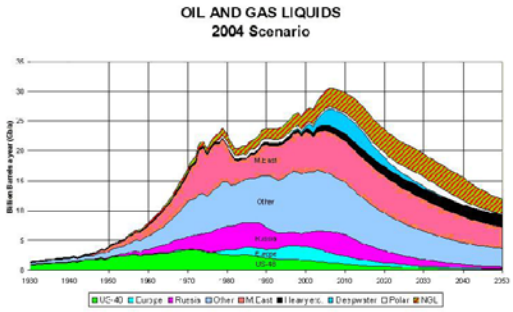
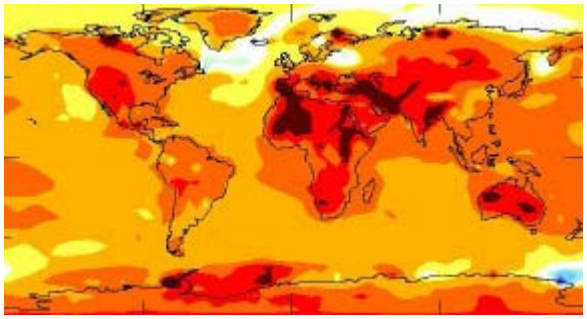
Peak Oil Ante Portas

Followed by global warming

Submission to the Senate Inquiry on Oil Supplies



Decline of everything which depends on oil
(Colin Campbell, ASPO)



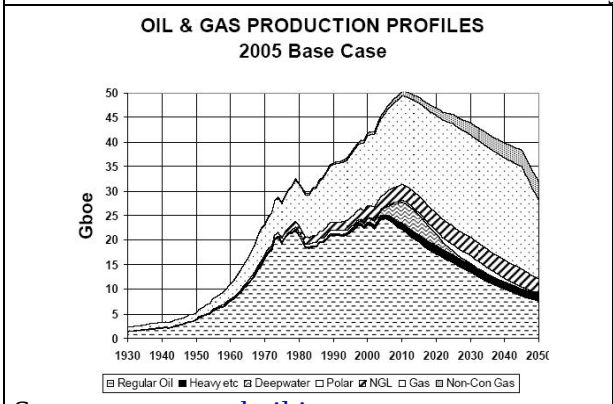
Different planet from 2 ^{o}C warming
(James Hansen, NASA)

Prepared by Matt Mushalik mushalik@tpg.com.au 24th February 2006

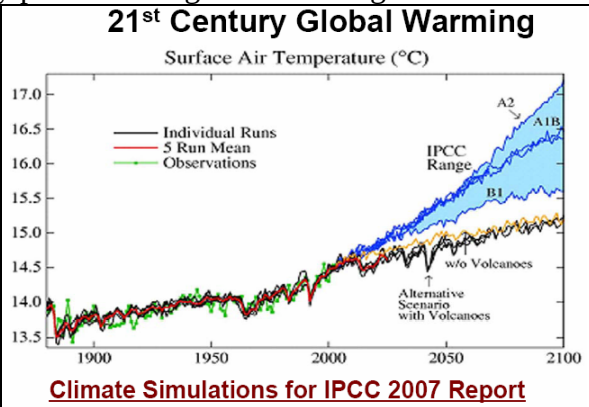
Executive Summary and Recommended Strategy

The world's oil production is reaching a bumpy plateau (peak oil), which will be followed by a permanent 2% p.a. decline caused by oil-geological limitations, most likely starting between 2008 and 2010. Conventional oil has already peaked. The period of easily flowing and cheap oil is definitely over. Though initially a liquids crisis mainly in the transport sector, peak oil will trigger a global energy crisis as the world will desperately try to fill the emerging oil supply gap by other forms of energy. This will result in a first class primary energy problem which will be very difficult to solve by technology alone.

Simultaneous double whammy peak oil and global warming



Source: www.peakoil.ie



Source: http://pubs.giss.nasa.gov

http://www.columbia.edu/%7Ejeh1/newschool_text_and_slides.pdf

This comes at a critical time when climatologists warn us we must reduce the burning of fossil fuels at the rate of 60-80% by 2050 (around 1.5 % p.a.) and that we may reach a point of no return in already 6-10 years there, too. Just a 1 degree warming will result in an ultimate sea level rise of 5-6 m as happened in the last interglacial period. Melting of ice sheets which cause these sea level rises are non-linear when meltwater runs down ice cracks and lubricates the bottom of ice sheets which accelerate their flow towards the ocean.

Ironically, peak oil, which will slow down economic activities or even lead to a prolonged recession, may help to avoid an even larger climatic problem. But nothing would be more disastrous than a return to coal as primary source of energy in massive CTL projects or large scale mining operations of tar sands and oil shale without geo-sequestration. Though Australia's coal might be considered as "abundant", the green house gas absorption capacity of the atmosphere is not and the limiting factor is on the sink-, not the source-side of the coal burning process. We therefore have much less burnable coal than we think.

Targets & timings
Prepare to save 2% oil pa from 2008/2010
Reduce green house gas emissions by 1.5% pa

It is vital to understand peak oil and global warming as a double challenge with concrete time limits for action and quantitatively set targets to be achieved. This is not a matter of debate, opinions, views and arguments but of learning and accepting nature's laws (oil depletion laws, atmospheric laws) and calculating solutions. The multiple systems failure in New

Orleans and the destruction of oil producing facilities in the Gulf of Mexico demonstrated how self-regulating nature is.

Definition: A sustainable system runs on genuinely renewable fuels and/or energies, without disturbing nature's equilibrium.

Biofuels can only contribute a small percentage of our current fuel consumption, are in competition to food supplies, depend on rain falls, sharpen the soil degradation crisis and also require fossil fuel inputs like fertilizers. They are so precious they should only be used in the agricultural sector itself.

Nuclear power was the big hope after the 1st oil crisis in 1973 but waste disposal problems, safety concerns, massive government subsidies and now nuclear proliferation have limited its success. In Australia, nuclear power is only useful if the equivalent amount of coal fired capacity is turned off for good or if it is used for an electrified rail transport system. A decision on nuclear power would have to be done right now as most nuclear power technology on a 1,000 MW scale would have to be imported and a local skill basis be developed which may take at least 10 years. It is a drama of the 1st order that the energy complacency in government is mirrored by a complete unawareness in the electorate about the coming oil and energy crisis and the urgency of such decisions.

All renewable energies (solar, wind, wave, geothermal etc) produce electricity, not fuels. Liquid production (e.g. hydrogen) from electricity would waste enormous amounts of energy due to thermodynamic laws governing the transformation of energy. The hydrogen technology (fuel cells, large scale H_2 production and distribution) is not commercially ready yet to help us overcome the immediate peak oil problem. As renewable systems have low energy densities, the waste from transforming high level electric energy to fuels and possibly back to electricity in electric motors would not be affordable.

Australia's natural gas should be used to build up renewable energy capacities which produce, not consume energy. The production of solar cells, for example, is quite energy intensive. If this is not done, we may fall down the energy ladder. There should be no more gas export deals. Instead, solar panels should be exported on a massive scale. This will help to create employment and counteract the drain of local purchasing power for costly oil imports.

It will not be easy to replace a continuously declining oil production with alternative fuels and/or energies in the required quantities to maintain the current consumption pattern in air, sea and land traffic. Peak oil – and that should be absolutely clear – is the beginning of the end of using planes, trucks and cars as we know it. Therefore, there should be an immediate moratorium on airport expansions, freeways, giant car parks, car dependent shopping centers etc.

The investment capital which is freed by such a moratorium must be used to finance the projects we need to overcome oil dependence and establish renewable energy systems. **If demand management of car and truck traffic and modal shift to public transport and rail freight is not done now, peak oil will do it and that will be chaotic and outside our control.**

Energy efficient electric rail is the solution for peak oil and global warming in the transport sector	
	
Transperth EMU on Mitchell Freeway	Electric freight train in Austria (hydro power)

The only sustainable mode of land transport with current, proven technology is electric trains powered from renewable energy with energy storage in hydro schemes.

A priority list of uses for oil must be developed. Medical supplies, emergency services and food production come first. Another priority is setting aside an Australian oil field with sufficient oil for several decades to be refined into aviation fuels for international business flights so that Australia can remain connected to the rest of the world after peak oil. In land transport, a quantum leap in energy efficiency (KWh per passenger and ton of freight) is required and that can only be electric rail, both urban, inter city and inter state and passenger and freight. Therefore, a massive rail revival programme has to be started immediately.

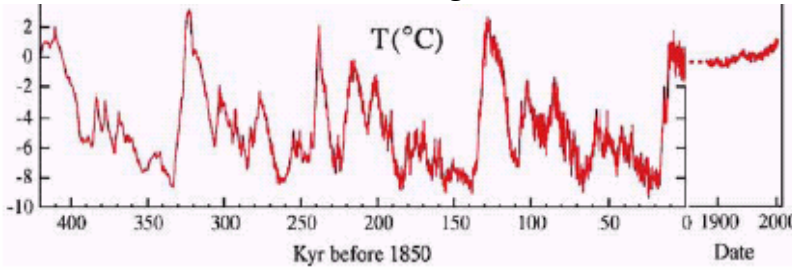
Both governments and the private sector are in denial mode over peak oil and global warming. They assume - without having checked it - that market forces will do the necessary transition to other technologies and forms of energy. That allows them to continue business as usual.. But in the absence of viable and quick alternatives we are rather going to see a war type of economy after peak oil where its most important resource - oil - is continuously “withdrawn” and where governments will see themselves forced to step in to regulate physical shortages. Moreover, they seem to think that sustainable systems as defined above are an obstacle to economic development while in fact they are a pre-condition for the long term survival of our economy. The more denial now the more damage to the economy later. A new business model has to be developed.

All decision makers, whether government or private, must undergo intensive training in both peak oil and global warming with the aim to enable them to do basic calculations themselves so that they can convince themselves about the proximity and the magnitude of the problems and which few options are left to solve these problems in the remaining time before tipping points are reached. At present they depend on advisers and – quite naturally – they will cherry pick the advise which fits their prejudices, wishful thinking or ideologies.

Worse still, we have now come to the shocking situation where advise from scientists which does not fit preconceived policies is now being muzzled. This is not the way the physical problems of peak oil and global warming can be solved. Nature is not part of an endless debating club competition. If we do not take action, nature will. And this process has already started. It is plain to see. We are not running out of oil yet but out of time.

Excursion outside the TOR: Is there still time to rescue our climate?
Read J. Hansen's http://www.columbia.edu/%7Ejeh1/newschool_text_and_slides.pdf

1. An alternative scenario in which green house gas emissions are being reduced can stabilize the Earth's climate, but this strategy is currently not being pursued in the required quantities and at the required speed of change
2. **Another 10 years of business as usual** (more fossil burning infrastructure) and an alternative scenario at a later stage will no longer be able to control a run-away climate change in future with i.a. large scale flooding of coastal strips.
3. Action is therefore needed NOW, not later. Green house gas reductions must be 60 to 80 % to ensure that temperature increases do not exceed 1 °C in this century
4. The public must understand these facts and put as much pressure on politicians as is needed to overcome shortsighted, vested interests of the fossil fuel industry



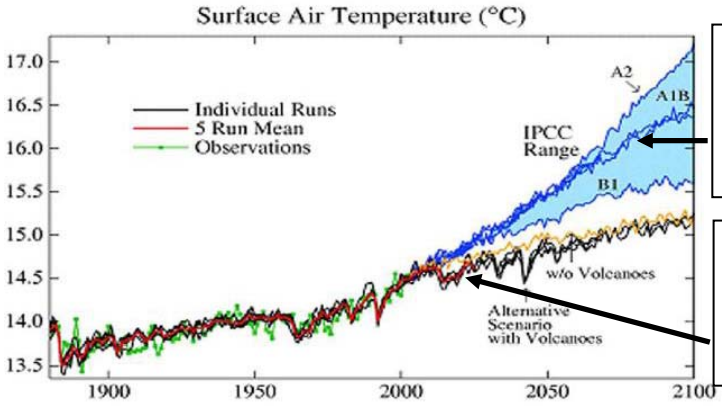
Ice ages and inter- glacial periods differ by just 5 °C. Increase in temperature by 2-3 °C would lead us into a hot, unknown world and sea levels 25 ± 10 m higher than today

Facts:

(a) We are now in the Holocene, an interglacial period, which lasted for about 10,000 years with a comparatively stable climate and sea level. The preceding ice age, at its peak 20,000 years ago, was around 5 °C cooler than now. Sea levels were 110 m lower. The previous interglacial period was 1 °C warmer and sea levels 5-6 metre higher than at present.

(b) Green house gas emissions from burning fossil fuels since the industrial revolution are now **IRREVERSIBLY ACCUMULATING** in the atmosphere and heating up an already warm planet Earth. An increase in temperatures of 0.75 °C since 1880 has already been measured. Due to the time lag inherent in our climate system, a further 0.6 °C is unavoidably in the pipeline. An additional warming of 2-3 °C resulting from business as usual would mean a different planet Earth outside our present and past experience where today's extreme weather events become average.

Conclusion: The processes controlling the Earth's temperature, GHG concentrations, ice melting and sea level changes are highly complex and non-linear. History tells us better than models that a 1 °C increase in temperature leads to a 5-6 m sea level rise.



These BAU scenarios with CO_2 emissions growing around 2% pa will mean a different planet Earth and a climate outside our experience

This alternative scenario with a reduction of green house gases by 60 to 80 % must be pursued NOW, not when it is too late

J. Hansen is director of NASA Goddard Institute for Space Studies http://pubs.giss.nasa.gov

Part A

TOR: Projections of oil production and demand in Australia and globally and the implications for availability and pricing of transport fuels in Australia

In Australia, oil production has peaked in 2000, followed by a dramatic drop of oil production in the 1st 4 years of the new millennium (see Appendix 1 with graphs from Woodside Petroleum and Bruce Robinson). The CSIRO report "Future Dilemmas", published in Oct 2002, highlighted serious resource constraints in its energy chapter (see Appendix 1.1). Unfortunately, this study was largely ignored by all governments. The media reports now that scientists who contributed to the underlying research for this study are being muzzled.

> Recommendation #1: Scientists reporting about resource constraints and the limitations of possible alternative fuels should be encouraged to speak out. A well informed public is needed to understand all problems of the coming oil crisis.

New oil fields (Bayu Undan, Mutineer – Exeter 72,000 b/d from 3/2005, Enfield) allow production to increase again, but below the 2000 peak and the long term outlook is again decline. Australia's oil import requirements will increase.

Globally, oil production is reaching a peak (Appendix 2 with graphs from Colin Campbell of ASPO) which will rather be a bumpy oil production plateau as already seen for Non-OPEC countries in the last year (see Appendix 32), accounting for roughly 55 mb/d. The same applies to the top 22 oil companies which struggled to maintain production of around 17 mb/d (Appendix 27)

Following table shows some of the projections of peak oil years available from various sources:

Author	Method/Quote/Source	Peak Year
Matthew Simmons, American Investment Banker	**"….that peaking of oil will never be accurately predicted until after the fact. But the event will occur, and my analysis is leaning me more by the month, the worry that peaking is at hand; not years away…."** http://www.simmonsco-intl.com	At hand
K.S. Deffeyes, Geologist	According to Hubbert's method, oil peaks at the half way mark. Having calculated a total estimate of 2,013 Gb, this was reached in December 2005 www.princeton.edu/hubbert/current-events.html	2005
Chris Skrebowski, Editor of ***Petroleum Review***	From a slide show at ASPO's Denver conference in Nov. 2005: "Whatever approach we use the answer seems to be peak by 2008" (Incremental bottom up method) www.aspo-usa.com	2008
Colin Campbell, ASPO, Geologist NewsletterJan2006 www.peakoil.ie	Regular oil All liquids (=regular + deep water + polar + heavy + bitumen + gasfield NGLs + oil from coal, shale and tar sands)	2005 2010
PFC Energy www.csis.org	**"OPEC production capacity and reserves will suffer from the additional strain and some models suggest that even OPEC will struggle to fill the differential between Non-OPEC supply and global demand beyond 2015-2020"**	2014 (high demand) 2020 (low demand)

The question of reserves

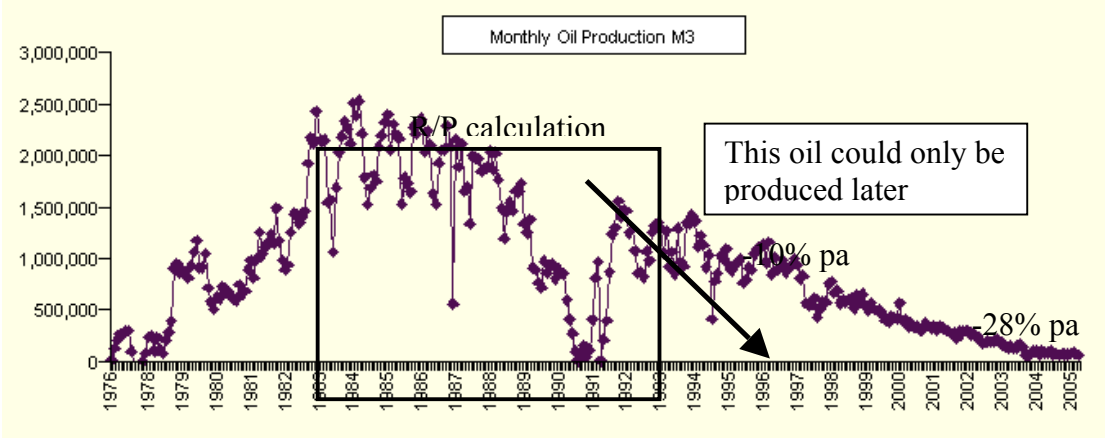
Oil reserves as published in the BP statistical review are most widely used (www.bp.com) and stand at 1,188 Gb end 2004. It is important to read the review's footnote on the source of the data: "primary official sources, 3rd party data from the OPEC Secretariat, World Oil, Oil & Gas Journal and an independent estimate of Russian reserves based on information in the public domain". In other words, these reserves contain political data (unverified reports from Governments), not industry data. The International Energy Agency (IEA), Paris, (www.iea.org) found in its WEO 2004 (page 92) that 230 Gb of OPEC reserves are overstated. If this is the case, OPEC's oil depletion clock has to be advanced by 20 years! A summary of this problem with many links to original sites is contained in submission 75 on energy efficiency to the Productivity Commission available on line at:

www.pc.gov.au/inquiry/energy/subs/sub075attachment2.pdf.

Recommendation #2: Oil reserves published by BP cannot be used as basis for billion dollar decisions in oil dependent infrastructure without properly checking the trustworthiness of the data sources.

Why it is wrong to calculate "when we are running out of oil"

It is common practice to use oil reserves and divide them by the world's annual production to calculate "how long oil will last", a number in years. This is also called the reserve/production (R/P) ratio. However, this simplifying calculation is oil-geologically irrelevant. The production profile of oil over time is non-linear due to reservoir rock physics and usually follows a growing path up to a peak and then a declining curve after the peak.

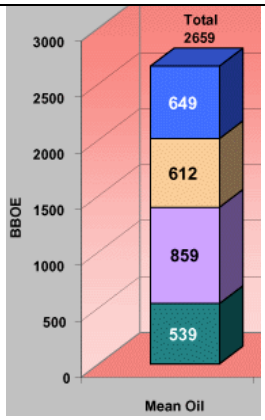


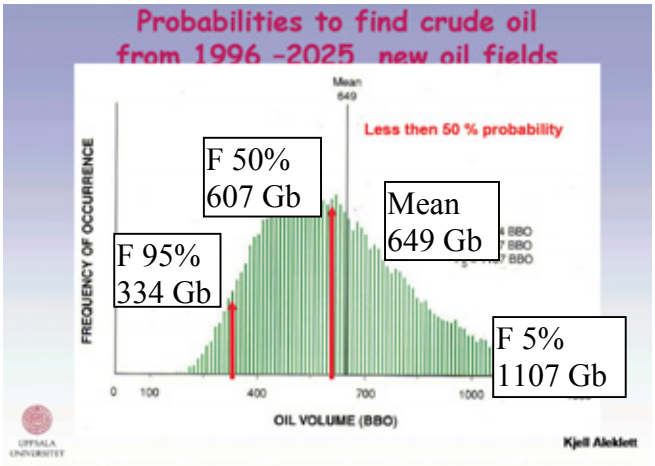
Production profile of UK oil field Brent in the North Sea. The 5 year moving average decline rate between 1992 and 2004 was between 10% pa. in the beginning and 28% pa. at the end of this period. Source: www.og.dti.gov.uk

In the above example, an R/P calculation for Brent in 1983 would have yielded a constant peak production for ten years, then dropping to zero after that. In reality, production decreased after the peak to about half after 10 years, but then continued, albeit at ever declining annual rates, for more than another 10 years.

Therefore, current world reserves may take 70-80 years to be produced, when production **peters out.** The critical event in oil history is the peaking, not the ultimate running out of oil. The global production curve is the superimposition of many peaking curves from fields all over the world at various stages of growth or decline. This must be properly modeled.

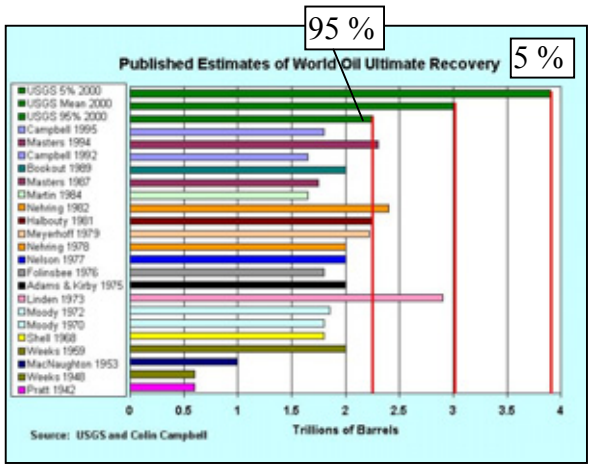
Which Estimated Ultimate Recovery (EUR) to take?

The latest, most extensive oil geological assessment was done by the US Geological Survey in 2000. However, the USGS 2000 mean estimate (right) contains 612 Gb reserve growth oil of which the USGS team itself said that it is hypothetical and should serve as a stimulus for discussion and further research and 649 Gb of undiscovered oil which defies discovery trends in the first 10 years of its study period. Source: www.usgs.gov	 World excluding US	2,659 Total Undiscovered conventional Reserve growth conventional Remaining reserves Cumulative production

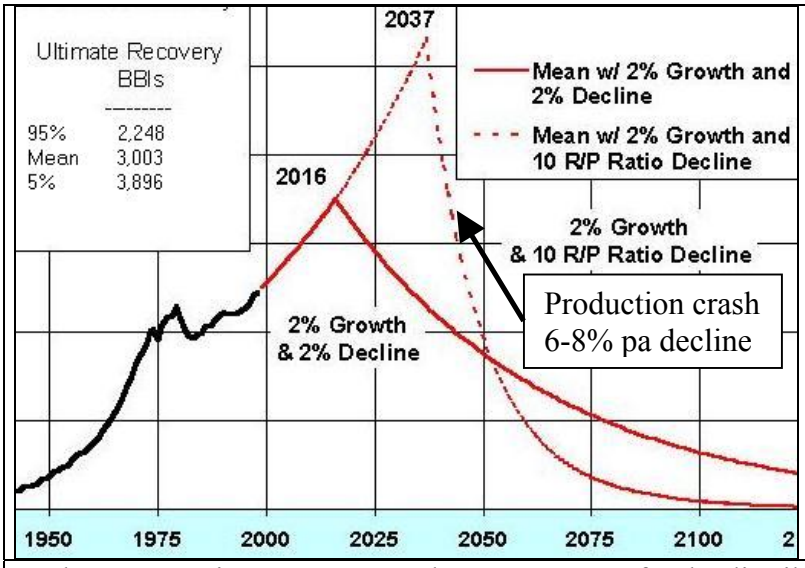


A mean estimate is not necessarily the most likely estimate. The graph (left) shows the interdependency between the probability and the size of the USGS undiscovered oil estimates. The 649 Gb has only a probability of less than 50%.

Who would invest on such a low chance of success? Yet this is what governments (and banks) are relying on when they base their policy on these types of estimates. Source: http://www.aspo-australia.org.au//PPT/Aleklett.pdf



Therefore, every published EUR and all production forecasts built on it go along with a probability. In general, the larger the EUR, the less probable it is. For example, the longest bar in the chart of EURs (www.eia.doe.gov , left) has only a probability of 5%.. Thus, it is not safe to conveniently pick the highest EUR from a pool of estimates in the hope that we will be alright. Investors like super annuation funds need certainty that their investments get safe returns when funding oil dependent infrastructure. Instead of using the mean estimate, they should rather use the USGS 95% probability estimate of 2,248 Gb (as of end 1995) which is fairly close to many other estimates.

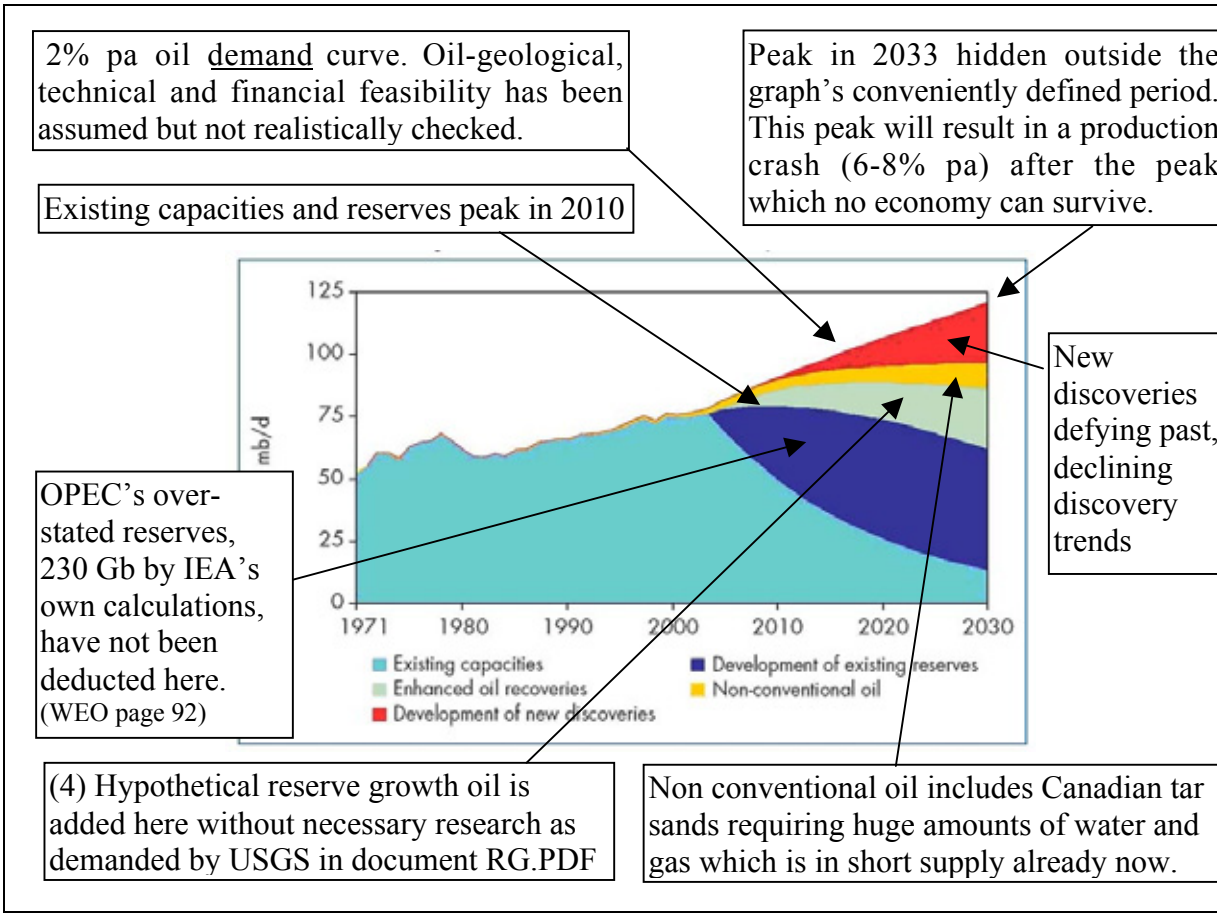


The USGS did not forecast oil production. The public relations wing of the Department of Energy, the Energy Information Administration (EIA) www.eia.doe.gov published several scenarios (not forecasts) in a slide show titled "Long term Oil Supply" one of which is shown (left).

In these scenarios, reserves and resources are freely distributed under 2% demand growth curves given by economists. This is an oil-geologically questionable and highly unrealistic procedure which leads to late, theoretical peaks after 2030. In order to observe the EUR, these late peaks are necessarily followed by production crashes of between 6% and 8% pa. which no economy can survive. They are non-desirable doomsday scenarios. More moderate decline rates at 2% pa would produce a peak around 2016. A detailed analysis of these scenarios can be found at:

www.pc.gov.au/inquiry/energy/subs/sub075attachment1.pdf

The International Energy Agency's World Energy Outlook 2004 is also based on the USGS 2000 mean estimate. The following embellished Fig. 3.20 is from page 103.



Parts of the graph are inconsistent with other findings in the same report, assumes that huge investments are made and that these are successful which is by no means

guaranteed. In a smaller table (3.4, page 102) the WEO 2004 also reveals its 90% probable case which **peaks between 2013 and 2017**. These are the hidden warnings by report writers which are too often overlooked.

> Recommendation #3: An estimate (EUR) with the highest possible probability should be used. Such EURs can be expected to peak no later than 10 years from now. Due to the uncertainty of oil data from OPEC and Russia, peaking can happen even much earlier. The main conclusion is that it is highest time to prepare for peak oil.

The Federal Government's energy white paper "Securing Australia's Energy Future" released in June 2004 a couple of months before the last election does not know anything at all about the peaking of oil production. It quotes the following oil reserve and production data:

(a) page 119: "World oil reserves ….. about **1050 billion barrels in 2002."**
(b) page 120, Figure 3: global oil production is **to increase from 75 million bpd in 2000 to 104 million bpd in 2020**

and then adds, without further calculations, following sentence:

(c) page 119: "Despite increasing demand for oil, there are sufficient reserves to supply world oil demand for around 40 years"

Statements (a), (b) and (c) are inconsistent. The sums are wrong (math year 10 required). If oil production is allowed to grow up to 2020, the remaining reserves in that year would be so small that production would have to decline up to year 40 to observe the total, clearly not sufficient.

Apparently, the statements (a) and (b) were conveniently picked from 2 different sources and a rough back-of-the-book calculation added (may be an R/P) without checking that this cannot work together. A unforgivable methodology flaw of the 1st order.

One might ask following questions:

- Where are the detailed calculations for this 40 year period?
- Which oil-geological evidence was used and where are the sources?
- What is the probability of this forecast to materialize?
- Was an oil geologist employed in the team who wrote this statement?
- Who is legally and financially responsible for actions or omissions of actions resulting from using this statement in multi billion dollar investment decisions of oil dependent infrastructure?

A detailed critique of the energy white paper can be found at the Productivity Commission web site (Energy Efficiency Inquiry), submission 4:

main report text
www.pc.gov.au/inquiry/energy/subs/sub004main.pdf
1st set of appendices
www.pc.gov.au/inquiry/energy/subs/sub004appendices1-3.pdf
2nd set of appendices
www.pc.gov.au/inquiry/energy/subs/sub004appendices4-11.pdf

It is absolutely important that the above "sufficient oil supply" issue be resolved as the NSW government relies on this statement when planning new toll roads and freeways.

> Recommendation #4: The Federal Government's energy white paper released in June 2004 should be immediately withdrawn from circulation and re-written by truly independent oil geologists and energy consultants with technical and scientific qualifications. The old team should not be used again.

The complacency and lack of sense of urgency around peak oil is widespread in Government. The BTRE published working paper 61 in May 2005 entitled "Is the world running out of oil? A review of the debate". The title already shows the wrong question (see above) which of course was not answered. Such a debate can go on until peak oil has arrived. There is a detailed critique of this WP 61 available at:

http://www.southaustralia.biz/Events_Calendar/Event_PDFs/GODTO/CritiqueBTRE_WP61.pdf

Here are the main points which are typical for the attitudes in government departments:

Lack of Experience

- No experience with previous oil crises and their impact including physical oil shortages. Therefore no sensitivity when first alarm bells are ringing
- The naïve view that OPEC oil from the Middle East will always be a freely available commodity in world markets, reliably supplying the gap between demand and Non-OPEC supply
- Failure to link geo political events to peaking of oil production
- Lack of understanding strategic considerations in URR estimations of various players

Mindset

- An almost religious belief that price mechanisms, market forces and technology will solve all future oil and energy crises
- No appreciation of the magnitude of the problem to replace oil with other fuels or energies
- Failure to recognize and accept that technology cannot by-pass physical laws governing oil depletion and that boundary conditions imposed by nature are not open to debate
- Lack of an auditor's mindset which is essential to lift the veil of confusion surrounding oil data

Methodology

- Inability to distinguish, prioritize and categorize technical facts, opinions, interpretations and arguments
- Inability to read between lines in reports and identify hidden warnings

Trust/Mistrust

- Trust political oil data more than the advise from benevolent oil geologists

Objectives

- Absence of any objectives (e.g. green house gas abatement, improvement of health, reduction in oil vulnerability etc) other than those to ensure "efficient" markets

The really interesting and pressing questions were not addressed by BTRE:
How will the transport sector adapt to rising diesel prices? Which superannuation funds are exposed to oil dependent infrastructure and to what degree? The mining industry, including uranium mining, requires huge amounts of fuels for processing. How will this sector be affected by declining oil production? The same applies to agriculture. What is the sensitivity of food prices with rising oil prices and shrinking quantities? How has urban planning to change?

Part B

TOR: Potential of new sources of oil and alternative transport fuels to meet a significant share of Australia's fuel demands, taking into account technological developments and environmental and economic costs.

The author of this submission is not an oil-geologist who can recommend on new oil fields but here is a summary of facts on alternative fuels and their limitations.

LPG
Assuming 1 million tons now exported (mainly from the West coast) are used for transport domestically, this would be the equivalent of 8 million barrels of oil pa, a fraction of our current total oil consumption of more than 300 million barrels. Along the East coast, LPG is imported. All taxis would therefore be highly vulnerable to an LPG supply interruption

Ethanol
Let us do some number crunching and try to answer following questions:

a) How many hectares of sugar cane fields would we need to run Sydney's cars?
Basic assumptions:

(1) Yield of 80 tonnes of cane per hectare per annum
(2) 12.5 tonnes of cane can be distilled into 1,000 litres of ethanol
(3) There are 2.5 million cars all running on E85 engines requiring 40 litres per week

Now let us calculate:
2,500,000 cars * 40 litres * 52 weeks * 12.5 tonnes / (1,000 litres * 80 tonnes) = 812,500 ha

That is almost **double** the area now under cultivation in Australia (420,000 ha). In other words:

> 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)

b) How many litres of ethanol a week would we get for an average Australian car if all current Australian sugar cane production would be used for ethanol production?

Let's assume 10 million cars in Australia running on E85 engines: 420,000 ha * 80 tonnes * 1,000 litres / (12.5 tonnes * 52 weeks * 10,000,000) = 5.2 litres

All current sugar cane used to produce ethanol: 5.2 litres ethanol/car/week

Ok, that's no sugar on your table and not more than 100 km driving a week even with advanced engine technology and smooth driving.

c) 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.

Councils in sugar cane country now want cane acreage limited as the run-off from fields laden with excess fertilizer and flowing into ocean waters would eventually kill off all corals close to our shoreline.

There are doubts about the net energy balance of ethanol production. With present technology and according to information available on the public domain (NEVC & US Dep. Of Energy), ethanol production means 1 unit of (fossil) energy is turned into 1.38 units of ("renewable") energy contained in ethanol. This ratio may depend on the type of production process, in particular the heat source for the distillation.

d) The Australian Sugarcane Milling Council calculates in submission 48 to the Biofuels Taskforce that the Federal Government's current target of 350 megalitres biofuels pa. by 2010 is just 1.4 % of Australia's present fuel consumption.

e) Conclusion: the ethanol example shows the quantitative limitations in the use of one of the alternative fuels. It seems biofuels are best used in the vital agricultural sector itself with the aim of decreasing its dependency on oil-based fuels. While urban areas can always organise public transport to replace car usage, regional areas with their spread-out farms do not have this option. Governments will have to decide on priorities if biofuels are to play an efficient role during the coming oil crisis.

Bio-diesel

All Australian oil seed converted to bio-diesel would be the equivalent of just 6% of our current diesel consumption (energy white paper, page 123). This could be on the low side as the paper wants to downplay the importance of alternative fuels.

Electric cars

Recharge electric cars at night in our garages. Our grid will be going to its knees just from air conditioners in one of the next hot summers. So this would overload the system. New cabling, substations and power plants would be needed. Would these plants be coal fired? Worsening the green house gas effect? Or electricity from photovoltaic cells on our roofs? A first solar panel factory using Australian technology is now being built in Germany and not here. Which car manufacturers produce electric cars? Acceptable prices for such cars would mean worldwide mass production which in turn would require that many countries provide the power supply infrastructure for electric cars.

Natural gas

The Federal Government is in no hurry to develop gas as a fuel in the transport sector. Instead, huge amounts of easy gas from shallow waters is exported to countries whose energy problems we can never solve. In the east of Australia, gas production will already peak around 2014. Where will the gas for the East coast come from? The West coast? Or PNG? By pipeline or LNG tanker? Not cheap. 30% of energy is lost

in liquefaction and transport alone. And we must reserve NG for fertilizer production, otherwise, in the long term, our agricultural production is in danger. Energy intensive mass production of PV cells also needs gas.

Fuel cell cars

There are many unsolved technical problems. Using hydrogen, **an energy carrier**, produced from which primary source of energy? Coal? Nuclear? The Journal of the Institute of Minerals *www.iom3.org/materialsworld* has calculated that 100,000 wind turbines or 100 nuclear power plants would be needed to replace all oil burning vehicles in the UK with hydrogen powered cars. It is also unknown what impact unavoidable hydrogen leakages would have on the atmosphere, may be worse than CO_2, we don't know.

Recommendation #5: There is no quick fix solution to fill the emerging oil supply gap. Otherwise this would have already been done. Every contribution is welcome but attention must be paid to the energy profit ratio and how effective investment capital will quantitatively contribute to replace a certain amount of oil. It is dangerous to create the impression in the public that hydrogen cars will be next and that we can continue business as usual. The laws of thermodynamics apply, not wishful thinking or political expediency.

Part C

TOR: Flow-on economic and social impacts in Australia from continuing rises in the price of transport fuel and potential reductions in oil supply.

The author of this submission experienced (and survived) 3 oil crises in the 70s and early 80s in 3 different countries. Many recommendations in this paper stem from this experience. These crises were temporary but the coming oil crisis will be permanent.

1973/74 in Europe

European governments saw no other option than to introduce Sunday driving bans in response to the OPEC oil embargo following the Jom Kippur war, 3 years after peak oil in the US.

Pre-WWII autobahn with a hastily added 3rd lane battered by boom traffic in the early 70s rests idle during driving bans on Sundays in 1973 as curious highway patrol officers overlook this eerily silent scene.

This was not a matter of price, but physical availability of oil supplies from Rotterdam where oil tankers did not arrive in the usual numbers. Australia did not experience any shortages back then which is a reason for its complacency now.

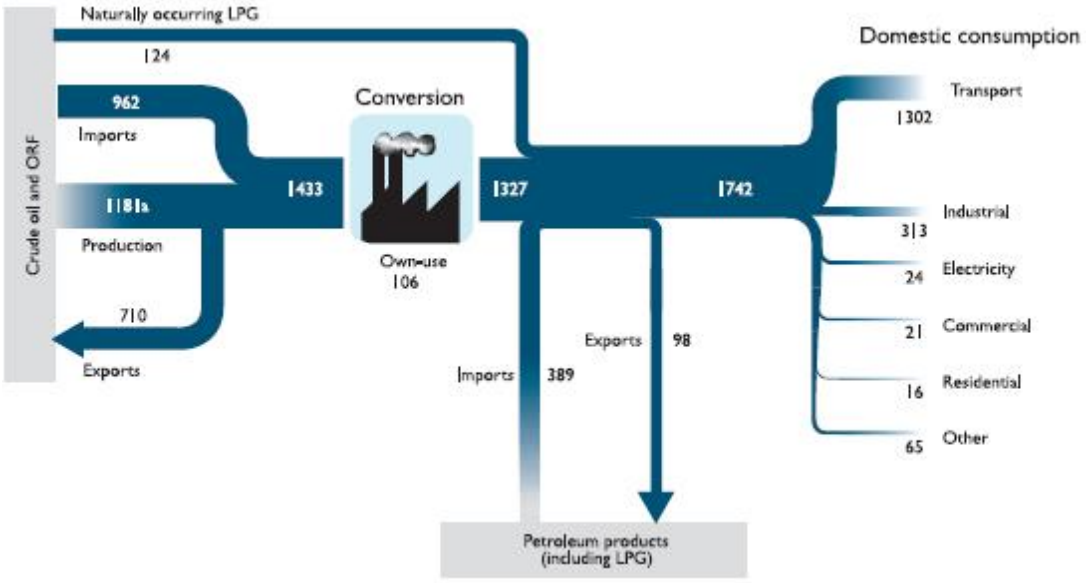
1976 in Tanzania

This resource poor country imposed a permanent Sunday driving ban for private cars in the late 70s from 2 pm Sunday until 5 am Monday to stop weekend trips. This affected mostly foreigners in the cities, mainly the Capital Dar es Salaam. Town planners designing a new Capital in Dodoma visited Canberra to get ideas what other countries are doing. They came back with the advise not to copy Canberra's plans. The oil wasn't there. It was also a foreign exchange problem.

1980 in Malawi

This land locked country gets all its fuel supplies via a rail line through Mozambique. In 1979 Iran's Shah was toppled which sparked a 2nd oil crisis. While there were world wide oil shortages, rebels (today they'd be called "terrorists") in Mozambique made things worse by disrupting this rail line and within 2 weeks all wheels came to a standstill. Brand new project vehicles were mothballed. Alternative supplies by road tankers were organized from neighbouring Zambia, a 1,000 km long rat race. Petrol & diesel prices were frozen and a quota of 20 litres per car was introduced. Filling your tank was a major operation taking 2-3 days. A black market sprung up immediately with all the associated happenings: fires in garages when storing petrol, petrol fume poisoning, siphoning of petrol when leaving you car unattended etc. The only useful thing you could do with your car was trying to fill it up, drive it home quickly, lock it up safely in a garage and use it as a filling station for your motorbike.

Now Australia is neither resource poor nor a land locked country. But declining domestic oil production and increasing imports will change all that. The critical event could be a terrorist attack on an oil tanker in the Malacca Straits or near Singapore. A lot of refined products are being imported from there.



The above graph shows the flow of petroleum supplies (Energy white paper, p.83). While many are at ease that Australia is a net energy exporter the oil import dependency is actually very high: 962/1433=67% in crude oil and (1327*67%+389)/1742=73% in petroleum products. By stopping exports - as was

done after the 1st oil crisis – this dependency could be reduced to 18% . But contractual export obligations would first have to be phased out, possibly over several years.

> Recommendation #6: The Federal Government must immediately establish a strategic oil reserve. Regulations should be put in place to allow for driving bans or other rationing systems in case an oil crisis develops quickly. The public must be made aware of such measures so that motorists get mentally prepared for what is to come. The higher the elasticity of demand for petrol and diesel, the smaller the negative impact and the lower the possible price increases.

The International Energy Agency held a workshop in March 2005 "Managing Oil Demand in Transport" with the 1st session entitled "How to save fuel in a hurry":
http://www.iru.org/images/WebNews/ParisMar05/prog.pdf
The fuel saving measures contained in this paper could be used as a basis to implement the above recommendation.

Flow-on impacts of peak oil

Our economic and transport system are not remotely prepared for peak oil.

The car fleet, beefed up by years of booming 4WD, V6 and V8 sales, is unsuitable to cope with permanently declining oil production.

> Recommendation #7: In order to stop this existing problem getting worse, taxes and import restrictions must be introduced on gas guzzling cars which will become an oil import liability in future. Exemptions for those needing 4WDs professionally (agriculture, engineering, mining etc.) should be made

Not a single Australian car manufacturer offers hybrid cars. Holden's proto type of the E-Commodore idles in the Powerhouse museum while this company is laying off 1,400 workers. Australians now start to favour smaller cars. Even if 50% of all annual car sales (1 million under economic boom conditions which may not continue for ever) were hybrid cars or cars consuming half of the present average it would take 20 years (10 million cars divided by 500,000) for a full replacement. Assuming an optimistic saving of 50% by hybrid cars (which can only be achieved when driven economically and in urban areas), the total annual fuel savings could be at best 5% x 50% = 2.5 % pa which would not even match Australian oil production declines.

> Recommendation # 8: The Government's support of the Australian automobile industry (ACIS) should be made dependent on the production of small, fuel efficient cars.

The above simplified calculation of fuel savings does not consider the current level of immigration which may cancel out any progress made on the fuel saving front. It should be understood that population growth, after peak oil, means less fuel available on a per capita basis.

> Recommendation # 9: Immigration levels must be reviewed by independent sustainability experts, free from government interference, and numerically calculated on the basis of resource constraints.

The NRMA says motorists must get used to higher petrol prices. If this means just paying more at the filling station but continue driving as usual, then this is a totally flawed recommendation because this inelastic behaviour will almost guarantee that local fuel prices will skyrocket even beyond the rate of international oil prices. Peak oil means higher fuel prices AND consuming less fuel, i.e. driving less.

A similar statement came from the Prime Minister who said he cannot do anything if people "value" oil higher than before. No hint that savings are needed to bring down prices and no mention what the root causes for the current oil supply situation is.

In the first years of peak oil, motorists will have to learn to:

- Reduce or eliminate unnecessary fun rides or recreational trips
- Merge trips for different uses
- Do car pooling for regular travel to and from work
- Decide on the mode of transport depending on whether a car is needed or not

As the crisis will sharpen, a permanent switch to public transport will be needed. and/or relocation closer to work.

Recommendation #10: States have to prepare for the moment when stamp duty on home purchases has to be waived in cases where home owners have to move closer to work because there is no public transport. This will increase the mobility of employees and reduce demand for transport.

Toll road operators along with super annuation funds will come into financial problems as all their revenue calculations were based on certain traffic volumes which did not take into account peak oil. In the case of Sydney's M2 a study entitled "Insights into the financial operation of BOOT scheme toll roads in Australia" by Dr. John L Goldberg of the School of Architecture, University of Sydney, found that "Because of its large negative net present value this project is not commercially viable over the concession period even if the traffic forecast is achieved" and "Without this support [the Infrastructure Borrowings Tax Offset Scheme – IBTOS] the M2 Motorway, after 7 years operation, and City Link [Melbourne] after 5 years operation would be unable neither to pay a dividend nor fully meet debt service obligations, much less repay any of the large long term debts". This will be even more true after peak oil when traffic volumes are expected to decline.

Recommendation # 11: IBTOS should not be continued. Existing schemes have to be re-negotiated when light rail will have to replace car lanes no longer needed after peak oil.

Large car dependent areas of Sydney, for example, may become partially dysfunctional if there should be physical shortages as experienced in 1973 and 1980 in other parts of the world.

Existing public transport systems, neglected for decades during the car boom years, will not cope even if only a small percentage of motorists will be forced to use it. In Sydney, a reluctantly and slowly implemented clearway programme (separation of rail lines) is expected to increase rail capacity to the CBD by just 20% in 2010 but a recent timetable slowdown has actually reduced capacities. As a result, office workers will not arrive in time for work.

Most freeways will become oil import liabilities and contribute to a blow out in the trade deficit. Effects on the exchange rate and on interest rates are incalculable. Purchasing power which would actually be needed to make the car fleet more fuel-efficient is sucked out of the local economy.

The recently opened Cross City Tunnel in Sydney will come into financial problems. Busy to please the PPP counterparts by closing roads and re-phasing traffic lights with the aim to funnel more cars into the tunnel, government planners just couldn't be bothered to check on oil supplies for the period of the deed and thus missed on detecting peak oil altogether. Shareholders and super funds will have to pay the bill for this gross oversight. More details of this blunder in submission 8 to the CCT Inquiry at:
http://www.parliament.nsw.gov.au/prod/parlment/committee.nsf/0/7AF905745474FB08CA25710000165A8A

> Recommendation #12: A fuel availability analysis would show that there is no need for additional toll-ways, free-ways, airport extensions, huge car-parks, car dependent shopping centres, race tracks and other oil dependent infrastructure. Design capacities in the RTA with many excellent engineers should now be used to plan for light rail on the existing toll-ways, together with feeder buses into the suburbs. This is the only way to save toll-way operators from collapse after peak.

The agricultural sector will suffer most as many rural rail lines for bulk transport of agricultural produce have been closed and the cost of fuel-based inputs like fertilizer will increase.

Long distance truck traffic will be hit by diesel shortages and increasing fuel prices. Certain transports will become uneconomic and are likely to disappear.

The mining sector will also be affected. Peak oil means a general, world wide reduction in economic activities and therefore demand for raw materials. On the cost side, all diesel dependent extraction procedures will become more expensive and shortages may reduce output. In other words, our economy will be immediately damaged.

Of greatest concern is how the financial sector will react to peak oil. Everything will depend on how reserve banks across the world manage this crisis. If there should be political pressure to print money to pay for increasing oil bills, then this will be a guarantee for skyrocketing inflation. The international investment community will have to switch from real estate development and oil dependent infrastructure to really energy productive projects increasing energy efficiency, renewable energy capacities and green house gas abatement when using fossil fuels. If interest rates go up the paying capacity of consumers may be more limiting than the physical availability of fuels. The world will definitely enter uncharted waters where no economic rules of the past will apply.

PART D

TOR: Options for reducing Australia's transport fuel demands

Peak oil is like a relay race but in slow down mode with following targets:

(a) Demand for oil based fuels must be reduced at 2% p.a. after 2008, later at higher rates
(b) Transition to other fuels must be planned under the condition that green house gas emissions are reduced at 1.5% pa (60 % - 80 % by 2050)

(c) Increasing percentages of fossil fuels must be used to build up a genuinely renewable energy system

There is a real danger that peak oil damages our economy to such an extent that not enough funds are available to finance projects under (b) and (c). Market forces driven by rather short term shareholder interests do not have enough vision into the future to manage peak oil. Therefore, a critical path analysis is required to calculate the different phases of transition. This is clearly a function of Government which has to coordinate the efforts of the private sector like in a mission critical space flight where all components function in a well defined sequence.

Recommendation #13: A comprehensive energy development plan for a period of several decades has to be designed in which priorities and limits must be set for the use of fossil fuels and specific targets for the establishment of renewable energies.

Demand management

There are many government controlled factors promoting, rather than reducing the use of cars. The Institute for Sustainable Futures at the UTS, Sydney, published working paper CR2003/01 by Chris Riedy entitled "Subsidies that Encourage Fossil Fuel Use in Australia" including chapter 8 "Road Transportation Subsidies" and chapter 9 listing FBT exemptions. The hidden subsidies identified in chapter 8 alone amounted to more than $ 6 billion, not including the cost of accidents, congestion, air pollution and noise.

Recommendations #14: Motorists's charges and FBT tax rules have to be designed in such a way that there are no more direct or indirect subsidies to road traffic.

After peak oil, urban growth in capital cities which have reached their limits to growth will no longer be possible as the cost of commuting will skyrocket. In Sydney, for example, the recently published Metro Strategy assuming a further 1.2 million population is completely unrealistic.

Recommendation #15: For national fuel supply and global warming reasons, the Federal Government must bring State governments to curb their urban sprawl in capital cities and start seriously decentralizing urban development to much smaller solar cities which have to be energy efficient, transport minimizing and basically car-free.

As outlined above, alternative fuels may offset the permanent oil production decline by a couple of percentage points in the first years but ultimately a quantum leap in transport energy efficiency must be achieved. This can only be done by

- electric rail, both for passengers and freight
- coastal shipping for containers and/or bulk loads depending on distance

The following pages show some examples what has to be done.

Freight Solutions for the Future: Electric Rail & Coastal Shipping

← Truck trailers loaded on rail cars

There is a huge investment in the existing truck fleet, yet when diesel supplies shrink by 2% pa after peak oil (and biodiesel delivering at best a couple of % initially), this investment will idle at the same rate. By moving long distance trucks (or trailers) on electric trains, this limitation can be overcome.

← Rolling highway: complete trucks loaded on rail cars (www.hupac.ch)

← special container moved from truck to rail car without heavy lifting equipment (www.mobiler.de)

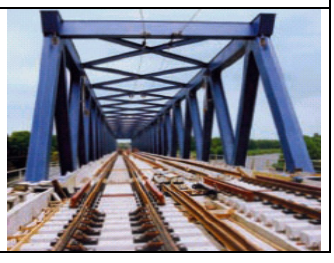
Power for electric trains would come first from gas fired power stations, later from renewable sources. Even nuclear power produces electricity, not fuels.

← Conventional electric container train

← ↑Coastal shipping is very energy efficient

← Decrepit Menangle bridge

Realignment, new bridges, electrification very urgent →



Immediate rail projects to prepare for peak oil	
	
↑ Main line at Gosford; additional tracks needed	↑ Example of quadruplication work between Cologne & Brussels
	
↑ Domestic flights up to 1,000 km to be replaced by electric night trains	↑ Example: night train to Copenhagen
Urban transport (examples from Frankfurt)	
	
↑ Light rail depot	↑ Car lanes out, light rail tracks in
	
↑ Light rail on dedicated tracks in center of 2x2 lane major road; high flexibility; from 70 off peak to 400 passengers depending on length of train (up to 100 m); 1 driver	↑ Feeder buses connecting light rail with low density residential areas

Recommendation #16: Auslink should be turned into a national rail revival programme including straightening alignments to allow higher speeds, quadruplication in urban areas, new bridges, full electrification, new rolling stock and dedicated power plants, preferably from natural gas.

This recommendation requires a major re-think and a shift of priorities from road to rail. Politicians basically think rail is a "black hole" but do not realize that this is the only mode of land transport which can survive the coming oil crisis. There is a unique financing opportunity now as the budget is in surplus. The root cause for this surplus is a 30% improvement in the terms of trade from the minerals boom. It is unlikely that this exceptional growth continues after peak oil. Therefore we cannot expect more surpluses when the first phase of peaking has already started. The time to get these rail projects off the ground is now, before the crisis manifests itself.

In the US, several car factories will be closed. This may happen here, too. Such factories could be adapted/converted to rail car workshops with the aim to keep the skilled workforce together. We should not forget that come peak oil, the order books of rail car manufacturers will quickly fill up as many countries who regularly plan new rail projects and just wait for financing opportunities have their plans ready in their drawers and just need to pull them out.

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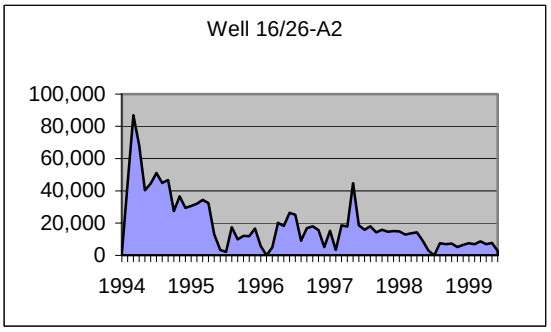
The Peaking of Oil Production

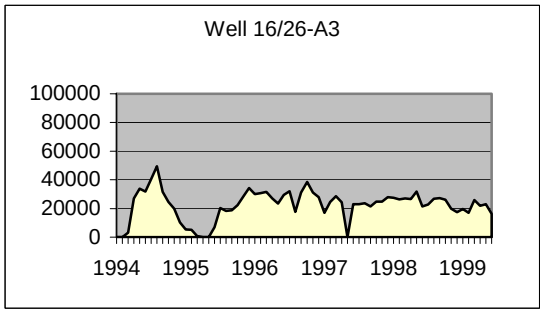
There are many different types of peak oil events over time, each having a profound impact on world oil markets, global oil flows and geo-political power struggles. Peak oil is not a theory, but reality for every oil supplier and ultimately for the whole world.

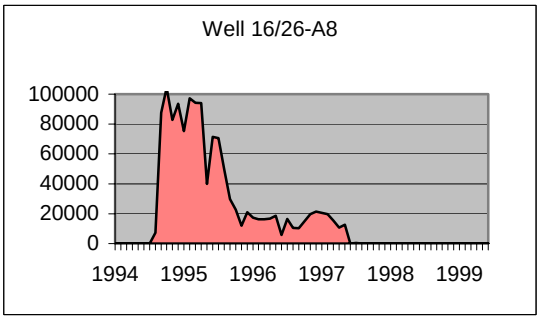
(1) Peaking at field level

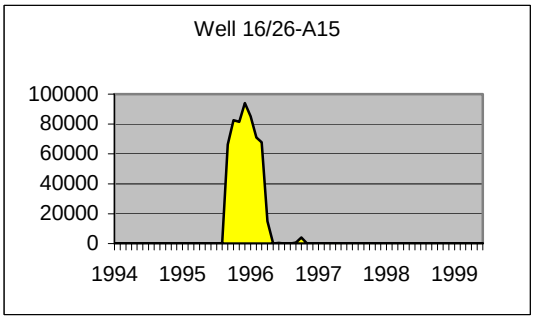
Before looking at the peaking of major oil suppliers, it is quite important to first understand the peaking at field level as this explains the mechanics of oil depletion.

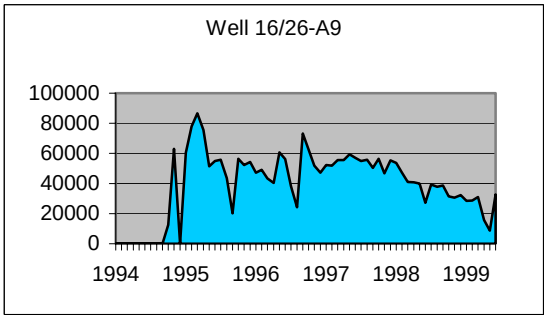
The following graphs are from UK's Alba oil field in the North Sea.

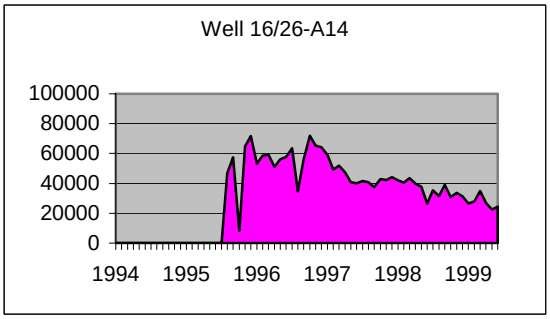


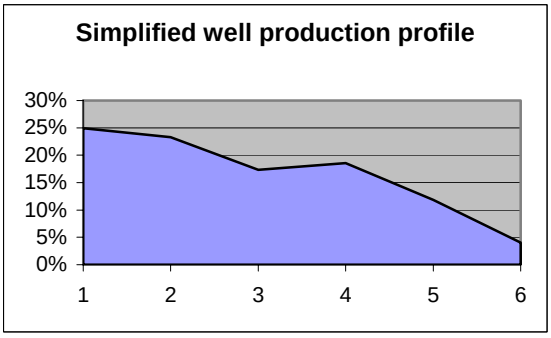






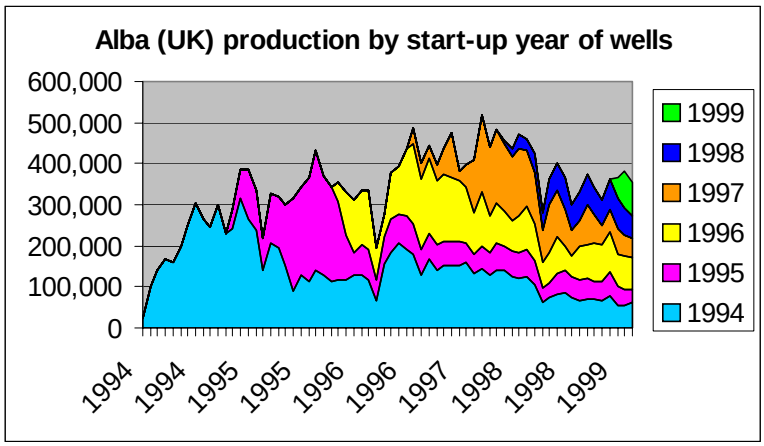






Individual wells display quite different production profiles over time ↑. There can be quite pronounced short peaks but also long production plateaus.

The average, simplified profile over 6 years is a mixture between a triangle and a trapezoid ←. In the first year already 25% of the total a well will ever yield is produced



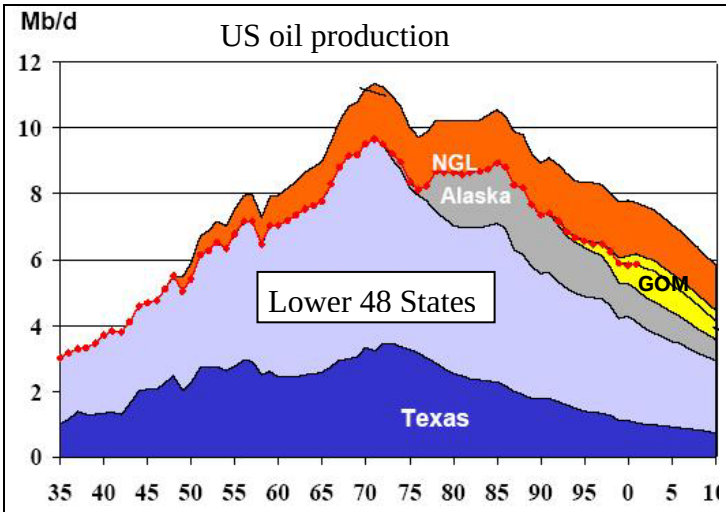
It can be clearly seen that well groups from each year are stacked on top of each other. If no more wells can be added, total production declines at the rate given by all declining wells still producing at that time. That's in a nutshell the basic principle of peaking and depletion.

The wells are grouped by start-up year. After a well group peaks, more wells are added. In principle it would be possible to cap production at a certain level by delaying start up of other wells but investments in the operation of the whole field need to be paid off as quickly as possible and one well follows the next, driving production to an inevitable peak for the whole field.

From the above we can conclude that the root causes for peaking at field level are a combination of:

- Geological peaking at well level due to reservoir rock physics (fluid mechanics)
- Optimizing investment returns for the whole field (stacking of well production profiles)
- Depletion of the whole field (no more wells can be added)

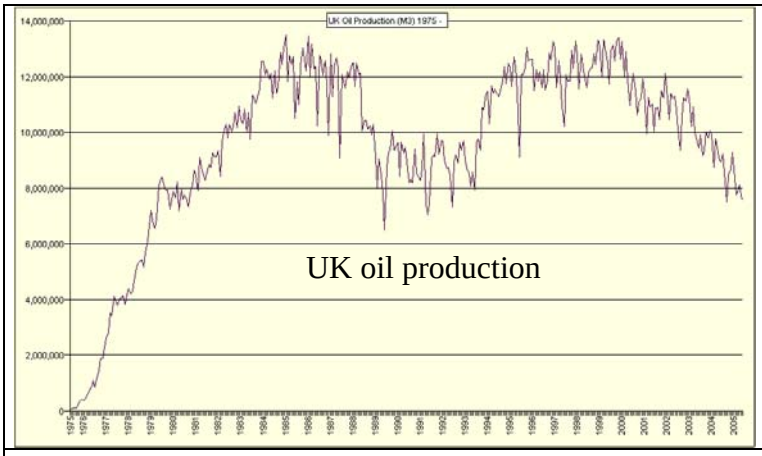
(2) Examples of peaking at country level



Source: www.lbst.de Future world oil supply. Note that natural gas liquids (NGL) have a rather flat production profile, different from regular oil which peaks around the half way mark (Hubbert's Peak)

In 1970, US oil production peaked. 14 years earlier, oil geologist Hubbert had predicted a peak in the first half of the 70s for the lower 48 States. There was a 2nd peak in 1985 from Alaska oil. Oil production in the Gulf of Mexico is now regularly shut-in during the hurricane season. Congress authorized drilling in the ANWR but there is less oil than in Alaska and production would show as another small hump on an otherwise relentlessly declining production path.

Impact: ME oil production had already overtaken US production in 1968, Saudi Arabia alone doubled its production in 4 years to reach 6 mb/d in 1972. By that time it must have been clear to oil experts that US production could no longer be increased. The US had lost its No 1 position as oil producer. This allowed OPEC to impose an oil embargo in 1973/74 after the Jom Kippur war. This 1st oil crisis caused a world wide recession. Matt Simmons, an American Investment Banker, re-wrote history in his 2005 book "Twilight in the desert, the coming Saudi oil shock and the world economy" when he found long forgotten US Senate hearing documents from 1974 and 1979 showing that Saudi Arabia had another motive to slow down: the rapid increase in oil production while fighting for supremacy on oil markets resulted in first water intrusion problems in their oil fields with a fear that over production could damage them.



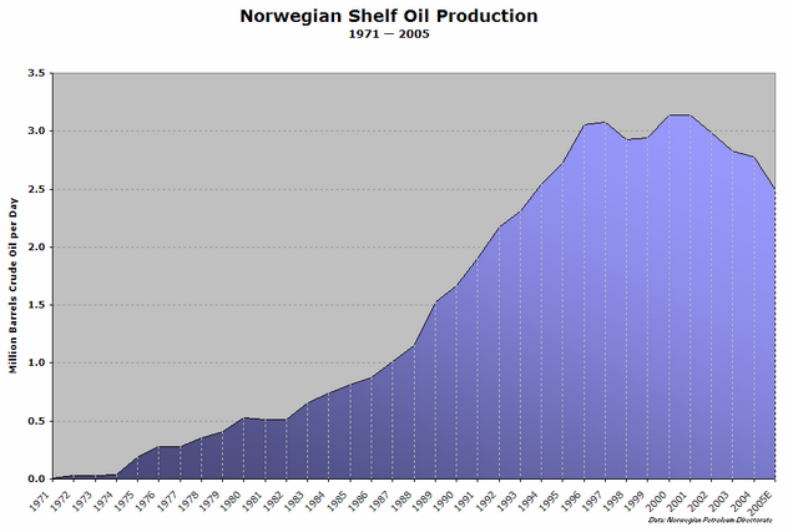
UK oil production

UK oil production (M3) 1975-2005; Source: DTI

UK's oil production shows 2 peaks. Production dropped after an accident on the Alpha Piper platform. New health and safety rules were introduced which required many oil platforms to be retrofitted with adequate safety features. UK oil production is now declining since Nov 1999, for geological reasons, recently at alarming rates of 10% pa.

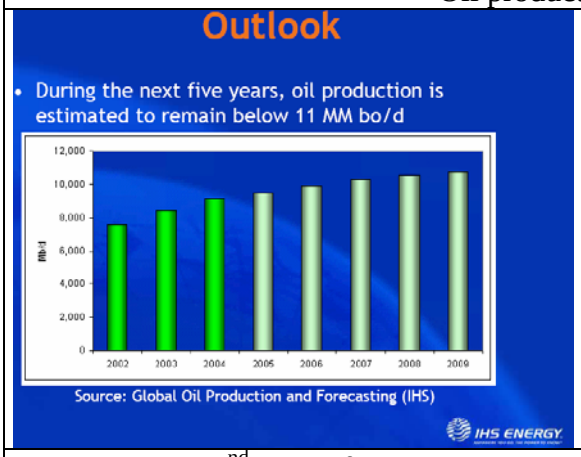
The Norway Post reports on 2/1/2006:

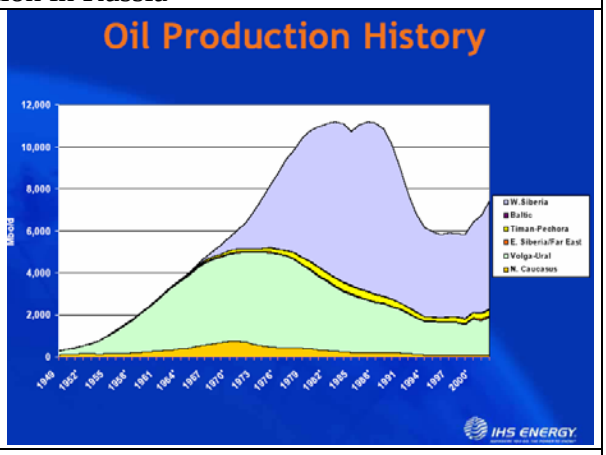
"The development throughout 2005 confirms the falling tendency since the year 2000. In 2001 the average daily production was 3.2 million barrels. In 2003 it had dropped to 2.875 million and in 2005 it was around 2.5 million barrels a day"



(3) Examples of countries still growing but approaching a plateau or peak

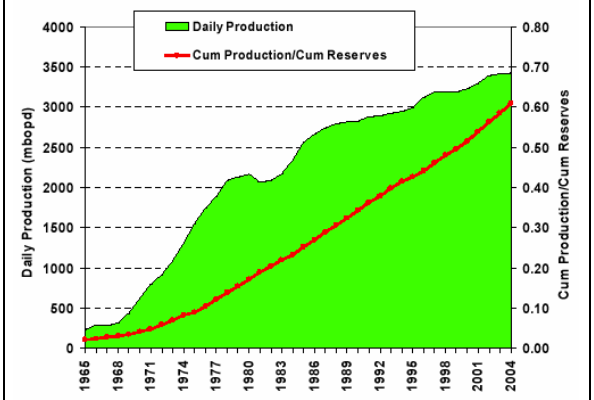
Oil production in Russia





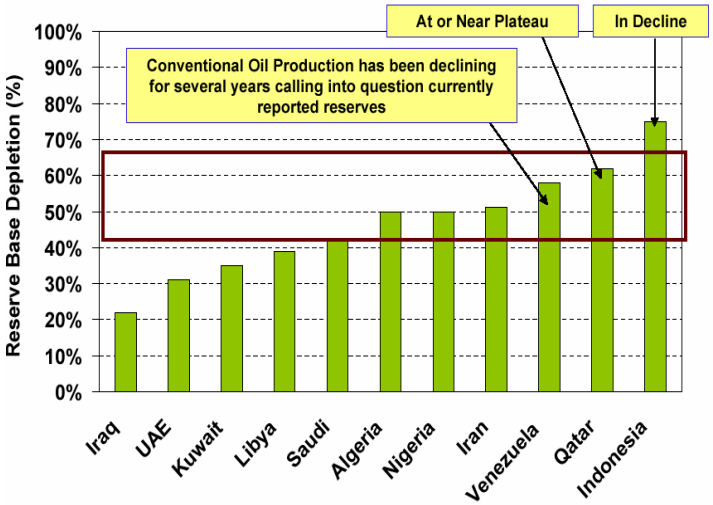
Approaching a 2nd peak after production had collapsed in the former SU. Growth rates are declining. Source: IHS, Dr. Felder, Regional Manager CIS

Oil production in China



Source: PFC Energy oil supply forecast 9/2004

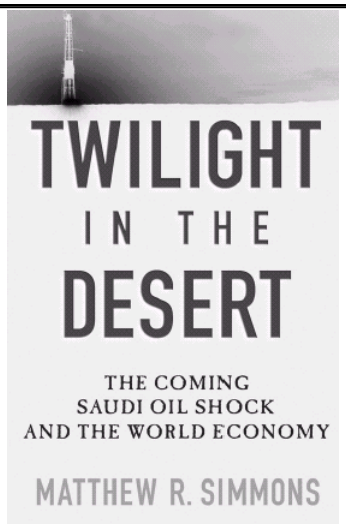
(4) Depletion levels in OPEC countries



Source: PFC Energy Oil Supply Forecast; www.csis.org/energy/040908_presentation.pdf

Bookreview: The Coming Saudi Oil Shock

We all think Saudi Arabia can double its oil production over the next 2 decades and provide for demand growth. Right? Wrong! Matthew R. Simmons, American investment banker and former adviser to Dick Cheney's energy task force in 2001, to which he contributed a study of the world's giant oil fields, smashes all our common beliefs in his new book "Twilight in the Desert". Already in early 2004 he challenged Saudi Aramco in a conference at the Centre for Strategic and International Studies, Washington, (**www.csis.org**). Saudi officials could not convince him of their claim to be able to maintain an even much reduced 10-12.5 mb/d for 50 years. Matthew now writes: "it would seem safe to conclude that Saudi Arabia's oil output is unlikely to grow in coming years and could soon begin to decline." (p. 283)



ISBN 0-471-73876-X
www.simmonsco-intl.com

Simmons' work is based on the study of more than 200 technical papers of the Society for Petroleum Engineers (**www.spe.org**), which reveal an aging Saudi oil production system, plagued by a myriad of problems to keep production at current levels. The main points:

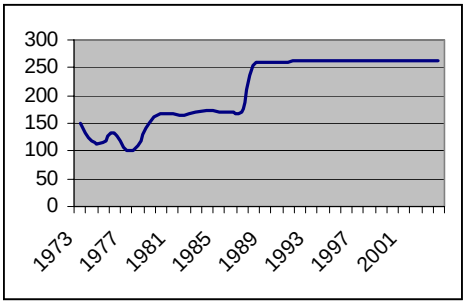
- Saudi oil reserve claims have never been verified by 3rd party inspections; after Aramco's nationalization in 1979, field-by-field reserve and production reports are shrouded behind a veil of secrecy
- 90% of Saudi oil comes from seven mature giant fields
- The 3 most important fields have produced at high rates for over 50 years; field pressures have been kept high by injecting massive amounts of (salty) water; the water cut is now exceeding 30%; when these injection programmes come to an end, steep production declines are inevitable, as already experienced in the Yibal field of neighbouring Oman and in many other giant oil fields around the world
- New discoveries have never produced substantial quantities of oil for a longer time
- When Saudi production starts to decline the global peaking is not far. Peak oil is a world class event which few understand

"The many consequences of such an event, some clearly predictable and others quite unforeseen, are of such monumental importance to the world economies that to ignore the eventuality of this occurrence is naïve"

Saudi Reserve Mystery

The last reliable reserve estimate is from 1978, when Aramco, then under a joint management of Exxon, Mobil, Chevron and Texaco, reported 110 Gb. 80 Gb have been produced since then. Premature loss of reservoir pressure and saltwater encroachment already in the 70s caused estimates to widely fluctuate (right). A total mystery is the addition of 100 Gb to proven reserves by a nationalized Aramco in 1988 - without matching new discoveries - during the quota war.

Saudi Reserve History in Gb



Source: Simmons (p.272) ; BP Statistical Review
1 Gb = 1 billion barrels

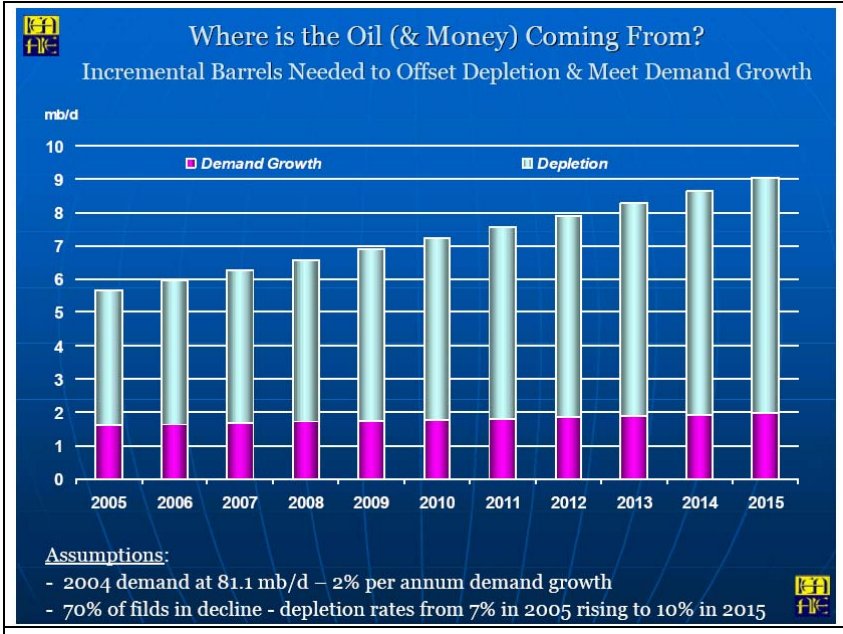
Conclusion: Future Oil Production Estimates are Unreliable

Conventional wisdom adopted the idea that new technology can produce more oil out of older fields. However, as decline rates in mature fields were accelerating "the industry is beginning to appreciate that advanced technologies, particularly extended reach, multilateral horizontal wells and hydraulic fracturing, are essentially turbo-charged super-straws designed to suck out recoverable oil faster – not miracle drugs that prolong field life and recover far higher percentages of the original oil in place" (p. 278)

Most Saudi oil fields are now reaching the end of the secondary oil recovery phase. The last, tertiary phase will involve sweeping the oil left behind, a cumbersome, costly and slow process.

(6) **Current Oil Production Outlook**

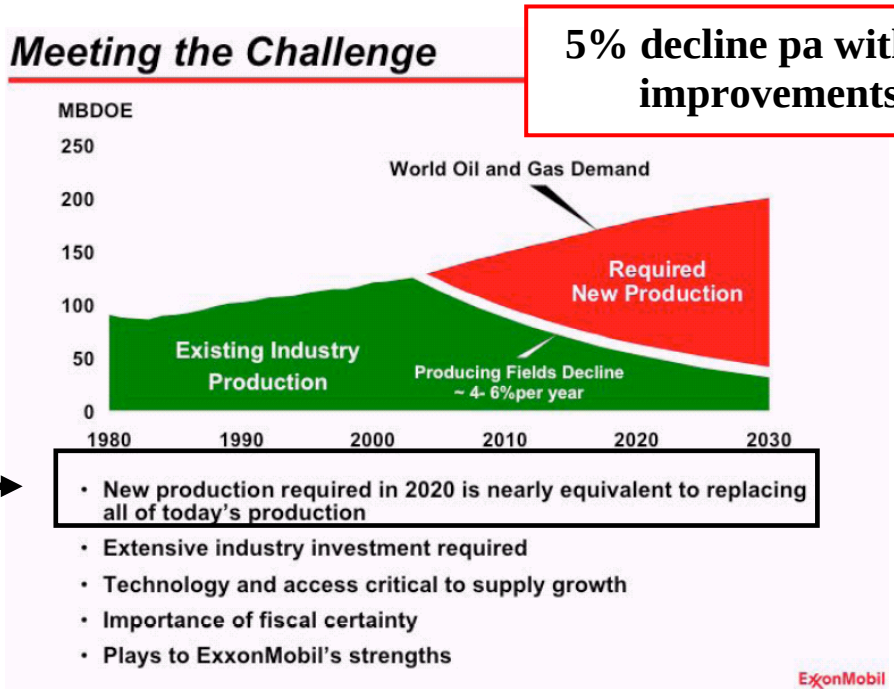
Depletion is the overriding factor, not demand growth.



Contrary to common belief which is fed by a constant stream of misinformation from the media the world's oil supply problem is NOT demand growth (1.5-2 mb/d pa) , but DECLINE (4-7 mb/d pa) in existing fields as depicted in this graph of the International Energy Agency by K. Rehaag, then editor of the monthly Oil Market Report .

Source: www.iea.org/dbtw-wpd/Textbase/speech/2004/kr_**rio**.pdf

Rampant decline in existing fields is also shown in this graph by Exxon.



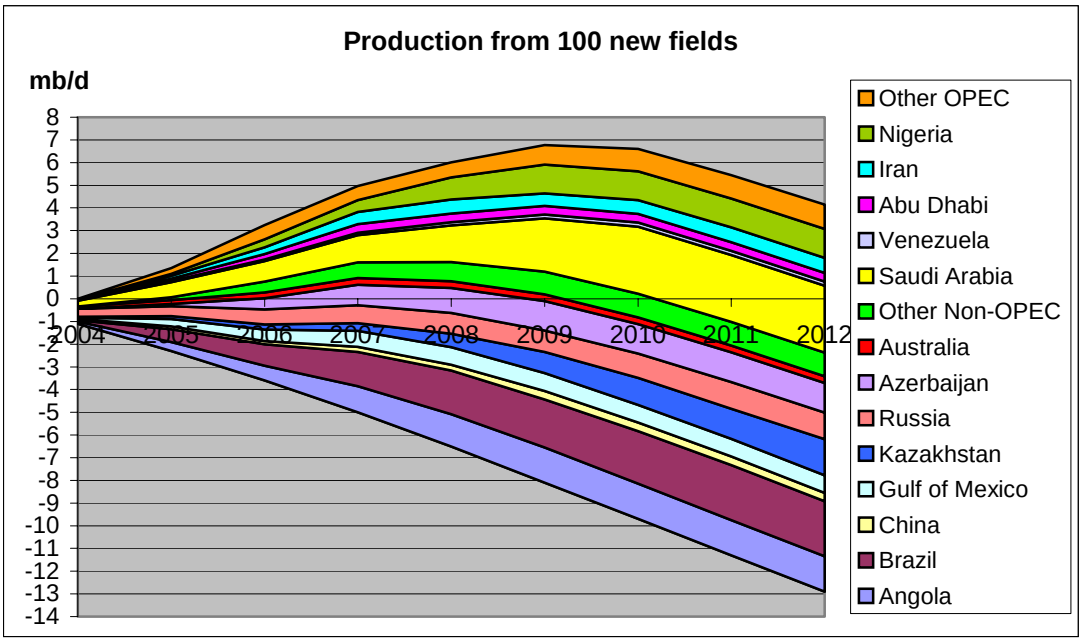
One may ask how it will be possible to replace nearly all of today's production in just 15 years. The "challenge" rather seems to be an "unsolvable problem":

The situation is summed up quite well by Chris Skrebowski, member of ASPO and editor of **Petroleum Review,** in following table (Oct 2005)

Table 1: Oil demand and supply balance							
In million barrels/day	2004	2005	2006	2007	2008	2009	2010
Oil demand (IEA)	82.1	83.5	85.3	87.0	88.8	90.5	92.3
Demand increase	2.9	1.4	1.8	1.7	1.8	1.7	1.9
New megaprojects	1.1	2.4	3.1	3.1	2.8	2.8	1.5
5% depletion (acts as additional demand)	4.1	4.2	4.3	4.4	4.4	4.5	4.6
Extra volume required	2.3	3.2	3.0	3.0	3.4	3.4	4.9

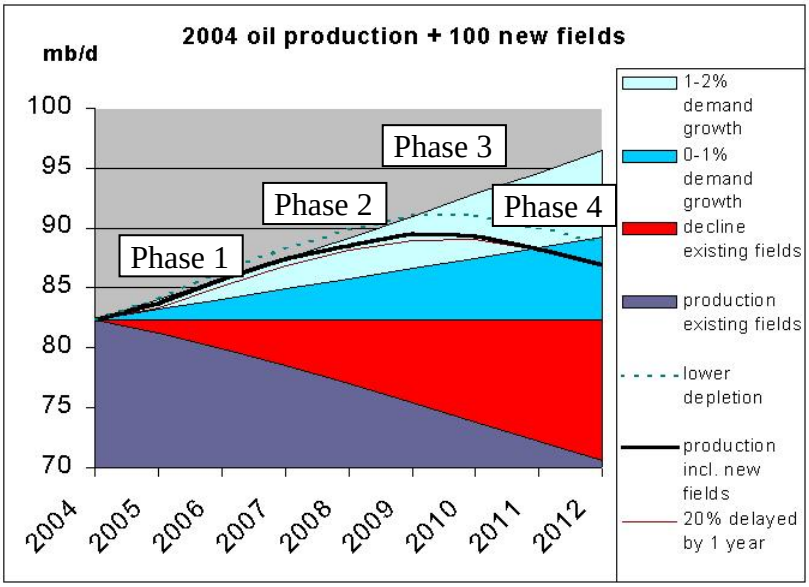
Source: http://sydneypeakoil.com/phpBB/viewtopic.php?t=652

Chris comments:
"The world has now reached the point where the volumes lost to depletion are much larger than the levels of likely new demand* [from China, India, US for example]. *This means total increments required (new demand plus depletion) are running at 7% pa, while the largest supply increments in 2006 and 2007 are contributing 3.6% and 3.5%. It would seem most unlikely that small projects and infill drilling could account for the remaining required 3.5%. The inescapable conclusion is that oil prices will have to remain high enough to destroy demand, bringing supply and demand back into balance."



The graph (up) is based on the April 2005 version of Chris' Megaprojects study. It is an **optimistic incremental production window** based on a list of new fields and modest depletion in existing fields between 1 and 1.6 million barrels/day pa, suggesting a peak around 2009 and 2010. Reality will not be as smooth as that, rather a bumpy production plateau. More details about how this graph was arrived at can be obtained from:
http://sydneypeakoil.com/matt/100NewOilFields1of3.pdf
http://sydneypeakoil.com/matt/100NewOilFields2of3.pdf
http://sydneypeakoil.com/matt/100NewOilFields3of3.pdf
http://sydneypeakoil.com/matt/100NewFieldsAddOn.pdf

The 4 phases of peak oil



Phase 1: Production struggles to follow a 2% demand growth up to 2008

Phase 2: After 2008, a 2% demand growth is no longer physically possible. Therefore, problems start already **before** peak oil.

Phase 3: Production begins to plateau around 2010 (peak oil)

Phase 4: After 2010, production from new oil fields can no longer offset decline in the rest of the fields. If trends between 2010 and 2012 continue, the production curve will hit the decline area around 2015 when production will be back to 2004 levels

(7) Peaking of what exactly?

Peaking of conventional oil: already happened in 2005

Peaking of Non-OPEC oil: On a bumpy production plateau in the last 12 months

Peaking of OPEC oil: this will depend on Saudi Arabia (see Matt Simmons book "The coming Saudi oil shock) but also on political developments in Iraq and Iran

Peaking of export volumes available on the world's markets. Growing consumption from increasing population and growing wealth from oil income in oil exporting countries will reduce export capacities

Peaking of per capita oil production

Global peaking is peaking of all liquids together: conventional oil, deep water oil, polar oil, natural gas liquids, shale oil, heavy oil, bitumen, tar sands. NGLs will follow gas production. Tar sands and oil shale are mining operations which have their own limitations

Each of these peaks will have a fundamental impact on the world economy.

(8) Peaking how?

Peak oil is not a big-bang event like 9/11 which announces itself (unless the geological peak coincides with a major geo-political event) but is rather a long, drawn-out process which may take a couple of years, along a bumpy plateau with multiple peaks. The world's oil supply system is huge and rather resilient in the short-term. We have just experienced how this system coped with a sudden production drop-out of almost 1.5 mb/d in the Gulf of Mexico after hurricane Katrina. Strategic reserves were used from both sides of the Atlantic to fill the gap. It will be difficult to detect the last peak in a series of peaks. Even under normal conditions there are a lot of ups and downs in production. Venezuela, Iraq, Nigeria, Russia, refinery and tanker capacities, oil markets know the problems. Demand destruction from high oil prices will dampen peaks. Strategic reserves from several countries will later be used in non-emergency situations to lift up decline periods. Therefore it may take 1 or 2 years until is has become clear that permanent decline has started.

Later peaks (which require higher EURs and are therefore statistically less likely), are followed by steeper declines. After 2010, many giant oil fields, which now still supply 30% of the world's daily oil, will then be 50, 60 even 70 years old and enter phases of declines which can be as high as 10% pa. (see "The world's giant oil fields" by Matt Simmons at http://hubbert.mines.edu/news/Simmons_02-1.pdf.) Most of these fields use state of the art technology with multiple horizontal wells. When water which is routinely used to maintain reservoir pressure reaches these wells from down, they have to be shut within a short time and production drops. Therefore, "optimists" who hope for and expect these later peaks make a big mistake. Not the strongest economy will survive these steep declines. Especially not without preparing for it. And if business as usual

continues until a later peak, we will be as unprepared as now. "Pessimists" expecting early peaks would be those with a prudent, safe approach and a strategy to prepare NOW.
(9) Web links to important oil depletion papers in the last 12 months:

February 2005: report by Robert L. Hirsch to the DoE entitled "Peaking of world oil production: impacts, mitigation & risk management";
http://www.cge.uevora.pt/aspo2005/abscom/Abstract_Lisbon_Hirsch.pdf

March 2005: IEA workshop "Managing Oil Demand in Transport" with the 1st session entitled "How to save fuel in a hurry";
http://www.iru.org/images/WebNews/ParisMar05/prog.pdf

April 2005: Conference on oil depletion in Edinburgh;
http://www.depletion-scotland.org.uk

April 2005: Chris Skrebowski's update of his mega oil field study
www.energybulletin.net/newswire.php?id=5395
With reference to Exxon Mobil's graph "Meeting the Challenge"
http://www.odac-info.org/bulletin/documents/gs_011105.pdf.

May 2005: ASPO conference in Lisbon
http://www.cge.uevora.pt/aspo2005/abstracts.php

October 2005: Chris Skrebowski's update of his mega oil fields study
http://sydneypeakoil.com/phpBB/viewtopic.php?t=652

October 2005: Hirsch report "The inevitable Peaking of Oil Production"
http://www.acus.org/docs/051007-Hirsch_World_Oil_Production.pdf

November 2005: ASPO-USA: Denver conference on oil depletion
http://www.aspo-usa.org/proceedings/powerpoint/

(10) Web sites with regular updates on peak oil

www.theoildrum.com
A community forum with daily contributions and analysis on oil, gas, alternative energies and global warming

www.peakoil.net and www.peakoil.ie
The official site of ASPO (Association for the Study of Peak Oil and Gas)

www.aspo-australia.org.au
The official site of ASPO-Australia

www.Sydneypeakoil.com
Sydney's community group on peak oil

www.energybulletin.net
Daily updates on links to of energy related news from around the world

Appendix 1

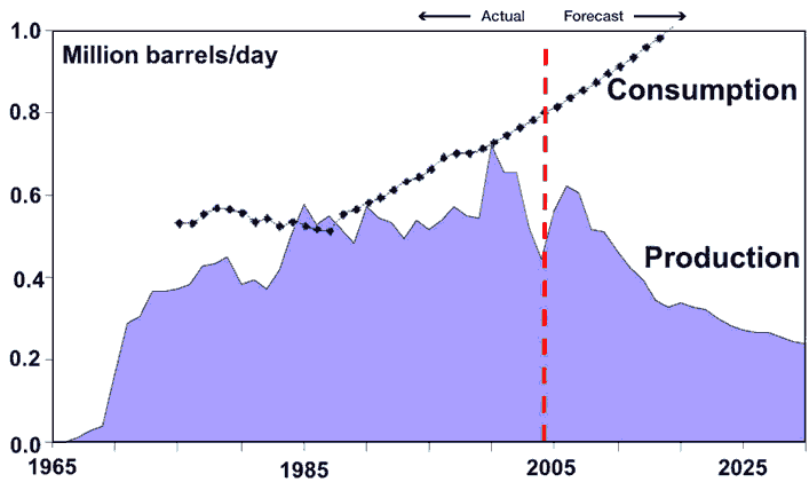
Australia's declining oil production

Australia's liquid fuel **production** decline began in 2000.

Year	Production Kb/day	Decline rate
2000	722	
2001	657	-9%
2002	626	-4.7%
2003	512	-18.2%
2004	455	-11.2%

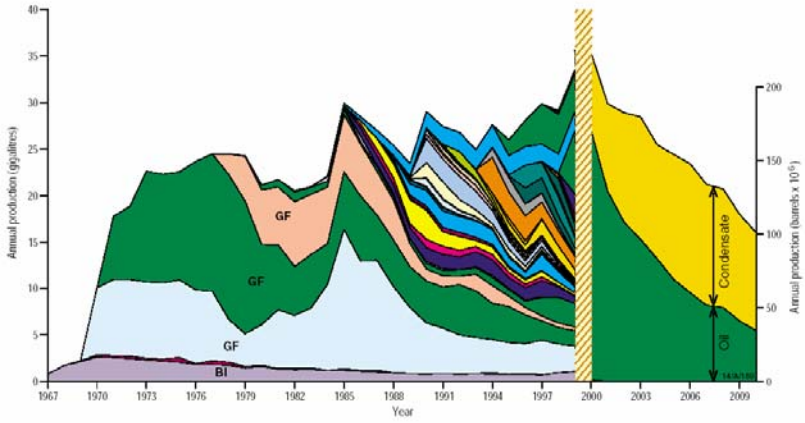
Source: Table 1.1b
http://www.eia.doe.gov/ipm

Kb/d=1,000 barrels per day
Current oil **consumption** is 846 kb/d or 309 mill. barrels per year.



Source of graph: Bruce Robinson's slide show at the ASPO International Workshop on oil depletion in Lisbon, May 2005
http://www.cge.uevora.pt/aspo2005/abscom/ASPO2005_Robinson.ppt

J.Akehurst (former CEO Woodside Petroleum Ltd): Challenges for Australia
www.woodside.com.au/NR/Woodside/investorpack/SG3682_3_ABARE.pdf

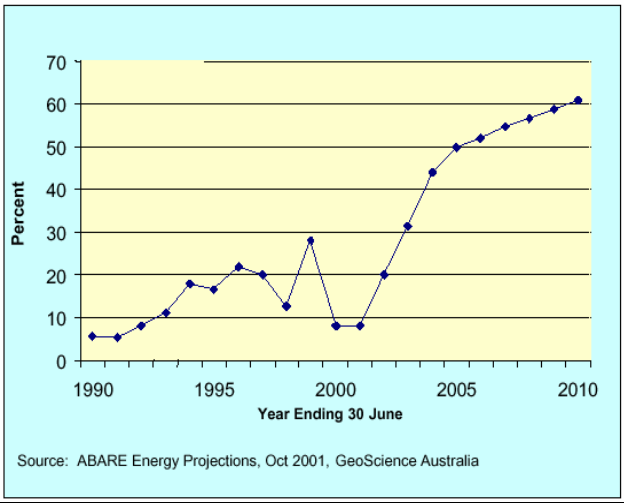


Condensate from gas fields cannot fully compensate declining oil production

The graph (left) illustrates the dramatic changes occurring in Australian oilfields. The large Gippsland fields are declining and being replaced by many smaller fields with shorter production periods and increased costs (risky exploration; more wells needed to maintain production)

A trade surplus of $ 1250 mill. in 2000/2001 from the net balance of oil imports/exports will turn into following deficits pa by 2010.
Calculated at different oil prices and exchange rates:
US$ 20/barrel and AU$ 1= US$ 0.55
AU$ 7.6 billion
US$50/barrel and AU$=US$0.70
AU$ 14.9 billion

Australia's oil import dependence is rising from a low 10% in 2000 to 60% in 2010.

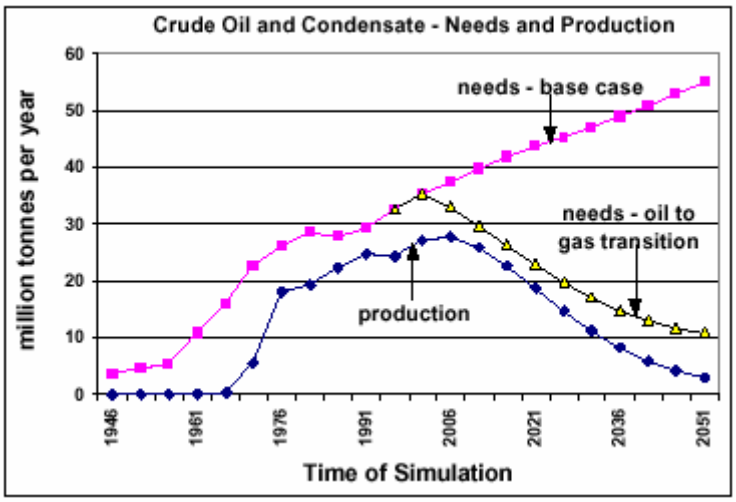


Last Update: 25/11/2005

Appendix 1.1 Australian oil production and gas transition

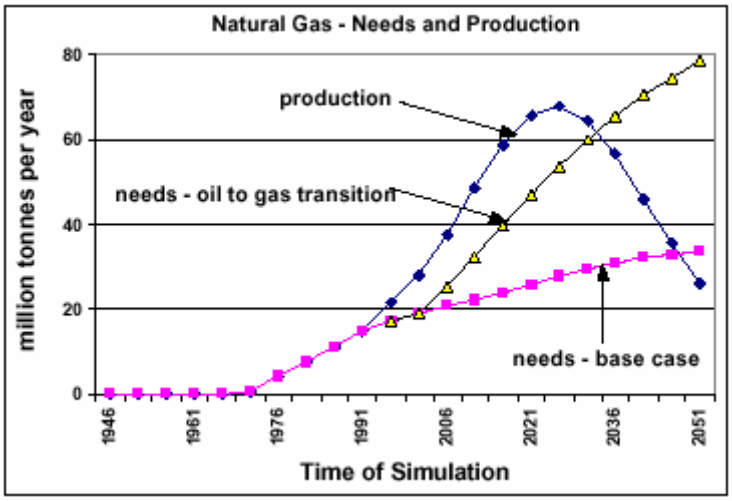
CSIRO's Resource Futures Division published the report "Future Dilemmas" in Oct. 2002, highlighting serious physical constraints in Australia's resource sector. It does not seem to have been noticed by planners in both the various levels of Government and private consultancies.

As shown in the following graph, a huge gap opens between Australian crude oil production (including condensate) and needs in the coming years.



Source: „Future Dilemmas", Chapter 5, The future of energy, page 171

In a (theoretical) oil to gas transition scenario, natural gas production will also peak between 2020 and 2030, belying a myth there is abundant gas which could support

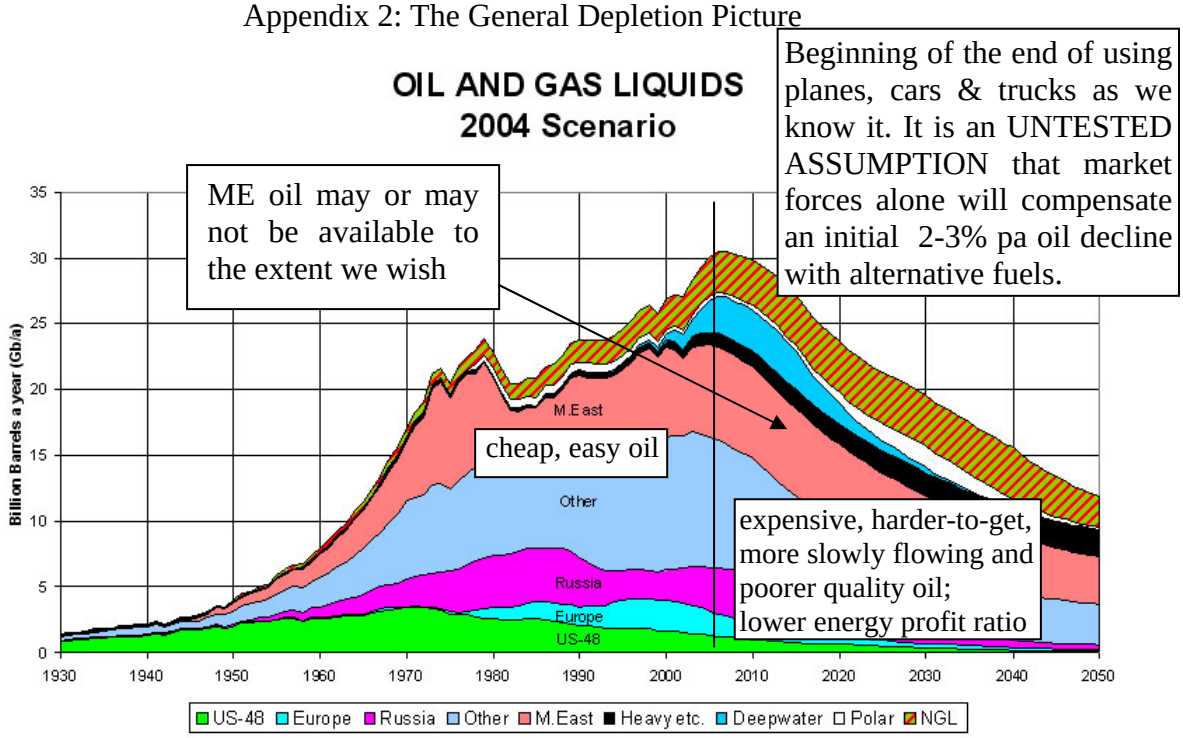


Source: „Future Dilemmas", Chapter 5, The future of energy, page 172

a business as usual approach in the use of private cars even after the whole fleet's transition to CNG vehicles. This technology, requiring a new supply infrastructure different from LPG, has up to now only been introduced in various bus fleets.

But the 2004 decision of the NSW Government to purchase diesel buses shows that the urgency and necessity for this transition job is by no means understood.

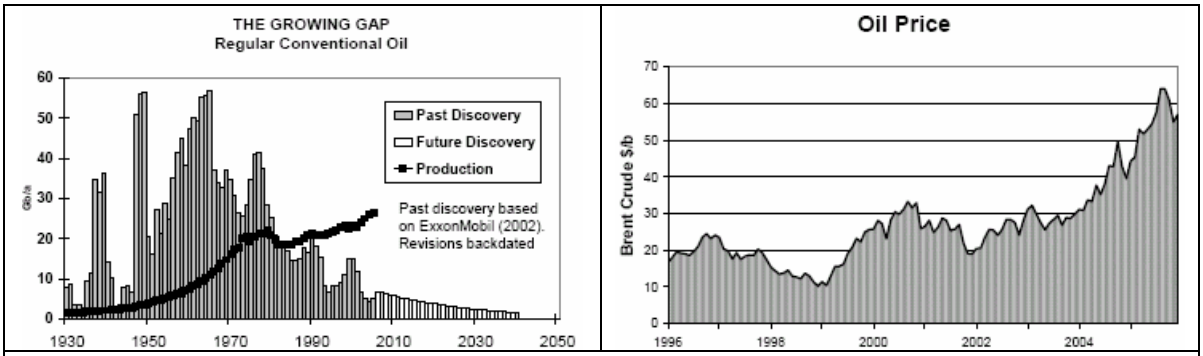
Appendix 2: The General Depletion Picture



ASPO's annual oil production simulated on the basis of technical reserve and production data. Half of the regular oil is already consumed. Though higher oil prices will result in exploration and production from new fields (+123 Gb) future production is limited by oil geology. Peak oil will trigger a general energy crisis as the world will seek to fill the gap. Our economy and transport systems will have to adapt. Prudent governance requires that we change our current energy & transport policies NOW before the crisis manifests itself.

ESTIMATED PRODUCTION TO 2100 — End 2005

Amount Gb				Annual Rate - Regular Oil						Gb	Peak
Regular Oil				Mb/d	2005	2010	2015	2020	2050	Total	Date
Past	Future		Total	US-48	3.6	2.8	2.2	1.7	0.4	200	1971
Known Fields	New			Europe	5.2	3.6	2.5	1.7	0.2	75	2000
968	759	123	1850	Russia	9.2	8.4	6.8	5.5	1.5	220	1987
	882			ME Gulf	20	20	20	20	11	680	1974
All Liquids				Other	29	26	22	18	7	675	2005
1074	1326		2400	**World**	**67**	**61**	**54**	**47**	**21**	**1850**	2005
2004 Base Scenario				**Annual Rate - Other**							
M.East producing at capacity				Heavy etc.	2.3	3	4	4	4	151	2021
(anomalous reporting corrected)				Deepwater	3.6	12	11	6	4	69	2011
Regular Oil excludes oil from				Polar	0.9	1	1	2	0	52	2030
coal, shale, bitumen, heavy,				Gas Liquid	6.9	9	9	10	8	276	2035
deepwater, polar & gasfield NGL				Rounding					-2	2	
Revised 25/12/2005				**ALL**	**80**	**86**	**80**	**70**	**35**	**2400**	2010

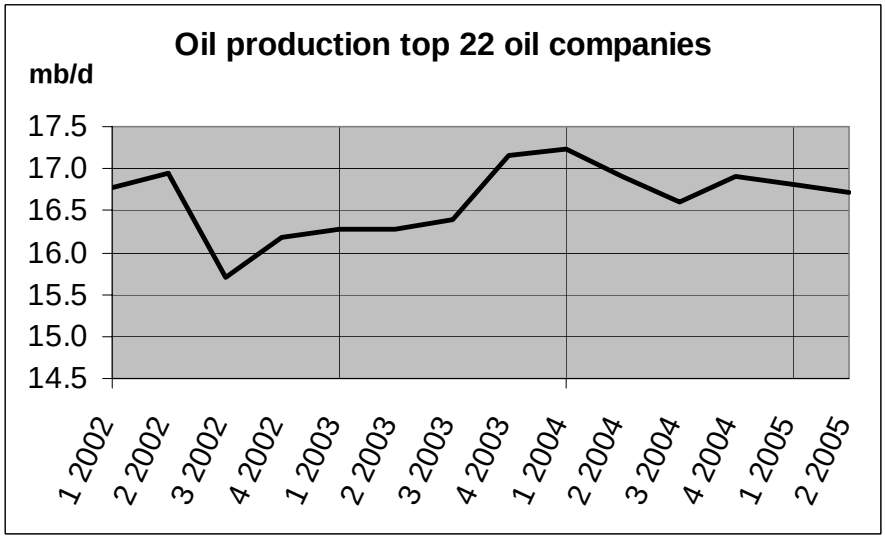


Peak production of regular oil must follow peak discovery, which happened in the mid 1960s, with a time lag (left). Prices react to peak oil but do not reflect yet that oil is a finite resource (right). After peak oil (there may be several peaks or a plateau), prices will increase until demand is physically forced down to declining production levels.

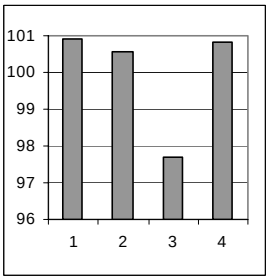
Source of graphs: Association for the Study of Peak Oil & Gas, www.peakoil.ie (ASPO Ireland)
Compiled by C.J.Campbell, Staball Hill, Ballydehob, Co. Cork, Ireland Last Update: 12/1/2006

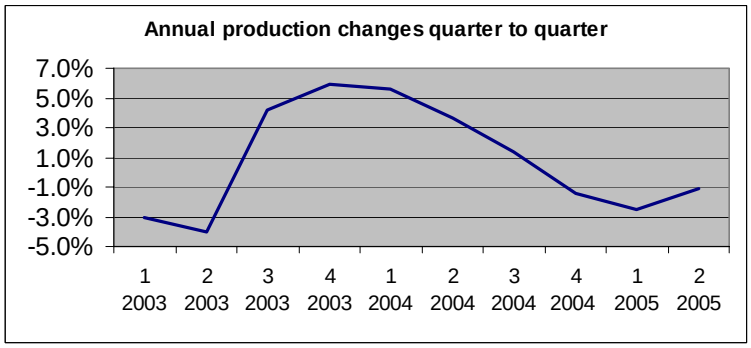
Appendix 27: Turning point for 22 top oil companies

The professional oil and gas journal ***Petroleum Review*** published in its October 2005 issue oil production data of 22 top oil companies accounting for 20% of the world's daily production. A production profile over 3 ½ years shows that production is not keeping up with growing demand. At best, we have a bumpy production plateau with a declining trend since end 2003.

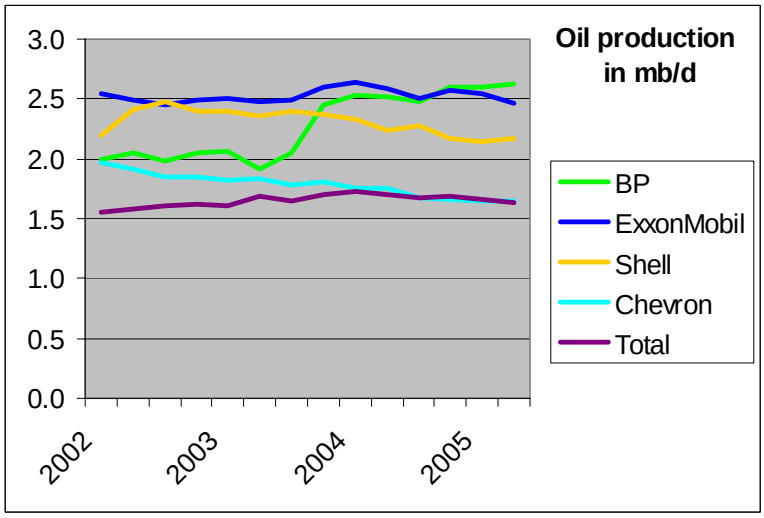


Oil companies are clearly struggling to maintain production levels despite high oil prices (left). A peak was reached in the 1st quarter of 2004.



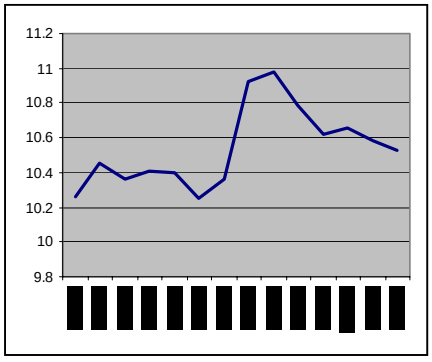


Adjusting for seasonal fluctuations (top, right), the annual changes comparing quarterly production figures (left) reveal that, after an enormous effort in 2003, growth rates have been declining ever since and have gone into negative territory for 3 consecutive quarters since 4/2004



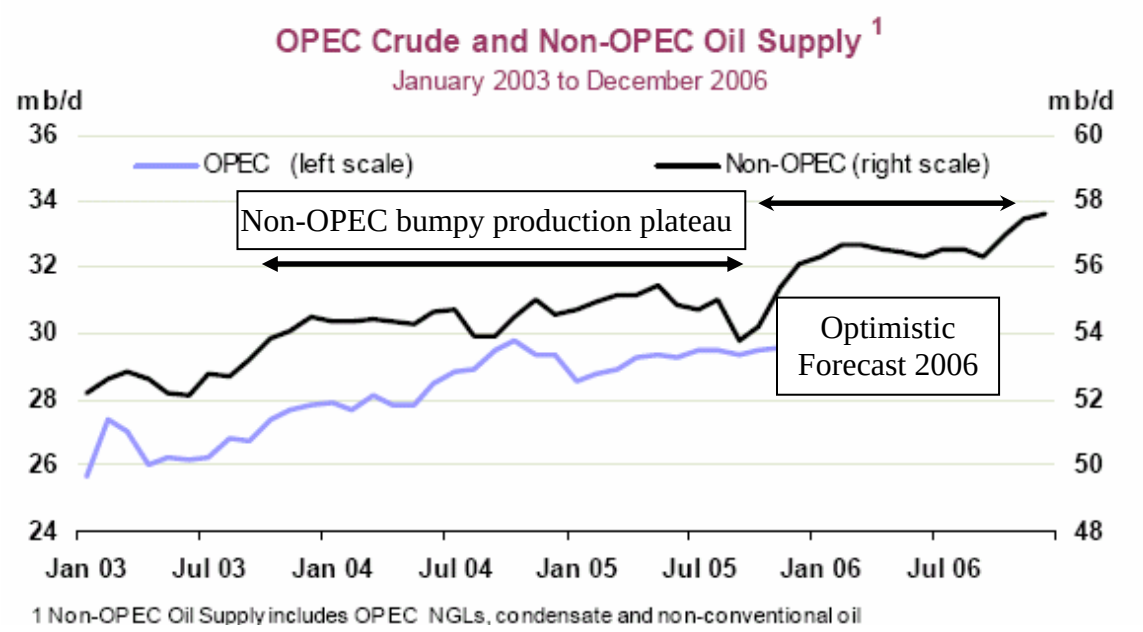
"BP is now the world's largest oil producer" is the title of Petroleum Review's October 2005 article on page 24. The performance of each of the top 5 oil companies is shown in the graph above. Source: http://sydneypeakoil.com/phpBB/viewtopic.php?t=653

The total for all 5 companies (down) shows a clear peak around 4/2003 and 1/2004

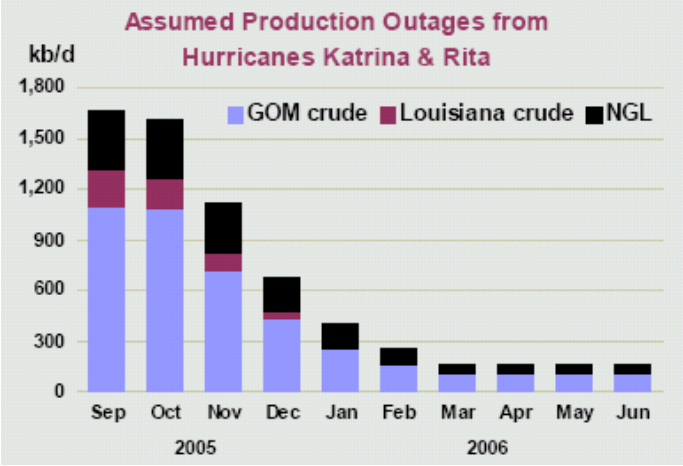


The situation is so critical that Chevron took the extraordinary step to start a web site www.willyoujoinus.com informing the public of the real issues facing the oil industry.

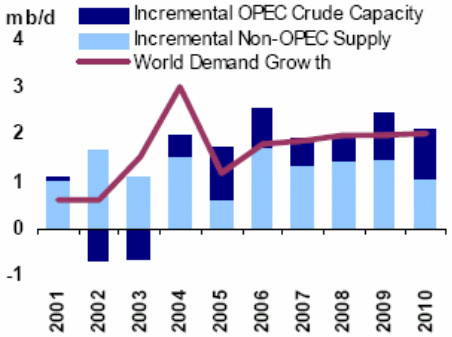
Appendix 32: International Energy Agency's Oil Market Report December 2005



IEA's annual forecasts have traditionally been on the high side by around 1 mb/d. It is clearly visible that Non-OPEC supplies have been struggling to maintain their 2004/2005 level. Gulf of Mexico hurricanes now inflict regular dents in oil production profiles. It is quite likely that the global geological peak will be masked by an event like the GOM hurricane season.



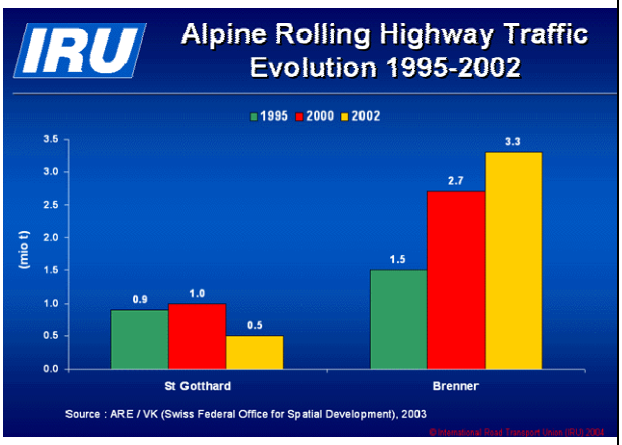
The IEA is politically bound by its member countries to project a positive outlook but tight oil supplies for the next years are shown on the graph to the right. The extra supply capacities in 2006 and 2009 are small and can easily be wiped out or delayed by accidents, natural disasters, political disturbances and other events. It is not clear at all whether decline in existing fields – which acts as additional demand and is between 1 and 1.6 mb/d per annum - has been incorporated. Oil price volatility will therefore continue. It is one of the signs of the approaching global peak of oil production expected by ASPO around 2010.

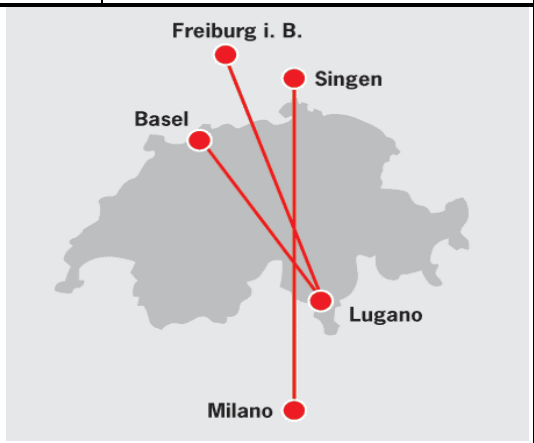


IEA Oil Market Report 12/2005
http://omrpublic.iea.org

Appendix 6: What other countries are doing:
Rolling highway between Germany/Switzerland/Austria/Italy/Hungary

Trucks loaded on special flatcars on their way to crossing the Alps by train (Freiburg in Germany to Novara/Italy). In order to stem the tide of transit trucks clogging mountain passes and road tunnels, Austria and Switzerland have introduced a night time curfew for trucks. The concept of rolling highways combines the advantages of road and rail.





More details at www.hupac.ch

Trucks simply use ramps. No cranes are needed. Maximum height/weight is 4 m and 44t

Sleeper car for truck drivers. Train timetable must be designed to cater for the needs of truck companies.