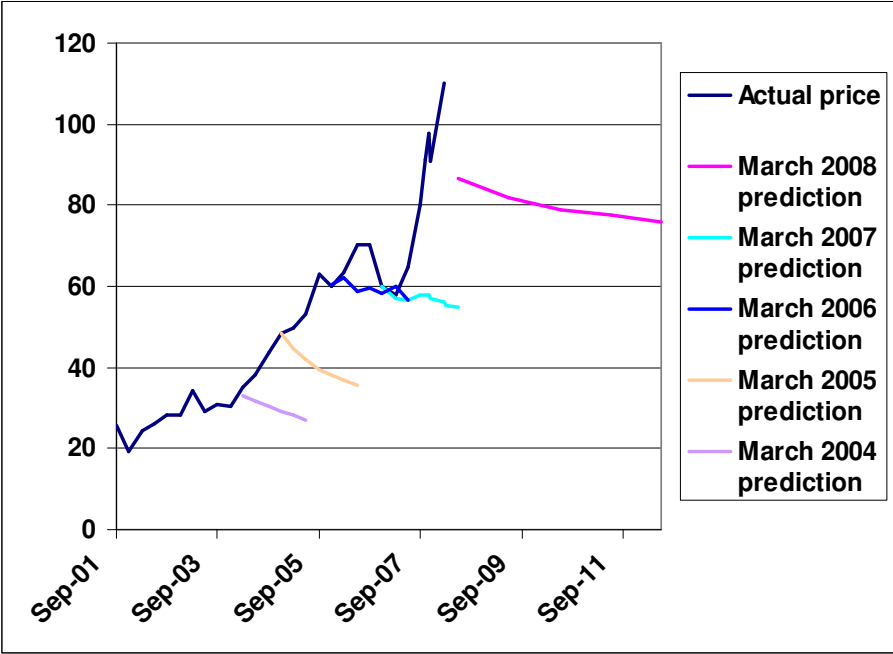


Figure 6 – ABARE forecasts of oil price 2004-2008 (Source: ASPO)

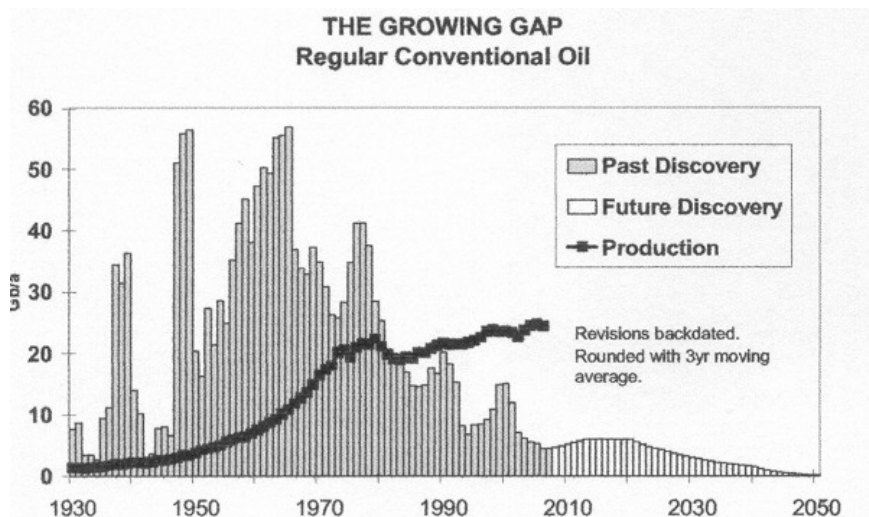


Figure 7 the growing gap between discoveries and production (source: ASPO, 4/08)

But what if nothing turns up? Then the planners, hitherto considered pessimists, will become the optimists and the public perception of the oil situation will change, leading to a change in behaviour.

6 Discoveries

What difference do “major” new discoveries make? Not a lot, unfortunately. The world’s demand for oil (a quarter of it from the US, from 2% of global population) is running at about 85 million barrels per day. Reductions made in the US will be swamped by growing demand from the expanding economies of China and India, whose newly-affluent middle classes aspire to North American lifestyles without the North American economy’s ability to fund the search for those reductions.

The peak period for discoveries was almost 50 years ago and the world is currently using at least four barrels of oil for every one it finds, and the gap is growing. (See Figure 7)

There is undoubtedly some oil left to be discovered. Also EOR (Enhanced Oil Recovery - more modern technology) can extract more of what is found. But the finds are getting smaller and harder to reach. And when compared to current world demand, oil finds in, for instance, the Arctic Wildlife Nature Reserve (in US,2001) offshore Brazil (2007), or the Caspian (Russia, 2002) will be quickly used up once the investment is made in the first place to extract the oil. For Australia, the Dunsborough field just discovered off Western Australia could hold 30 million barrels of recoverable oil. But Australia uses over 800 million barrels per year.

The only truly unexplored potential provinces are the Arctic and Antarctic.

The International Energy Agency (IEA), an OECD organization, questioned OPEC’s ability to act as the global “swing producer”: - in other words, when the OECD nations have hit their production limits, then OPEC will step in and increase its own production from its vast reserves – by veiled allusion in 2005 (“current trends are unsustainable”), more directly in 2006 (“the supply situation will be tight by 2012”) and unambiguously in 2007 (IEA 2005,2006,2007). The IEA’s “reference scenario” forecasts for production (consumption comes to the same total) remain unchanged and are shown in Table 2.

Table 2 IEA Production Forecast (in m bpd)¹ "Transition economies" are those countries in the Caucasus which were formerly part of the Soviet Union

	2004	2010	2030
OPEC	32.3	36.9	57.2
OECD	20.2	18.2	13.5
Transition Economies ¹	11.4	14.5	16.4
Other countries	15.2	17.7	16.3
Non-conventional	2.2	3.1	10.2
[^] Total Production	82.1	92.5	115.4

7 Climate Change

It is not the case, unfortunately, that Peak Oil is the only imminent environmental crisis with which the world has to deal. At the time of writing there is much public concern about the effects of greenhouse gas emissions and their impacts on global warming, The convergence of climate change issues, peak oil issues and, in Australia at least, water issues presents a huge environmental policy challenge. Many of the technical options to produce alternative fuels would have to be ruled out on the grounds of their greenhouse effect. For a view of alternative fuels, let us bow to Australia's elected representatives.

8 Alternative Fuels

In 2005 the Australian Parliament charged the Rural and Regional Affairs and Transport Committee of the Senate with holding an Inquiry into Australia's oil future and alternative transport fuels. They initially called for submissions – almost 200 were received - and spent much of 2006 hearing evidence. Their Final Report was tabled in February 2007 (Senate Rural and Regional Affairs and Transport Committee, 2007). There is much in it. My own poor summary of their findings on options for transport fuels is offered below.

- *Energy carriers*: In this category were hydrogen and electricity. The production of the energy can be by any means available. On hydrogen, the Inquiry's verdict was that it was "a fuel that might be considered in the distant future, but [was] not a useful option to consider in Australia's current or medium term fuels mix." but on the question of electrification – especially of urban transport - they were silent.
- *Biofuels*: The Inquiry identified "significant unresolved issues" with biofuels. Since then the switching of some crop production from food to fuel has led to rioting in poorer countries over the rising price of food.
- *Gaseous fuels*: The Inquiry backed away from the use of natural gas as a transport fuel, (compared to its interim findings, released in September 2006), and were sceptical that the supply of other alternatives (like LPG) was sufficient to replace oil.
- *Conventional oil*: A strategy that depended on increased exploration for conventional oil being successful was considered too risky.
- *Non-conventional oil*: "Many of the options (eg CTL, coal-to-liquid, or GTL, gas-to-liquid) remained as technical rather than commercial options under current policy settings. Their commercial viability would be badly affected by the imposition of a price on carbon emissions, as envisaged under the ETS (Emissions Trading Scheme), due to their high production of greenhouse gases. Non-conventional options, especially CTL, required geo-sequestration (carbon capture and burial) to work "if [they are] to avoid greatly increasing Australia's already substantial emissions of CO₂", something the Inquiry was surprisingly optimistic about, given that this technique had not been demonstrated in this country anywhere.

9 Implications for Transport

Consensus seems to be firming that Peak Oil will be upon us within five years, and Australia is woefully unprepared. Because of its heavy dependence on oil, the transport sector will be one of the first affected, ("97% of transport is fuelled by oil" - Department of Prime Minister & Cabinet, 2004). What follows is my personal opinion of some of the effects to be expected, rather than a summary of someone else's research.

Peak oil has the potential to be perceived as a more immediate threat to an individual's way of life than climate change, and once its effects are unarguable there will probably be more public pressure for action on the supply of oil than there is today for curbing greenhouse gas emissions. A public education campaign to improve awareness that these effects are inevitable seems called for.

Increasingly the global production of oil and gas will become dominated by those countries with the largest reserves – mainly in the Middle East and the Caucasus – as more and more countries run out of oil to produce. The geo-political implications of this are left for the reader to contemplate.

In Australia, as elsewhere, it will be necessary to treat oil-based fuel as a scarce resource and prioritise its use. Outside of urban areas, where there are fewer options for modifying behaviour than in cities, producing and distributing food will have the highest priority, while within urban areas - which house the majority of Australia's population – we will see a resurgence of public transport and low-energy independent transport to cater for the lowest priority use of all - discretionary use of private cars. Clearly there is more to what to expect than this but there will have to be a prioritisation of such refined fuel as the country can obtain, The Senate Inquiry heard evidence that the country's dependence on oil imports would increase from about 23% in 2005 to over 79% by 2021 (Senate Rural and Regional Affairs and Transport Committee. 2007 – submission 127 from Geosciences Australia.)

Bowers et al (2006) proposed a framework for assessing transport infrastructure proposals more appropriate for this changed environment.

"Transport" can take place on land, in the air or by water. The most oil-dependent mode is aviation, especially passenger aviation, for there is no technological alternative in sight to the heavier-than-air aircraft, powered by fossil fuel. Many observers (eg May, 2005) consider that, on ecological grounds, demand to travel by air needs to be reduced – and peak oil adds reinforcement to that view. This is obviously of concern to an island nation a long way from anywhere else.

Modelling of a permanent doubling in the world oil price, commissioned by the Queensland Government, projected air transport activities to be 27% lower in 2016-17 than it would otherwise have been without increases in fuel price. (Senate Rural and Regional Affairs Committee, 2006).

Road transport is also heavily dependent on oil, although not to the same extent as aviation. It is likely that the future will see more road vehicles, although possibly lighter and more fuel-efficient than those that we are used to. For both passengers and freight, it is possible (as discussed by Bowers et al, 2006) that dividing transport by function, into independent means and services provided by third parties, could be more productive than the more traditional divisions into road and rail, or passengers and freight, or even cars and public transport (which overlooks the potential of walking and cycling to meet short-distance needs in urban areas). For heavy vehicles, operations that permit refuelling at a central depot will be at an advantage while the infrastructure for an alternative fuel distribution system (or systems) is

being planned and built. But the expected growth in road freight will not happen – though undoubtedly the road freight sector will make great advances in its use of fuel - and the rail freight sector will undergo a renaissance.

The death of air-travel-based tourism, the end of globalisation, the re-evaluation of rail, the loss of excise revenue on petrol sales - the implications are far-reaching and extend far beyond transport. ASPO Australia has active working groups not only for transport and urban planning and the oil & gas industry – and biofuels specifically - but also for active transport, agriculture, fisheries and food, the construction industry, defence, the financial and economic sector, health, remote communities, and social services.

The news is not all bad. If car use is reduced, so also will the road toll be. If it is halved - something ASPO Australia sees as quite possible if its recommendations to the Senate Inquiry, all do-able today, were taken up – there would be some 800 Australian lives saved each year, and some 15,000 hospital admissions avoided, We would see fitter healthier kids and parents, both physically and mentally (through the benefits of physical activity from increased active transport). better friendlier safer communities, better streetscapes, lower urban speeds, less local air pollution, less noise, less road congestion, no road rage

10 Conclusions

This paper has presented evidence to show that Peak Oil is not a theory, it is an imminent reality that the world in general, and Australia in particular, will have to acknowledge and live with.

In this review of the oil situation, I have shown what peak oil is when it is expected to bite and the degree of consensus among :”experts” as to this timing. Given its importance to the world it is incredible that no reliable data source exists, no agreement on definitions and we are dependent on individuals to come up with their ”best estimates’ and on the press to monitor official statements, The establishment of an auditable dataset must be a high priority for researchers.and policy makers.

In Australia, with a seeming abundance of energy resources, hope rests with engineers to “come up with something”: If current efforts are unsuccessful, we will see a shift in public attitude towards energy conservation. but while the jury is still out on that success the role of the engineer is crucial.

The oil price is highly volatile and presents a severe risk, to be managed, to Australkian transport.

The Australian Parliament was sufficiently concerned to mount an Inquiry in 2006 into our oil future and alternative transport fuels. I have summarised its findings, which perhaps reflected more the politics of Senate control at the time than the matter under investigation.

My own views of the implications for transport are summarised. We will be in for an “Interesting” time.

Finally I would like to offer a quote from Winston Churchill. He was not talking about Peak Oil in November 1936, but he might as well have been. Peak Oil is not a new concept, but the “age of procrastination” is now ending and we must face the “period of consequences”.

“The age of procrastination, of half measures, of soothing and baffling expedients, of delays, is coming to a close. In its place we are entering a period of consequences.”

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