What will our vehicles run on in 50 years time ? (Preview)

Dave Kilsby, June 2007
(This is an expanded version of a presentation to be made at a Transport Conference in New Zealand in July 2007, as presented to the Sydney Transport Panel in February 2007).

The New Zealand Conference

In July 2007 (25th-27th) the NZ Ministry of Transport will be the major sponsor of a transport conference to be held in Christchurch [1]. There will be several international keynote speakers, plus about 86 papers (of which 25 are from non-New Zealanders) to be presented in four parallel sessions. Six of these deal with transport energy, including the one which I summarise here. My paper is called "What will our vehicles run on in 50 years time" (the theme of the conference is "Transport - the next 50 years" and it is an attempt to convey to New Zealanders the findings of the 2006 Australian Senate inquiry into Australia's Future Oil Supply and AlternativeTransport Fuels.

Credentials

In September 2000 the Sydney Transport Panel held a seminar on a similar theme – what would the new century bring for transport? Even in 2000 it was evident to me that transport had an energy problem looming, and I spoke on this subject at that seminar [2]. Since then I have written two submissions to the Senate Inquiry [5] - one from the National Committee on Transport of Engineers Australia [submission 4], and one from the Urban Planning and Transport Working Group which I now convene, of ASPO Australia (ASPO is an international movement, the Association for the Study of Peak Oil and Gas) [submission 133]. In July 2006 I presented my evidence in person to the Senate Committee when it conducted hearings in Sydney.

The Senate Inquiry

In November 2005 the Australian Parliament referred the issue of Australia's oil future and alternative transport fuels to the Rural and Regional Affairs and Transport Committee of the Senate to inquire into. Initially the Senate Committee called for submissions from interested parties, and about 200 were received. The Committee then spent from April to August in various Australian cities hearing evidence, and was then due to table its final report in Parliament in September 2006.

September 2006 came and went, and the date for tabling the final report was first postponed to the last sitting day of the Australian Parliament in November 2006, and then to the first sitting day of Parliament in February 2007. By then, thanks to a structural change in the Senate which took effect at the beginning of July 2oo6, the Chairmanship of the Inquiry has passed from Senator Siewert, a Green Party Senator from Western Australia, to Senator Heffernan, a Liberal (Government) Senator from NSW.

Fortunately the Committee had recorded its deliberations in an Interim Report [3} in September 2006 – without recommendations – and it is upon this report that my presentation to the New Zealand conference was based. In early February 2007 the program of monthly talks of the Sydney Transport Panel of Engineers Australia (which I chair in 2007) had an unexpected vacancy and I filled it by giving a preview of the New Zealand Conference, and of my paper in particular. The Final Report of the Senate Committee [4] was tabled in the Australian Parliament the following afternoon.

When the Final Report was tabled, I noted two main departures from the Interim Report. First, the Committee had changed its mind about the potential of natural gas as an alternative transport fuel – it was no longer viewed favourably, with demonstration of the feasibility of geosequestration of carbon dioxide, to enable the commercialisation of various "clean coal" technology options, seen as the preferred way forward. Second, some comments about energy security which appeared in the Interim Report (see below) had disappeared.

The Committee report was tabled in Parliament at the same time as the early recommendations of a Taskforce on Emissions Trading, which attracted all the media attention. If, as seems likely, Australia puts a price on carbon emissions, it is even more important that geosequestration be shown to be feasible – and the sooner the better.

Australia and New Zealand

The first thing that I did was to look for similarities and differences between Australia's and New Zealand's energy positions, since my expertise lies in transport not energy. Table 1 confirms my initial impression that while Australia uses its considerable coal reserves, New Zealand relies more on renewable sources of energy such as hydro power and geothermal energy. Both countries have 35-40% oil in the energy mix (domestic consumption), though in Australia's case a large proportion is also produced domestically

	Australia 2005	New Zealand 2005
Oil	35%	38%
Coal	35%	13%
Gas	22%	20%
Hydro	5%	12%
Geothermal	0%	12%
Other renewable	2%	5%

Table 1 Australian and New Zealand energy supply mixes 2005
Sources : Australia: 2005 Interpolated from graph in [5]
NZ 2005: [6]

Table 2 shows the extreme vulnerability to overseas market conditions of New Zealand, and the way in which more domestic oil production in Australia was exported than was used domestically, resulting in higher exposure to overseas markets than might be expected.

Oil	Australia 2003/04	New Zealand 2005
Imported	22%	35%
Indigenous - used	14%	3%
Indigenous - exported	16%	presumed 0%
Total used domestically	35%	38%

Table 2 Australian and New Zealand dependence on overseas oil 2003-2005

According to the EIA Energy Annual (EIA is the US Energy Information Administration), in 2004 Australia was one of only five OECD countries (out of 28 – the others were Canada, Mexico, Norway and – just – Denmark) to be an exporter of energy, and the production of these countries was dwarfed by the consumption in the United States and Japan in particular. Table 3 shows the production and consumption figures for 2004 by region of the world, irrespective of whether the countries belonged to the OECD or not.

Region	Countries>0	Production	Countries>0	Consumption	Difference
N America	4	15.9	6	25.0	-9.1
Cent & S America	17	7.0	45	5.4	+1.6
Europe[1]	33	8.6	34	18.3	-9.7
FSU	13	11.3	15	4.1	+7.2
Middle East	14	24.8	14	5.9	+18.9
Africa	23	8.4	56	2.8	+5.6
Asia & Oceania	22	8.3	42	23.3	-15.0
All	126	84.3	212	84.8	-0.5

Table 3 World Oil production and consumption in megabarrels/day 2004
Source: [7]
[1] Consumption excludes former Yugoslavia, Czechoslovakia – figures not available

Peak Oil

The reason why I foresee an energy crisis that will affect transport is of course Peak Oil – the point at which global oil production reaches a maximum before beginning a slow but inexorable decline. Nearly all transport runs on oil, and 75% of Australian oil consumption is accounted for by transport [5]. In New Zealand the figure is even higher.

I did not spend much time explaining to the Sydney Transport Panel the concept of Peak Oil – my views are well known. Figure 1 conveys the essential message. The production profile of an individual oil well can be represented by a bell-shaped curve – production starts slowly, accelerates, reaches a peak and then declines, Aggregation of hundreds of thousands of such individual profiles leads to a global profile which is similar. There is ample evidence that we are now approaching the peak of global production, though largely because of the quality of available data the timing of the peak is uncertain. It is thought likely to occur sometime in the next two decades, with the most commonly forecast period being 2010-12. In the 1950's it was forecast that oil production in the US would peak in 1970 – although the forecaster (Marion King Hubbert, who worked for Shell) was much ridiculed at the time, US production actually peaked in 1971.

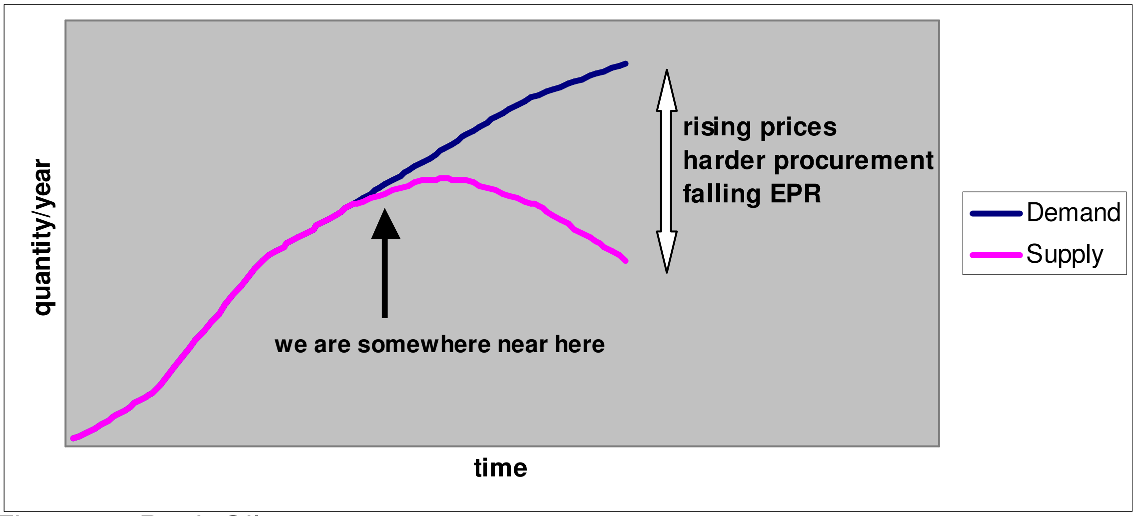

Figure 1 : Peak Oil

For the last 100 years and more, the global production of oil has risen to keep pace with the world's demand for it. Demand continues to rise at about 2% per year due to growing economies and the emerging middle classes in China and India, but, after the peak, oil supply will no longer be physically able to rise. The price mechanism will kick in with a vengeance, and although better technology available now may be able to suck increasing amounts of oil from under the ground or at sea, this will only serve to make the decline, when it comes, that much steeper because oil is a finite resource not renewable except on timescales measured in millions of years. The world is in no danger of running out of oil in the foreseeable future, but the Age of Cheap Oil is almost over.

What is certain is that once the peak is passed, the price of oil will rise, the physical supply will decline slowly and the amount of energy required to be used to extract the remaining oil will rise – the EPR, or Energy Profit Ratio. The major deposits held in the Middle East and in the Caucasus will assume greater importance as other sources dry up – with obvious geopolitical implications.

Senate Findings – general

The Interim Report of the Senate Committee [3] made the following observation about energy (italics mine) which seemed to me to be very important in view of the actions of the Chinese, in particular, in seeking to replace market-based trading with, effectively, bilateral energy treaties. No reference to this point could be found when the Final Report [4] was tabled.

> *It should not be assumed* that surplus energy will be available for purchase, even if countries like Australia and the US have the finance. (Source : [3] 2.5)

It also made the following comments:

> Peak oil proponents have criticised official estimates of future oil supply with detailed and plausible arguments. The Committee is *not aware* of any official agency publications which attempt to rebut the peak oil arguments point by point in similar fashion. (Source: [3] 2.16)

> In the Committee's view, the possibility of a peak of conventional oil production before 2030, *even if it is no more than a possibility*, should be a matter of concern. (Source: [3] 2.17)

> Longer term planning *[beyond 2030]* is needed (Source: [3] 2.19)

The Senate committee was clearly influenced by the submission from Geosciences Australia. Thus attempted to combine an Australian production profile (with various levels of probability of future production) with a national consumption profile from ABARE (the Australian Bureau of Agricultural and Resource Economics). The Interim Report said:

> On Geoscience Australia's figures, it appears that over the next 20 years Australia's self-sufficiency in oil and petroleum products will decline from 84% to 20% (using a middle range estimate of future production), or from 98% to 31% (using an optimistic estimate of future production). (Source: [3] 2.26)

Figure 2 shows the growing future gap for the nation between domestic production and consumption. This diagram has been criticised by economists as being "economically illiterate" – apparently because it does not allow for the effect of price in balancing production and consumption – but I would counter that economists are rather better at finding oil on paper than scientists – mainly geologists – are at finding it under the ground. When the laws of physics and the laws of economics conflict, my view is that physics will prevail.

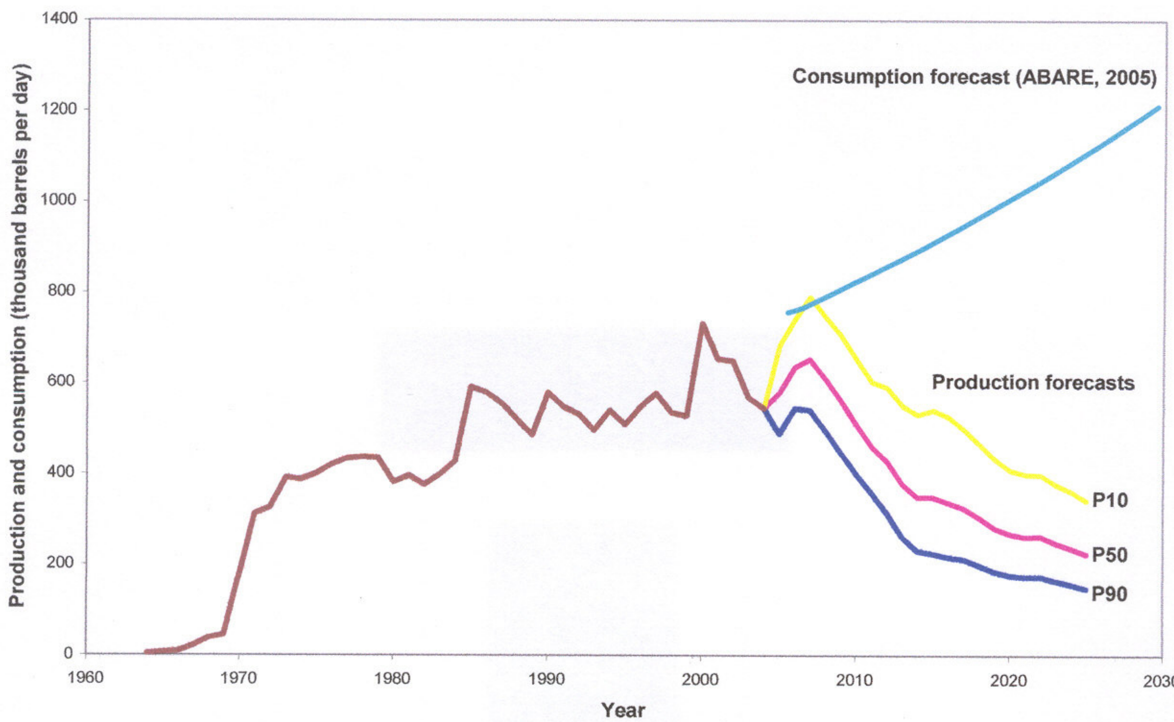

***Figure 6:** Forecast Australian consumption of petroleum products (excluding LPG) and forecast of Australian crude oil plus condensate production rate at various probability levels*

Figure 2.
Source: [8], submission 127

Supply side options

The supply side options considered by the Committee are described in more detail in the next section. The main options were seen as:

- discovering more Australian oil
- using more gaseous fuel - natural gas, LPG, hydrogen
- using more biofuels
- other technological options

The emphasis below is, again, mine rather than that of the Interim Report.

Searching for more oil in Australia

> *It remains to be seen* whether the Government's initiatives will have a significant effect on exploration activity, or if they do, whether significant reserves will be found, and *if they are found*, whether the cost of extraction will generate a fuel price that is competitive with the alternatives. (Source: [3] 4.11)

Gaseous fuels – natural gas

> Natural Gas can be used in both diesel and petrol engines, Both require extensive modification, but the technology is *regarded as mature* (Source: [3] 4.35)
>
> … both *advantages and disadvantages* as a transport fuel. (Source: [3] 4.36)

The advantages were seen as ready availability, domestic gas reticulation, relative abundance, price stability, environmental pluses. The disadvantages were seen as on-board storage size/weight, limited range, energy cost to compress (and, for LNG, to liquefy), cost of conversion. To the disadvantages might be added the fact that natural gas is the last abundant source of fossil fuel energy and when it is gone there is no other source of energy available to ease the transition to a post-oil world.

> The Committee is of the view that it would be prudent to put in place measures to encourage *the rapid take-up* of natural gas in the transport fuels mix ...These will be explored in more detail in the final report …(Source: [3] 4.38)

But the Final Report, when it appeared, said:

> The Committee has altered its view expressed in the Interim Report, that it would be prudent to put in place measures to encourage the rapid take-up of natural gas in the transport fuels mix. (Source: [4] 6.69)

In the Final report the Committee expressed the view that consideration should be given to establishing a national domestic gas strategy, to ensure that supplies are sufficient for domestic purposes well into the future. (Source: [4]} 6.71). It noted that:

> There are, however, significant obstacles to the wider use of gas for transport, These include a lack of distribution infrastructure, incompatibility with most of the transport fleet, economic penalties for some users if appropriate adjustments are not made, a slow return on investment for some users, and possible consumer resistance from limited range and a lack of a clear price differential from LPG. (Source: [4] 6.73).

Gaseous fuels – LPG

> LPG's principal advantage over natural gas is that it liquefies readily and does not have to be stored under refrigeration to remain a liquid. (Source: [3] 4.40)
>
> The Committee agrees that LPG may be a suitable substitute fuel for petrol in some vehicles, but questions whether *supply is sufficient* to

> support a large proportion of the current fleet being converted to operate on it. (Source: [3] 4.43)

Gaseous fuels – hydrogen

> … more correctly described as an energy carrier…Hydrogen *does not occur naturally* and must be produced as part of a manufacturing process. (Source: [3] 4.44)

> There are *formidable technical issues* to be overcome before hydrogen could be widely used as a transport fuel. These include the very large amounts of energy required to compress it and maintain it in a liquid state suitable for transport fuel use, storage problems resulting from its propensity to leak through the walls of metal pipes and tanks, the lack of a source of supply, and a complete lack of distribution infrastructure. (Source: [3] 4.45)

Biofuels

In this category the main contenders are ethanol (mainly made from sugar-cane or grain), and biodiesel (made from canola, palm oil & other crops). (Source: [3] 4.14-15) The draft New Zealand energy strategy [6] relies heavily on biodiesel.

> …*significant unresolved questions*… (Source: [3] 4.17)

The unresolved questions on which the Committee was not satisfied Included the EPR, or the amount of energy required to be invested to produce a unit of energy from biofuel, the production capacity, competition between fuel production and food or textile production in land use, sustainability (eg palm oil plantations that encourage deforestation), and the effect on vehicle engine warranties.

> Among the most interesting of these [technological innovations] is the potential use of *lignocellulose* to produce ethanol... (Source: [3] 4.19)

> This *[the Government target of 350 million litres of biofuels by 2010]* should be substantially increased if we are going to move to secure Australia's energy future…(Source: [3] 4.22)

Other technology (Non-conventional oil, CTL, GTL etc)

> The evidence … indicates that there are also environmental penalties associated with these options, which result in *substantially greater CO2 production than conventional oil …*(Source: [3] 4.27)

> … their price will be *significantly impacted* by the imposition of a price on carbon dioxide emissions …(Source: [3] 4.31)

CTL, if it is to avoid greatly increasing Australia's already substantial emissions of CO2, must rely on geo-sequestration of carbon dioxide, a technique which is *as yet unproven* in this country…(Source: [3] 4.31)

Electrification of urban transport

The Committee did not consider this at all, on the grounds that urban transport is a state responsibility.

My own summary of the supply side options canvassed in the Interim Report is given below.

- Find more oil : too speculative
- Use gaseous fuels more
  - natural gas : possible
  - LPG : not enough of it
  - hydrogen : not a useful option
- Use biofuels more
  - Significant unresolved questions
  - Some promising innovation
- Other technological options
  - Reliance on geosequestration working
  - Viability will be affected by carbon emissions price
  - Technical possibilities rather than commercial options
- Electrification of urban transport : silence

Demand Side Options

The Committee also considered options for influencing the national demand for oil, which it saw as principally :

- increasing engine efficiency
- changing behaviour

The Interim Report observed:

> Positive measures to provide more alternatives to the use of cars *[in the outer suburbs of cities and in rural/regional areas]* would probably be more politically acceptable *[than increasing the fuel efficiency of vehicles]* (Source: [3] 5.8).
>
> Fuel efficiency or possible oil depletion do not figure particularly in the 2004 AusLink White Paper. (Source: [3] 5.14).
>
> The Commonwealth's current policy is that public transport is the responsibility of the States. (Source: [3] 5.20).

> … Vast areas of post World War 2 suburbia have been designed in the assumption that most travel would be by car, and with the aim of making this easier …(Source: [3] 5.22).
>
> Turning around this situation requires better public transport services *and* supportive planning policies (Source: [3] 5.23)
>
> The needed *[urban strategic planning]* initiatives involve State and local government. Most of them require regional scale planning going beyond the boundaries of any one local government area. (Source: [3] 5.24).
>
> The Committee suggest that this *[COAG investigation of options for managing urban congestion]* should include the Commonwealth reconsidering the policy behind the concessionary fringe benefits tax on cars. (Source: [3] 5.31).

Committee recommendations

The Interim Report of the Committee did not contain any recommendations, The Final Report however made ten recommendations – two were general, three related to supply side options and five to demand side.

General recommendations

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

2. The Committee recommends that in considering a less oil dependent scenario the Government take into account the concerns expressed in *World Energy Outlook 2006* [9], namely –

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

Comment: The *World Energy Outlook* is an annual publication of the OECD's International Energy Agency (IEA). The Committee based its analysis of global oil futures on IEA forecasts, despite many reservations expressed by commentators on these.

Supply side recommendations

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

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

5. The Committee recommends that the government commission a research group within the Department of the Treasury to identify options for addressing the financial risks faced by prospective investments in alternative fuels projects that are currently preventing such projects from proceeding …

Comment: The Committee clearly felt that the production of ethanol from plant waste was a technology worth supporting.

Demand side recommendations

6. The Committee recommends that the Government, in consultation with the car industry, investigate and report on trends in the fuel efficiency of the light vehicle fleet and progress towards the 2010 target for the fuel efficiency of new passenger cars …

7. The Committee recommends that Australian governments investigate the advantages and disadvantages of congestion charges, noting that the idea may be more politically acceptable if revenue is hypothecated to public transport improvements (as has been done in London, for example)

8. The Committee recommends that Commonwealth Support for Travelsmart projects be maintained beyond the currently planned termination date.

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

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

Conclusions

These are my own conclusions and not the Committee's.

It is clear that aviation is the transport mode most at risk under a peak oil scenario, with road transport not far behind. Rail transport is less vulnerable as a land transport mode, with water transport also little affected. Yet air and road transport are the modes that are forecast to grow fastest in future, both in absolute and percentage terms.

The essence of the peak oil problem is risk management (Source: [4] 3.135). No two places are exactly alike and better information is called for.

The title of the paper ("what will our vehicles run on?") is the wrong question to be asking– it implies that there will be a technological "fix"available.

Options will be more local than global

It is already too late to do much to mitigate the coming effects of peak oil. We should have taken action in regard to mitigation options at least fifteen years ago.

This is not to say that nothing can be done, But the options available will be much more geared to adaptation (learning to live with less oil) than mitigation (finding alternatives to oil for transport).

The appropriate question to ask is not " what will our vehicles be running on but "what sort of a world will we be living in?"

References

1. www.transport07.co.nz
   For details of Christchurch conference 2007
2. www.kilsby.com.au/archive/p0900.pdf
   For "Energy Futures for Transport", written for IEAust/UNSW Seminar 2000
3. www.aph.gov.au/senate/committee/rrat_ctte/Oil_Supply/int_report/index.htm
   For Interim Report of Senate Committee Inquiry 2006
4. www.aph.gov.au/senate/committee/rrat_ctte/Oil_Supply/report/index.htm
   For Final Report of Senate Committee Inquriy 2007
5. www.dpmc.gov.au/publications/energy_future
   For Australian Energy White Paper "Securing Australia's Energy Future" 2004
6. www.med.govt.nz/upload/43136/draft_energy_strategy.pdf
   For discussion paper on draft NZ Energy Strategy 2005
7. www.eia.doe.gov/iea
   For EIA International Energy Annual 2004
8. www.aph.gov.au/senate/committee/rrat_ctte/Oil_Supply/submissions/sublist.htm
   For submissions to Senate Inquiry 2006
9. www.worldenergyoutlook.org/2006.asp
   For IEA World Energy Outlook 2006