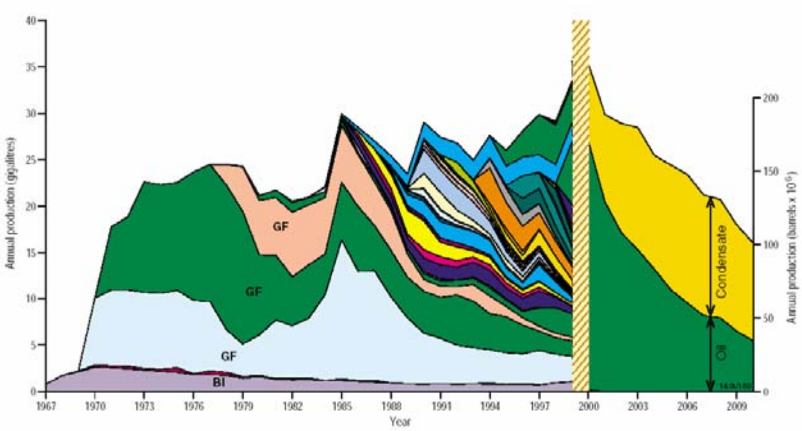
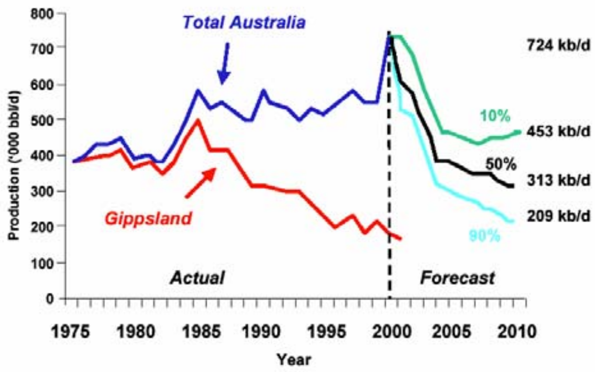
Appendix 1

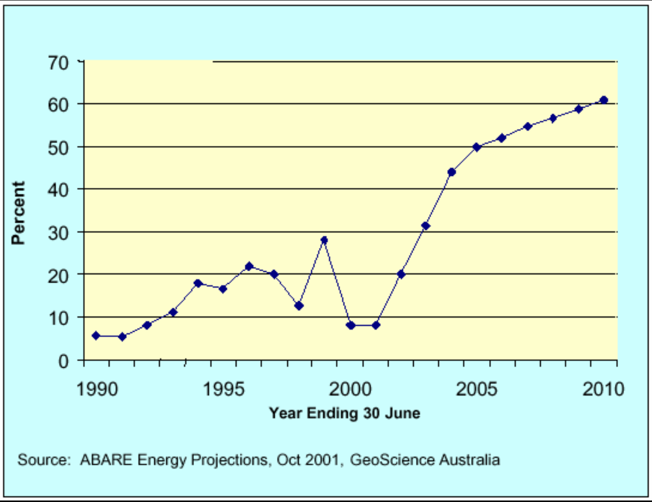
Australia’s declining oil production



Australia's liquid fuel **production** decline began in 2000. The graph (right) shows decline paths for 3 different probabilities (50% is the mean). Current oil **consumption** is 846 kb/d (kb/d= 1,000 barrels per day) or 309 mill. barrels per year.	*Fig A.6 Historic Oil Production and Forecast Future Production Probabilities and Related Volumes* Source: T.G. Powel, APPEA Journal (2001)

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.

Australia's oil import dependence is rising from a low 10% in 2000 to 60% in 2010.
A trade surplus of $ 1250 mill. in 2000/2001 from the net balance of oil imports/exports will turn into an estimated $ 7.6 bill. deficit pa by 2010,
(calculated at US$ 20/barrel and AU$ 1= US$ 0.55;
at US$50/barrel and AU$=US$0.7 this would be an annual $ 14.9 billion deficit)



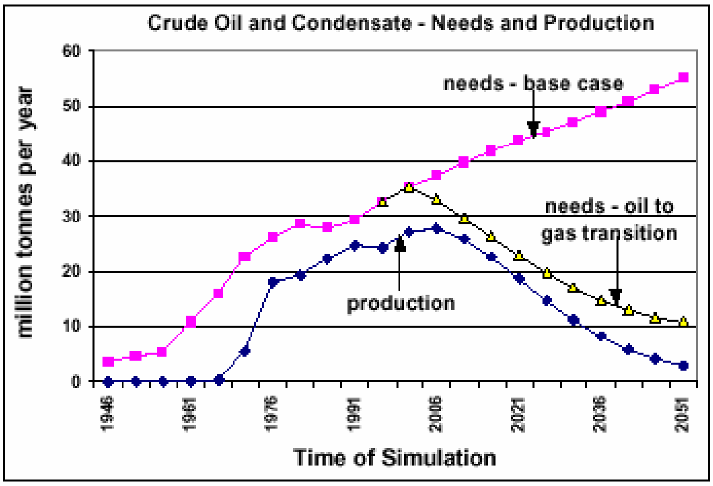
Source of graphs:
http://www.woodside.com.au/NR/Woodside/investorpack/SG3682_3_ABARE.pdf

Last Update: 19/10/2004

Appendix 1.1 Australian oil production and gas transition

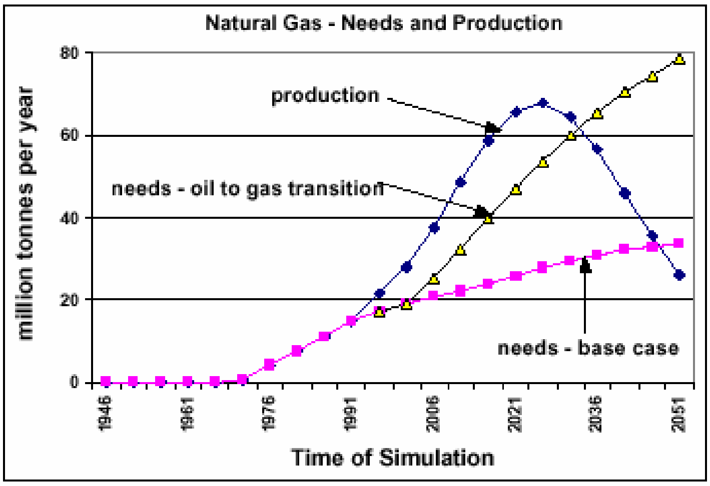
CSIRO’s Resource Futures Division published the report “Future Dilemmas” in Oct. 2002, highlighting serious physical constraints in Australia’s resource sector. It does not seem to have been noticed by planners in both the various levels of Government and private consultancies.

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

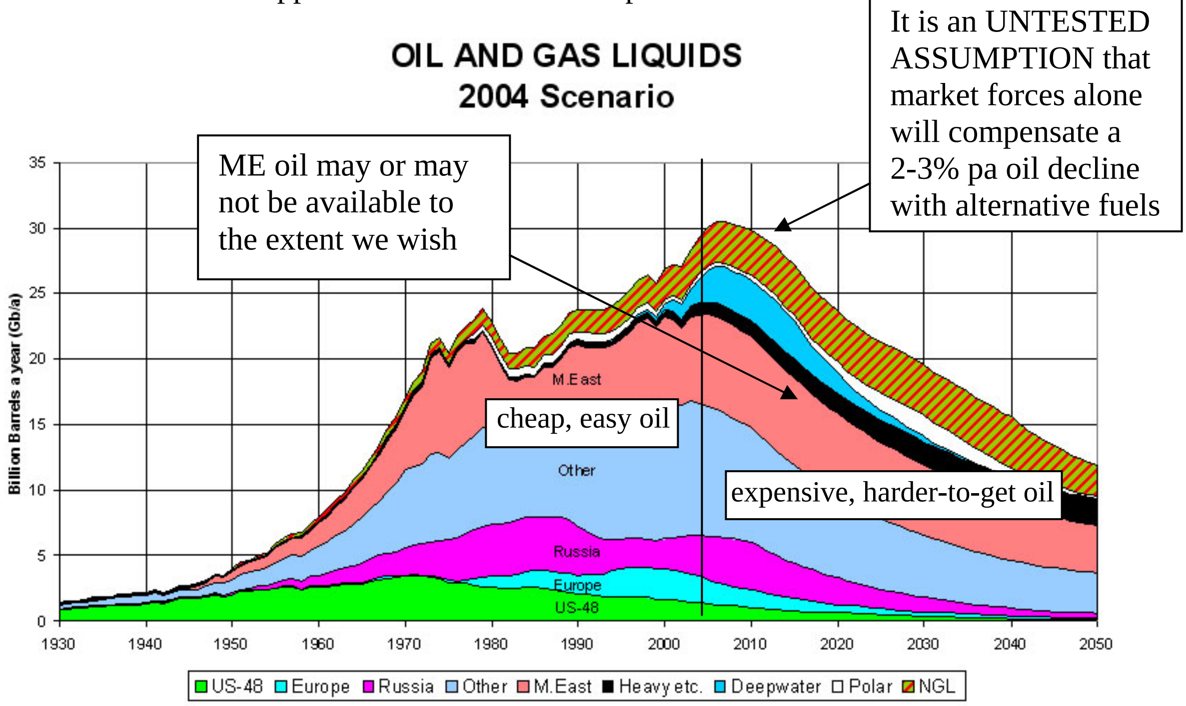
In a (theoretical) oil to gas transition scenario, natural gas production will also peak between 2020 and 2030, belying a myth there is abundant gas which could support



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

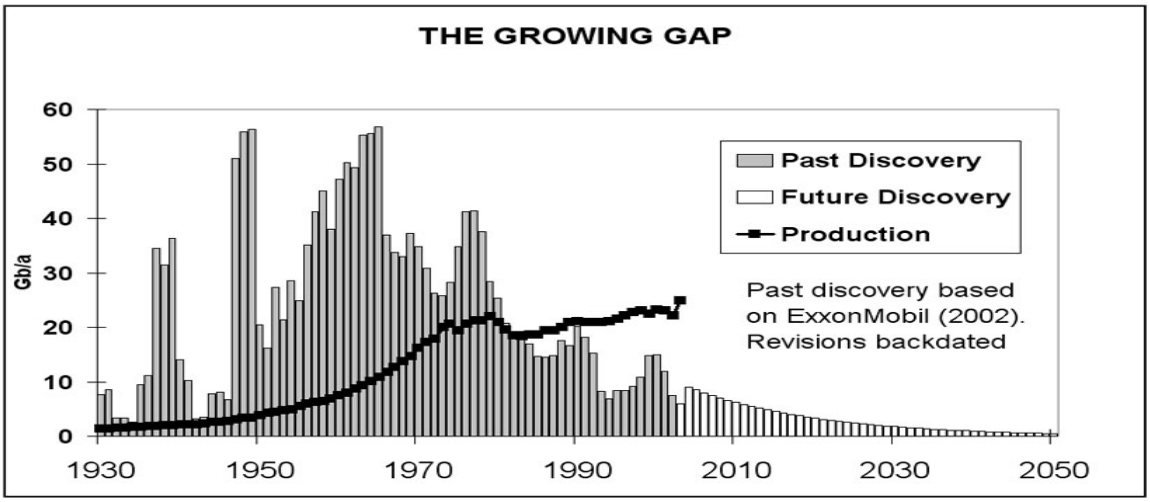
a business as usual approach in the use of private cars even after the whole fleet’s transition to CNG vehicles. This technology, requiring a new supply infrastructure different from LPG, has up to now only been introduced in various bus fleets.

Appendix 2: The General Depletion Picture



ASPO's computer model based on technical reserve and production data generates the above graph. Higher oil prices will result in exploration and production from new fields (+150 Gb). Production is limited by oil geology. Beyond a certain period oil may no longer be used in large quantities for internal combustion engines in land transport.

ESTIMATED PRODUCTION TO 2100									End 2003	
Amount			**Gb**	**Annual Rate - Regular Oil**					**Gb**	**Peak**
Regular Oil				Mb/d	**2005**	**2010**	**2020**	**2050**	**Total**	**Date**
Past	**Future**		**Total**	US-48	3.6	2.8	1.7	0.4	200	1971
	Known Fields	New		Europe	5.0	3.6	1.8	0.3	75	2000
920	780	150	1850	Russia	9.1	10	5.5	0.9	210	1987
	930			ME Gulf	19	19	17	10	675	1974
All Liquids				Other	27	23	17	9	690	1997
990	1510		2500	**World**	**64**	**58**	**43**	**20**	**1850**	2005
2004 Base Scenario				**Annual Rate - Other**						
M.East producing at capacity				Heavy etc.	2.6	3	4	5	195	~
(anomalous reporting corrected)				Deepwater	4.7	7	5	0	55	2014
Regular Oil excludes oil from				Polar	0.9	1	2	0	50	2030
coal, shale, bitumen, heavy,				Gas Liquid	8.2	9	11	6	270	2027
deepwater, polar & gasfield NGL				Rounding		1		-2	80	
Revised	06-08-04			**ALL**	**81**	**80**	**65**	**30**	**2500**	2006



Source of graphs: Association for the Study of Peak Oil & Gas, at www.asponews.org

Compiled by C.J.Campbell, Staball Hill, Ballydehob, Co. Cork, Ireland

Last Update: 24/10/2004

Appendix 2.4 Matt Simmons on the failures of common wisdom in oil & gas production

Matthew Simmons, energy investment banker and former advisor to the Bush Administration and the 2001 Energy Task Force in the US.

Read his articles and slides at www.simmonsco-intl.com

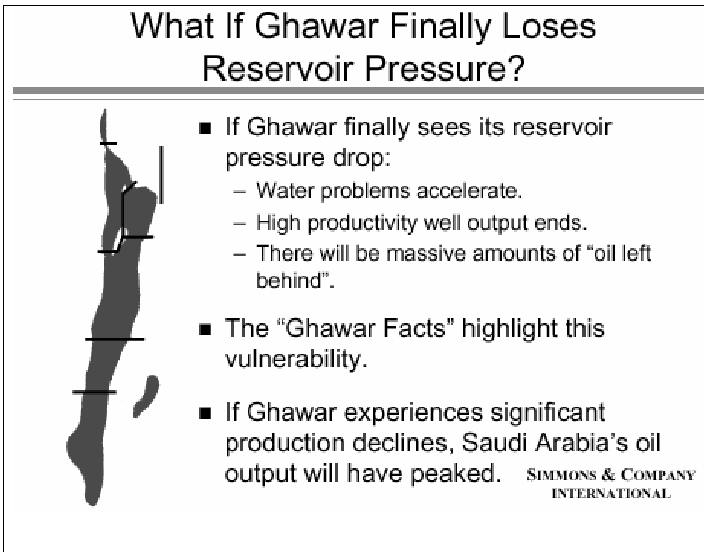
(1) World peak oil unpredictable but may be at hand

On 27/5/2003 Simmons addressed the second international conference of the Association for the Study of Peak Oil&Gas (ASPO) at the French Petroleum Institute (IFP) in Paris:

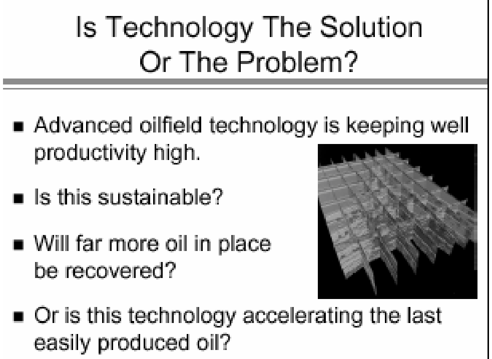
"....I think basically that now, that peaking of oil will never be accurately predicted until after the fact. But the event will occur, and my analysis is leaning me more by the month, the worry that peaking is at hand; not years away. If it turns out I'm wrong, then I'm wrong. But if I'm right, the unforeseen consequences are devastating. But unfortunately the world has no Plan B if I'm right. The facts are too serious to ignore. Sadly the pessimist-optimist debate started too late. The Club of Rome humanists were right to raise the 'Limits to Growth' issues in the late 1960's. When they raised these issues they were actually talking about a time frame of 2050 to 2070. Then time was on the side of preparing Plan B. They like Dr. Hubbert got to be seen as Chicken Little or the Boy Who Cried Wolf.... "

(2) Saudi oil: a glass half full or half empty?

On 9/7/2004 Simmons presented in the Hudson Institute, Washington DC, his findings on his analysis on Saudi Arabia's giant oil fields (see also Hubbert Centre Newsletter #2002/1, Colorado School of Mines), in particular Ghawar. This is the largest Saudi field, from where more than half of Saudi oil is coming and which is, according to Saudi Aramco**, 48% depleted**, even 60% in its northern and most productive region. Simmons studied 200 technical reports of the Society of Petroleum Engineers written by Saudi petroleum reservoir engineers covering a period of over 40 years and from these reports he now concludes that oil depletion in Saudi Arabia has proceeded much more than Saudis admit and the West assumes. In February 2004, in the Centre for Strategic and International Studies, Aramco presented its known optimistic 50 year outlook but could not convince Simmons who asks for more transparency in oil production and reserve data.



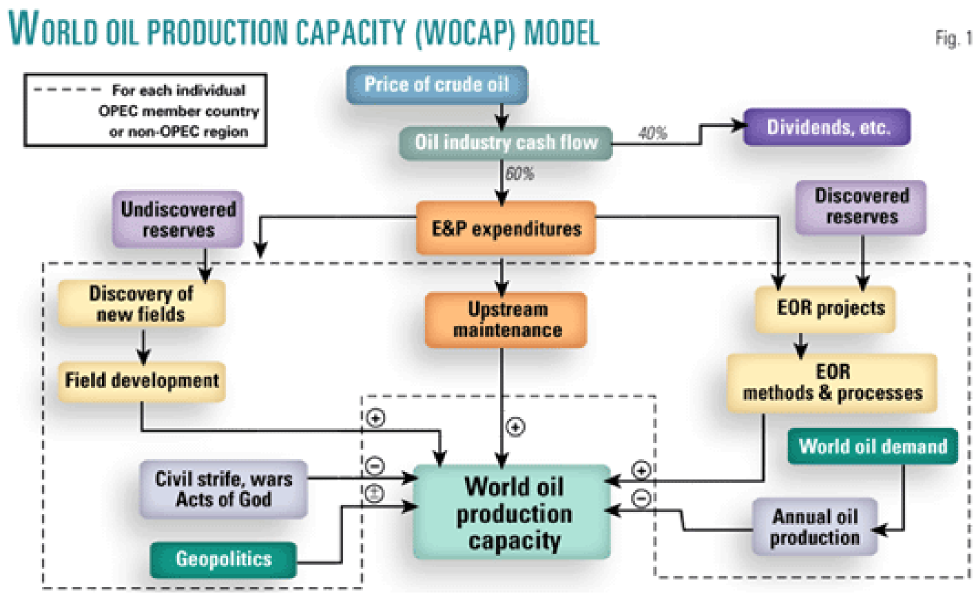
2 of Simmon's slides highlighting problems with Ghawar (left) and the general dilemma that technology increases production but results in faster decline after peak (down).



Last update: 24/8/2004; Sources: (1) www.peakoil.net/iwood2003/MatSim.html (2) File "Hudson Institute (BW).pdf " from www.simmonsco-intl.com Menu "Our Research", "Speeches", "Saudi Arabian Oil, A Glass half full or half empty"

Appendix 2.6 A.S. Bakhtiari's WOCAP model

A.S. Bakhtiari is a senior expert in the National Iranian Oil Co and has developed an oil production model which was published in the Oil&Gas Journal in April 2004 and is shown below.

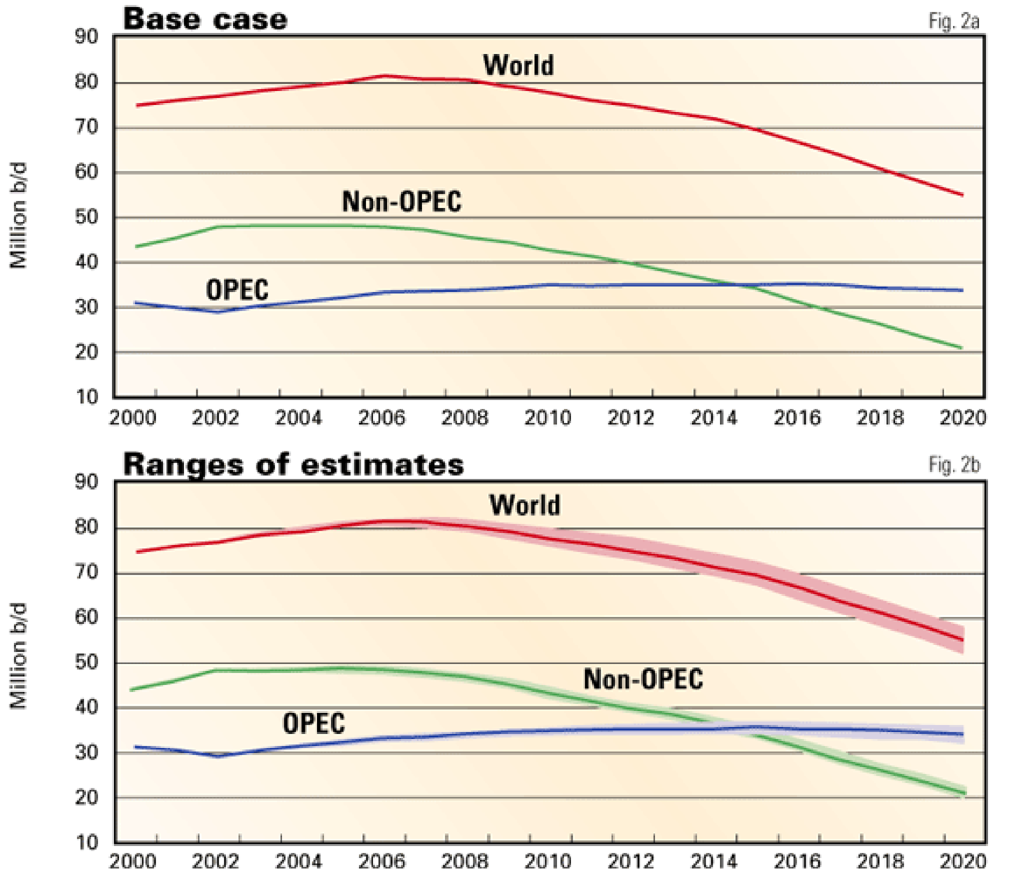


His simulations can be summarized as follows:

- World wide crude oil production including all other hydrocarbon liquids such as NGLs will peak during 2006-07 at about 81 mb/d (+- 1 mb/d). Even under his most optimistic scenario the model could not be made to peak after 2008.
- Irreversibly declining production after peak will fall to about 55 mb/d (+- 3mb/d) by 2020
- Non- OPEC production will continue along its current long plateau at around 50 mb/d for a couple of years.
- OPEC's production is likely to peak in the middle of next decade below 40 mb/d
- The North Sea is in full decline at a rate of 6% pa with total output soon to be lower than 5 mb/d and falling to 3.5 mb/d by 2010
- Russia has now taken over from the North Sea as a new contributor to growing oil production. However, Russia's oil fields were over-exploited during the Soviet era and are actually maturing. In 2003, Russia's output was 8.46 mb/d but the Wocap model could not bring this over the 9 mb/d mark. This is less than Wood Mackenzie's predictions of 10.4 mb/d in 2010.
- OPEC's countries like Iran and Kuwait "have reached the end of their oil capacity tether". Iraq, the greatest hope for future oil production, will have to wait until the situation has normalized.
- There are problems with Saudi Arabia, too. Its 2003 production of 8.7 mb/d is 32% of OPEC's total output and hinges on the performance of the super giant Ghawar field. Doubts have been raised by Matthew Simmons, an American investment banker about a series of technical problems in that field which seem to suggest advanced depletion.

World oil production outlook, (WOCAP) model

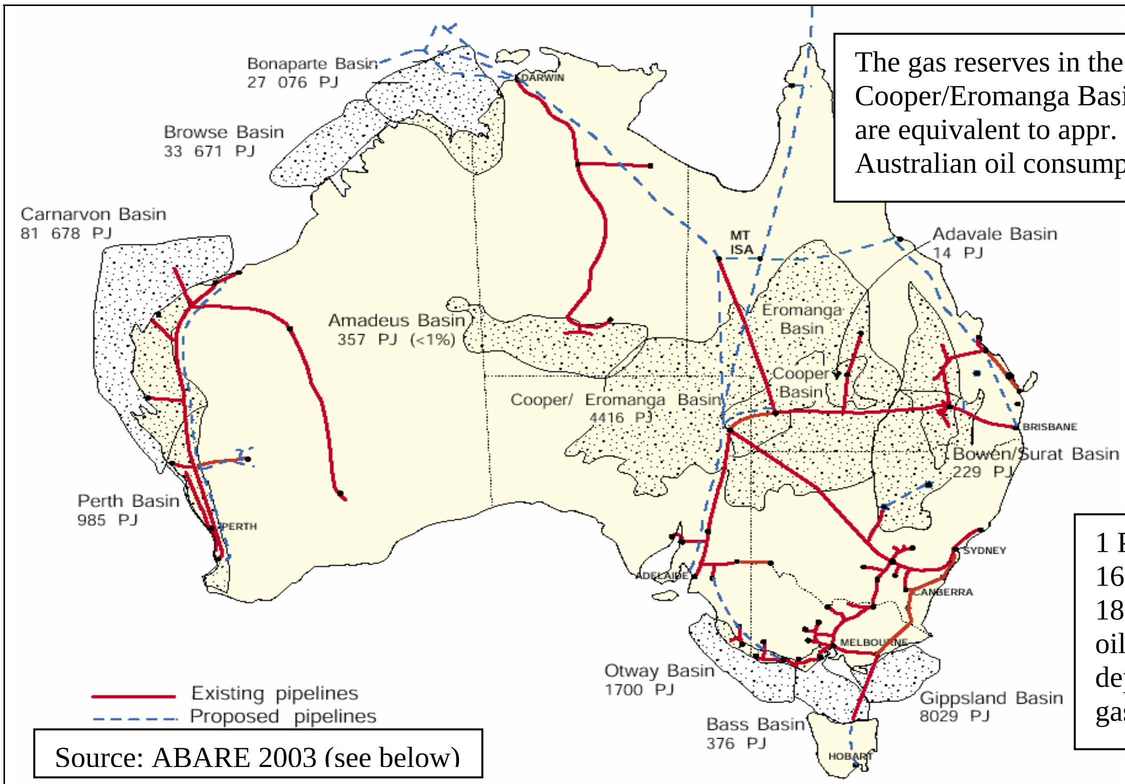
Fig. 2



Source of graphs: Oil & Gas Journal, April 2004

The graphs show that the Non-OPEC's plateau will merge with the world's peak.

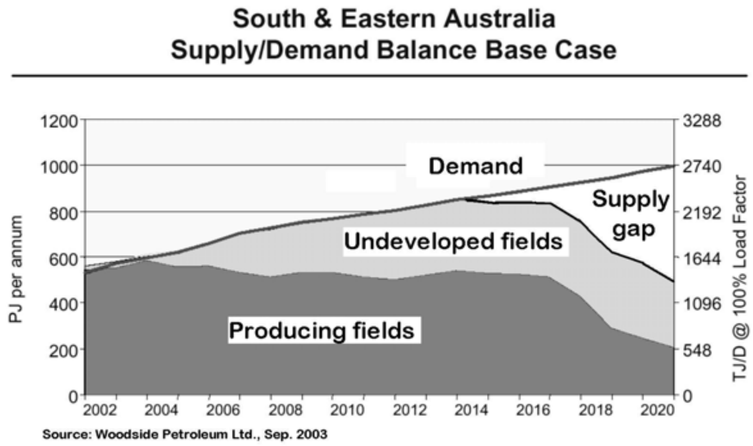
Appendix 3: Australian Gas Reserves and Consumption Pattern – Limitations



Source: ABARE 2003 (see below)

The gas reserves in the Cooper/Eromanga Basin of 4416 PJ are equivalent to appr. 940 days of Australian oil consumption in 2002

1 PetaJoule = 160,000 to 180,000 barrels oil equivalent depending on gas

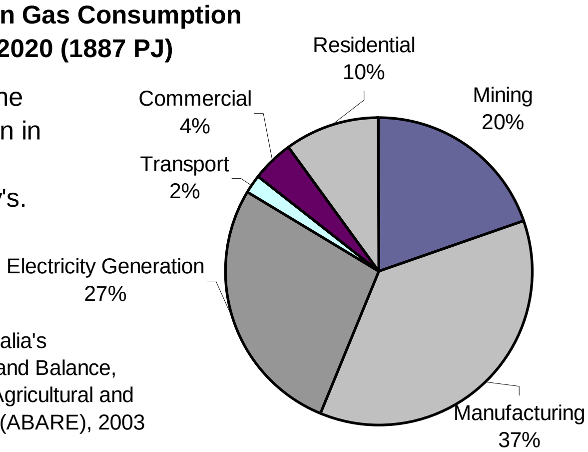


Gas, like any other non-renewable fuel, has a production profile first showing growth and then decline (left). A **supply gap opens around 2014** for the south-eastern coast states unless new pipelines to offshore gas fields in the north/west are built, where 90% of Australia's gas is found. Transport and production costs will be high; 40% of undeveloped fields there are in deep water (800-1200m).

The last gas deal with China is 100 mill tons LNG = 5400 PJ from the shallow parts (=1/4 of the easy gas!) of the Gorgon field in the Carnarvon basin.

Australian Gas Consumption in 2020 (1887 PJ)

ABARE assumes the consumption pattern in 2020 is not much different from today's.



Source: Eastern Australia's Gas Supply and Demand Balance, Australian Bureau of Agricultural and Resource Economics (ABARE), 2003

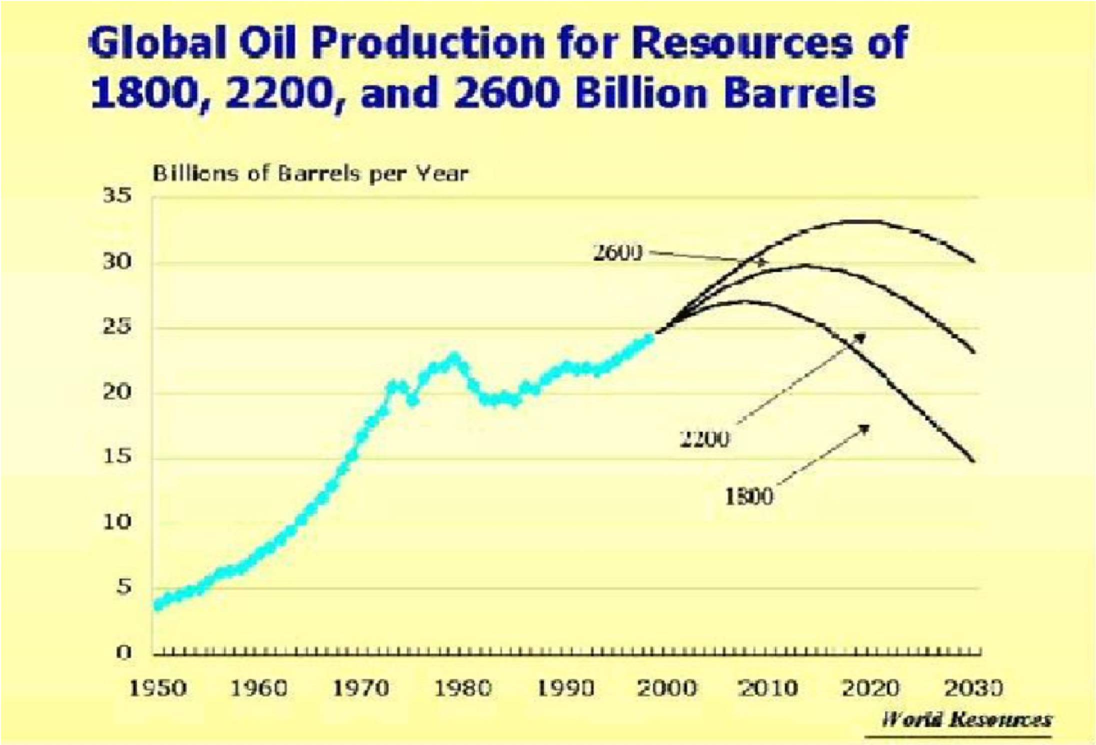
Australian gas is fully booked for anything else than transport.

ABARE makes no provision for a necessary shift towards the use of gas in the transport sector to replace depleting oil reserves. Unless oil consumption is reduced, Australia will have to import oil in increasing quantities. The resulting trade deficit can only partially be offset by gas exports.

Compare the Gorgon Venture's $30 bn over 25 years with oil import deficit figures given by Woodside Energy to the Resources Convention 2003, which at current prices and exchange rates would be $8 bn per annum

Read how current projects in the Carnarvon basin will deplete their reserves to 75% by 2025 in:
"Natural Gas – Magic Pudding or Depleting Resource" by Brian J Fleay (Murdoch University)
available at: http://www.oilcrisis.net/fleay/WA_GasFutureRevised.pdf

Appendix 4: CSIRO's "The World in 2020" – 3 Peak Oil Scenarios



Source of graph: http://www.asic.org.au/seafooddirections/2001/pdf/02.pdf (colors reversed)
CSIRO Resources Futures; presented in 2001 at a conference held in Brisbane

The above graph shows 3 (geometric) scenarios for 3 different ultimate reserve estimates (EUR). The area under the curves represents 1,800 / 2,200 / 2,600 billion barrels of oil (bbls). Approximately 1,000 bbls have been consumed already (being the area under the blue colored, past production curve). Despite the big difference between pessimistic and optimistic oil production estimates (2,600 – 1,800 = 800 bbls, equivalent to **doubling** pessimistic estimates of remaining reserves, there is only a 10 year difference between the respective peaks. In other words: even if the world discovered and produced 800 bbls more than the conservative 1,800 bbls, the oil peak year would move just from 2010 to 2020.

This paradox can be explained by the mechanism of growth in consumption of a finite resource. If the additional oil is used to satisfy a further growth element in demand from now until peak oil, there are 2 effects: the annual world consumption is (a) lifted from 27 bbls pa to 33 bbls pa for the period up to peak oil and (b) dragged upwards for the rest of the declining period over several decades. Therefore, most of that extra oil is produced much later, after peak.

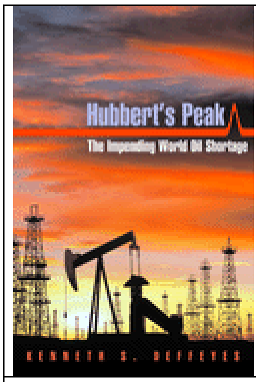
It seems the only way additional oil could help moving the oil peak further into the future (and thus allowing us more time to develop alternative fuel supply systems) would be to cap demand at current levels or even better to reduce it.

Appendix 5: Comparison of Estimates of World Oil Ultimate Recovery (EUR) and the Timing of Peak Oil

Remaining Reserves=Ultimate Recovery - Oil already consumed (around 1,000 billion barrels)

Author	Position/ Organisation	Source of Information	Estimation Method	Estimate Date	Peak Oil Year	EUR [billion barrels]
Albert A. Bartlett	Professor of Physics; University of Colorado	http://www.oilcrisis.com/bartlett/hubbert.htm	Best fit Gauss Curve	1997 (update 2000)	2004	2,000
Colin Campbell	Exploration geologist; Association of the Study of Peak Oil	http://www.peakoil.net http://www.asponews.org (a) regular oil [consumed to 2002: 896 bbls] (b) all liquids [consumed to 2002: 986 bbls]	Analysis of technical data	May 2004	(a) 2000 (b) 2007	(a) 1,900 (b) 2,700
Kenneth S. Deffeyes	Professor Emeritus; Princeton University	http://pup.princeton.edu/titles/7121.html page 158, "Hubbert's Peak", ISBN 0-691-11625-3	Logistic Curve	2001	2005-2009	2,000
L.F.Ivanhoe	Geologist and Geophysicist; Colorado School of Mines	http://dieoff.org/page90.htm Article in NEW FUTURIST Feb 1997: Get ready for another oil shock	Modified Hubbert Curves	1997	2010	2,000
Jean Laherrere	Consultant, Geophysicist, Paris	http://www.oilcrisis.com/laherrere/Copenhagen2003.doc. (a) high demand (b) low demand	Cumulative Discovery and logistic model	2003	(a) 2010-2015 (b) 2020-2025	2,200
	EIA (Energy Information Administration)	http://tonto.eia.doe.gov/FTPROOT/features/longterm.pdf http://www.eia.doe.gov/emeu/plugs/plworld.html Long Term World Oil Supply; Slide No 14 (mean estimate); EUR is resource, not proved reserve	2% growth and decline; Monte Carlo simulation	2000	2016	3,003 (USGS, recoverable resource)

Last update: 16/8/2004

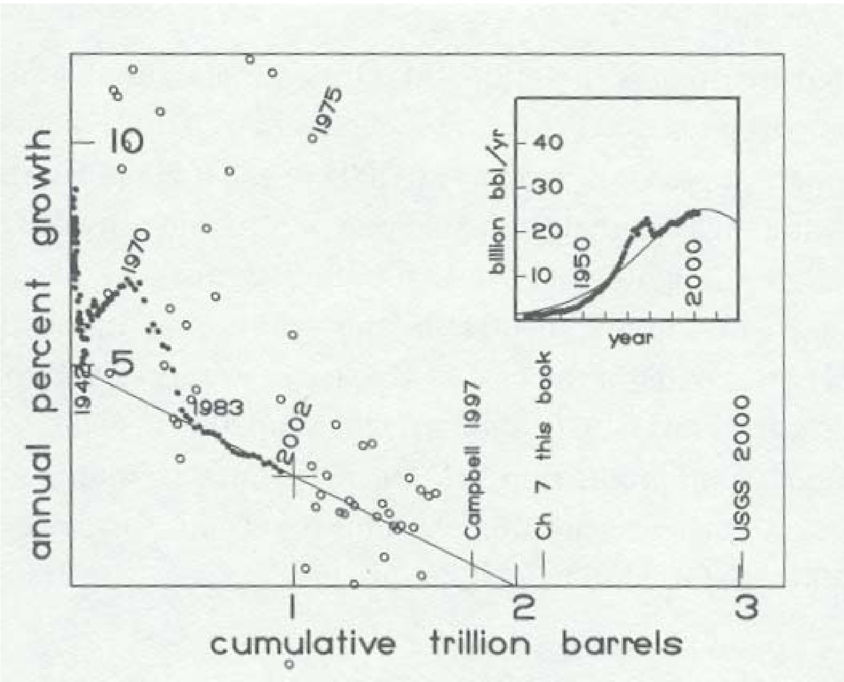


Hubbert's Peak
The Impending World Oil Shortage
Kenneth S. Deffeyes; Princeton University Press, 2001
Paperback ISBN 0-691-11625-3

Kenneth S. Deffeyes conducted research at the Shell Oil research laboratory in Houston and taught at the University of Minnesota and Oregon State University. He joined the Princeton faculty in 1967 and is now Professor Emeritus.

This is a book for those who want to understand the principles of oil & gas geology. You will learn how oil geologists have developed their understanding of when, how much and where oil and gas was formed in the past (oil & gas windows) and how oil engineers improved technology over the last decades to find and produce oil and, even as importantly, where not to expect any oil. You will gain respect for those risking time and money when drilling wells and come to value oil as a precious, finite resource.

Deffeyes plots oil production (solid dots) and discoveries (open circles) in a graph showing annual percent growth versus cumulative oil production (page 157, right). After 1983, a straight-line trend appears, pointing at a total future production of 2,000 billion barrels. Anomalous OPEC reserve additions in the 80s have been removed.



On the same page, Deffeyes writes:
"So when does world oil production peak and start downward? That's the big enchilada. You can use the spacing between the recent production dots and see that two or three more dots will carry us to the plus sign that marks the midpoint. Once we draw that straight line through the year 2002 dot, the logistic curve is fully defined. **The mathematical peak falls at the year 2004.7; call it 2005**. However, I'm not betting the farm that the actual year is 2005 and not 2003 or 2006. The top of the mathematical distribution is smoothly curved, and there is a fair amount of jitter in the year to year production. Remember, the center of the best-fit US curve was 1975 and the actual single peak year was 1970. Similarly, the year 2000 may be the year of maximum world production, and the mathematical midpoint will be 2004 or 2005. **There is nothing plausible that could postpone the peak until 2009. Get used to it.**"

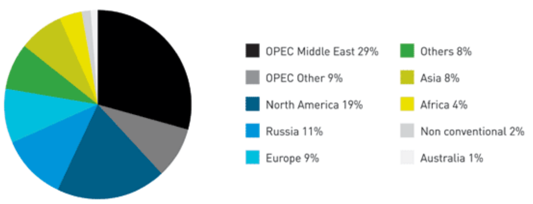
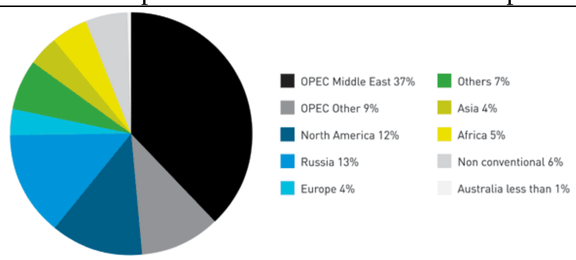
Appendix 6: Analysis of Chapter 7 Energy Security
"Securing Australia's Energy Future": Peak oil not on the government's radar

(1) Inconsistent statements about future global oil supplies

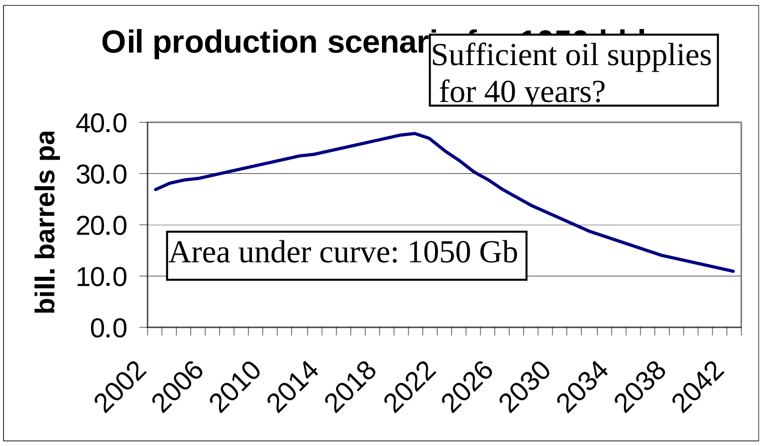
The estimates of oil reserves of 1050 Gb and increasing production up to 2020 are inconsistent with the statement that supplies are sufficient for 40 years, even under the assumption of a reserve growth of 150 Gb up to 2020.

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

World Oil Supplies as seen by the Energy White Paper, June 2004, adopted from IEA Figure 3: Global oil production (page 120)	
2000: Total production 75 million barrels per day	2020: Total production 104 million barrels per day
	
Source: International Energy Agency, World Energy Outlook 2002	

With (a) and (b), a future production scenario over 40 years would look like the graph below. It should be noted that this is just a geometric/numeric scenario, not necessarily feasible from the oil-geological point of view. Reserve additions over and above the 1050 Gb have been included and are fully available at the end of the period otherwise production would drop to zero after year 40.



1 billion barrels = 1 Gb

This simple, theoretical scenario has been modeled with following parameters:

- Production 2003–2042: 1050 Gb (=area under the curve)
- Reserve additions: 5 Gb pa up to 2020 and 3 Gb pa up to 2042
- constant R/P ratio=15 after 2020

The results are:

- Production 2003–2020: 594 Gb
- Reserve additions 2003-2042 equal to remaining reserves in 2042: 150 Gb
- decline rate after 2020: 6.1% pa

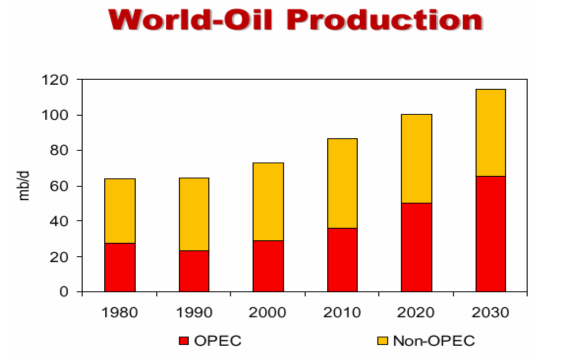
Increase now means steeper decrease later

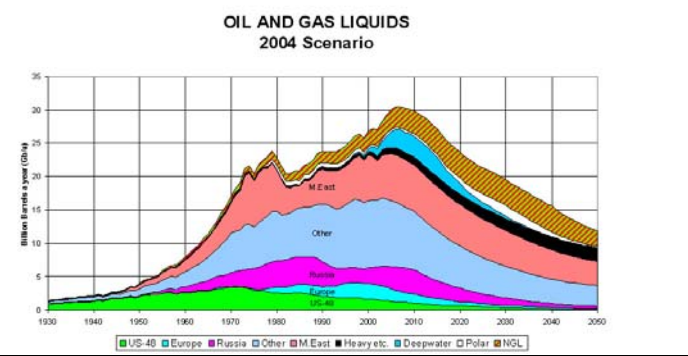
The graph clearly shows that – if production is assumed to increase up to 2020 – oil supplies have subsequently to drop in order not to exceed total reserves. This can only be achieved by a depletion rate of 1/15=6.7 % pa after 2020. **The resulting rate of decline from year to year comes out at 6.1 % shortly after 2020**, easing slightly off to 4.9% in 2042. The sums just don't add up for a sufficient supply for 40 years.

The energy white paper does not elaborate how it arrived at those 40 years but it could be that a simple, but dangerously misleading R/P calculation was done: 1050 Gb / 27 Gb pa = 39 years, suggesting a flat production curve. However, the future production of oil as a function of reserves is non-linear and rather determined by a complex set of parameters including economic, financial, geo-political, technological and, above all, oil-geological factors and must be computer modeled, field by field, using technical reserve and historic production data. The flow of oil in source rock, largely controlled by the laws of fluid mechanics, can only be speeded up by advanced technology to a certain extent, especially after peak oil. Therefore, future production forecasts cannot be forced into any flat or even ever growing demand curves.

(2) The International Energy Agency's Outlook ignores the geological reality of peak oil

2 contrasting outlooks on future oil production





Increasing production to 104 mb/d in 2020 forecast by: IEA, World Energy Outlook 2002	Decreasing production to 75 mb/d in 2020 estimated by: Association for the Study of Peak Oil & Gas in 2004

(3) Colin J. Campbell's critique of IEA World Energy Outlook 2002

The possibility of increasing oil production up to 104 mbpd as forecast by the IEA for 2020 was strongly criticized by oil geologists like Colin J. Campbell at the time the World Energy Outlook 2002 was published. His estimate was 75 mbpd, a substantial difference.

Excerpt from ASPO Newsletter #23 November 2002 (www.asponews.org), with expressly granted permission from the author:

"111. New flawed study from the IEA
The IEA maintains its tradition of publishing flawed information on oil supply in its World Energy Outlook of 2002. This is hardly surprising as it allows itself to be advised by the US Geological Survey and Michael Lynch, and does not, so far as is known, work with the industry database. We may comment on a few highlights.

The IEA defines Conventional Oil to be crude oil, Natural Gas Liquids and natural bitumen. It has supply matching demand, which it estimates will increase at 1.6% a year to 2030. A comparison with ASPO estimates is given in the following table, after adjusting for differing definitions and including processing gains. There is no particular difference to 2010, but thereafter the IEA departs radically to double the ASPO estimate by 2030.

The IEA gives a table of Past Production, Reserves, and Yet-to-Find of respectively 718, 959 and 739 Gb, giving an Ultimate of 2616 Gb. A footnote explains that the Reserves apply to 1996 whereas the Yet-to-Find applies to 2000. Although Past Production is described as "to-date", it evidently also relates to 1996. We can see here the footprint of the flawed USGS study, which related to the period 1995-2025. This Ultimate estimate of 2600 Gb, which is not too unreasonable for all liquids, gives a simple midpoint of depletion of 1300 Gb. Given that production through 1995 was 718 Gb, the midpoint would be reached when 582 Gb more had been produced, which at 27 Gb a year would be around 2016. Peak is likely to come before midpoint, since the heavy oils will not have much impact. This would not be a wildly inaccurate estimate, only six years from the

ASPO estimate, but is inconsistent with the IEA's claim that production would continue to increase to 2030.

The IEA expects that the increase to be achieved by obtaining higher recovery rate, thanks to economic and technological factors. It is noteworthy that it refers to rate not percentage recovered. It implies that production would have to fall like a stone after 2030 to respect the ultimate, but the IEA doesn't address that issue as it lies beyond its time-frame. At the same time, it does confess that "faster depletion will bring forward the time when production peaks", mentioning that the North Sea has done so and is in terminal decline. It also points out that the average age of the fourteen largest fields responsible for one-fifth of world output is more than 43 years, and that the discovery of giant fields has been falling both by size and number.

	2000	2010	2020	2030
Conventional				
ASPO Conventional	**64**	**60**	**46**	**36**
Deepwater	**2.3**	**7.2**	**5.0**	**1**
Polar	**1.1**	**2.0**	**5.9**	**1.6**
NGL	**6.0**	**9.3**	**10.7**	**10.7**
Total	73	79	68	49
IEA	72.2	83.6	95.8	107
Non Conventional				
IEA	**1.1**	**3.0**	**5.6**	**9.9**
ASPO Heavy	**1.4**	**3.3**	**4.3**	**5.0**
Processing Gain	**1.7**	**2.2**	**2.6**	**3.1**
TOTAL – IEA	75.0	88.8	104.0	120.0.
TOTAL – ASPO	76	85	75	58

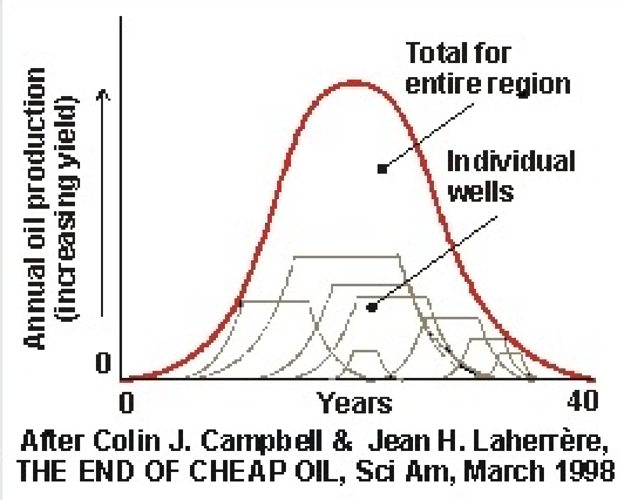
The IEA gives estimates of the above parameters by country. It is noteworthy that Saudi Arabia is given reserves of 221 Gb as of 1996, which is close enough to the current ASPO estimate of 193 Gb, taking into account production of 16 Gb since 1996. It is far less than the 259 Gb claimed by the country. But then, the IEA assigns the country a staggering 136 Gb yet-to-find. Evidently it does not realise that approximately 130 Gb of Saudi Arabia's oil lies in just two fields, Ghawar and Safaniya, found long ago, and that discoveries outside this prime belt have been quite modest, greatly reducing the potential for new discovery.

One can imagine that the economists employed to make these forecasts are well-qualified and intelligent, but lack actual oil company experience or data. They probably rely on published reserve data, as contained in the BP Statistical Review, and take the Yet-to-Find from the USGS. They cannot be expected to understand the practices of oil company reserve reporting, nor grasp the true impact of technological progress. Without access to properly backdated reserve data from the industry database, they can be forgiven for failing to determine the real discovery trend and its devastating implications. The report does, however, demonstrate a certain dim awakening to reality, even mentioning the words "depletion" and "peak", but it continues the long tradition of the organisation in providing grossly misleading and erroneous data and forecasts. It is difficult to exaggerate the damage done to its member countries, which are failing to implement sound energy policies as a consequence. They comprise: Austria, Belgium, Canada, Denmark, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, USA, UK, Japan, Finland, Australia, New Zealand, Mexico, Czech Republic, Hungary, Poland, Korea and Slovakia. Imagine what could be achieved by these countries, if they were to dedicate even a very small fraction of the IEA budget to making a proper study of this critical issue.

Compiled by C.J.Campbell, Staball Hill, Ballydehob, Co. Cork, Ireland"

(4) Peak oil basics

Peak oil was first discovered by Hubbert in the 1950s when he correctly predicted the peaking of oil production for the US lower 48 states in the early 70s. In the meantime his techniques have been modified, expanded and improved by many other oil geologists when applying them to the more complex world oil production.



Idealized, bell shaped production profile showing peak oil. The actual curve of each oil region differs from this theoretical graph but more or less follows this pattern. There are also differences between on-shore and off-shore profiles.

In an unconstrained situation (unlimited demand for oil, no Government interference, sufficient investment capital) oil production in any given region first increases steeply as the largest and easiest fields are tapped first.

When approximately half of the oil is produced, a peak is reached. The output from the first wells plateaus or declines while new wells from smaller fields cannot offset the starting decline which accelerates when the large fields mature and come to the end of their life. The last, ever smaller fields are hard to find, expensive to operate and have low well productivities.

Oil production comes to an end when it takes more energy to produce oil than is contained in the oil itself, irrespective of how high the oil price is.

(5) Understanding oil crisis events

Since the Club of Rome published “The Limits to Growth” in 1972 and the first oil crisis in 1973, the world is aware that oil is a finite resource. However, the role of peak oil in world events and oil crises is not well understood.

(1) 1973 saw the 1st oil crisis, just 2-3 years after the **US oil production (lower 48 states) had peaked in 1970/71**. OPEC, then holding a production share of 38%, used its new market position to punish the US for its support in the Jom Kippur war by imposing an oil embargo which resulted in a 4-fold price increase.
(2) the 2nd oil crisis in 1979/1980, triggered by the fall of the Shah in Iran and the Iraq/Iran war, brought another reduction in ME oil production, thereby exposing the weakness of Non-OPEC countries which at that time could not increase production quickly. **It coincided with the beginning of a plateau in Russian oil production**. Some geologists explain the **collapse of the Warsaw Pact in 1989** with the continued inability of the SU to supply sufficient quantities of oil to Eastern Europe in the 80s which could not import oil from elsewhere due to its non-convertible currencies.
(3) the 3rd crisis is to be expected when **Non-OPEC countries will reach their peak** together. This process seems to have started now, as the North Sea oil is peaking and 18 countries are in decline. The general oil supply/demand situation **is worse now than in 1973 as a substantial 740 Gb of the easy oil have been consumed since then** and demand levels are higher. It should be noted that an oil peak – not a shock event in itself - may stretch over a couple of years till a production decline becomes evident and the world oil supply structure changes.
(4) the next and final oil crisis will happen when the **whole world production peaks**, including all OPEC countries. No one can predict when this will occur, because the true status of reserves and production in OPEC countries is not known (**next intelligence failure**). The condition of FSU oil fields, overproduced in the Sowjet era, is also in doubt. Crisis #3 may merge into #4. Many oil geologists predict that over the next years world oil demand will test supply capacities with spikes in oil prices and resulting successive recessions limiting the growth in demand. World peak oil may not be detected until after the fact.

Appendix 7: Ethanol from sugar cane

Limitations in the use of alternative fuels

(A) How many hectares of sugar cane fields would we need in order 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?
Basic assumptions:

(1) as above
(2) Let's assume 10 million cars in Australia running on E85 engines

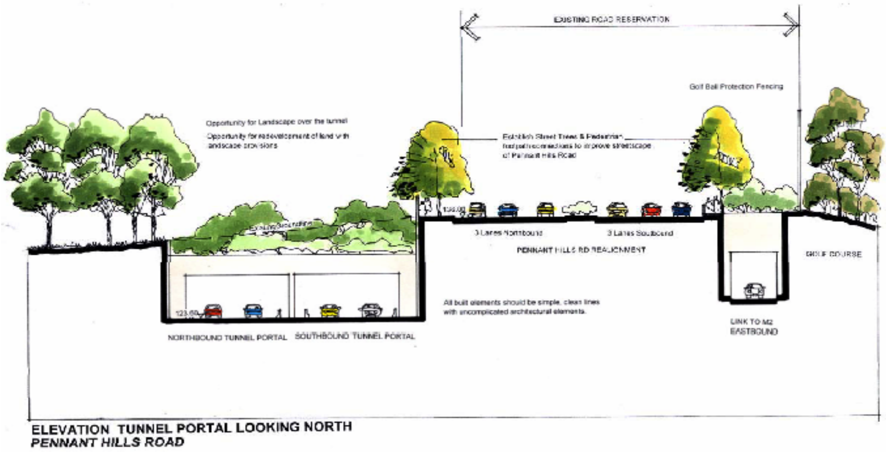
Here we go again:
420,000 ha * 80 tonnes * 1,000 litres / (12.5 tonnes * 52 weeks * 10,000,000) = 5.2 litres/week

Ok, that's no sugar 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. We would also need tanker trains or coastal ships to bring the ethanol down from Queensland. 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 finish off all corals close to our shoreline.
In fact, it is not even clear whether the whole process is worth-wile from the energy balance point of view. 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. Therefore, if we could **reduce our fuel consumption by 38% for good** (e.g. by driving less, building traffic minimizing cities or by switching to public transport) we could instead use the energy needed for ethanol production directly in our cars.

(D) Conclusion: the ethanol example shows the theoretical limitations in the use of one of the alternative fuels. The need for a net energy balance calculation before going into mass production of any fuel also demonstrates which problems we will have in future. Up to now, we have been maintaining energy inefficient activities by just pulling out more fossil energy from our reserves. That will no longer be an option after peak oil. Our biggest challenge will be to find a **renewable fuel with a high enough energy profit ratio to be sustainable over a longer period**. Building new freeways which generate additional traffic until peak oil while not knowing which fuel will drive our cars after peak oil is really not very clever.

Appendix 8: More questions than answers



Artist's view of proposed tunnel and Pennant Hills Rd, F3 to Orbital Link Study, SKM, page 14-19

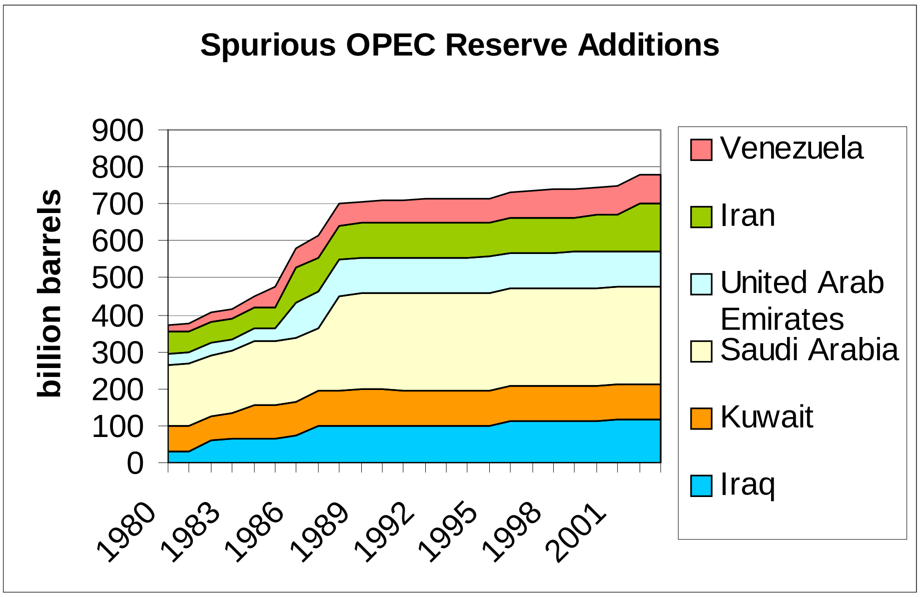
Where will the fuel for all these cars come from in just a couple of years time? This question must be answered before planning new freeways:

- 60% imported oil by 2010 from instable countries with declining oil production after peak oil? Burdening our trade balance? With incalculable implications on the AUS$ exchange rate and interest rates? Sucking away our domestic purchasing power?
- Imported petrol and diesel from Singapore where Australia now competes with China registering 2.5 million new, additional cars on the road every year?
- LPG? Assuming 1 million tons now exported 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
- Ethanol? Requiring 1 unit fossil energy to produce 1.3 units of "renewable" ethanol? And then 5 litres a week per car if we turned all Australian sugarcane into ethanol!
- Electric cars recharged at night in our garages? With our grid going to its knees just from air conditioners in one of the next hot summers? 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? With a first solar panel factory using Australian technology now being built in Germany and not here? Which car manufacturers have 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? In the east of Australia, gas production will already be peaking by mid of next decade. From the west coast? 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.
- Hybrid cars? Yes, if prices come down. But even if all new cars (8% of all cars every year) were hybrid cars, driven economically at 50% of current average consumption, our petrol consumption would go down by 4% pa, just the rate of Australian oil production decline. After 12.5 years fleet turnover we would need another, even more economic engine technology. No Australian car manufacturer sells a car suitable to survive the coming oil crisis. Where is the fuel for traffic growth?
- Fuel cell cars? Using hydrogen, **an energy carrier**, produced from which primary source of energy? Coal? Solar? Nuclear? Even a per mille hydrogen leakage from 700 mill. cars worldwide would have a yet unknown impact on the atmosphere, may be worse than CO_2, we don't know.

Many of the alternatives require huge investments. Peak oil is likely to be followed by a recession with tight budgets worldwide. We now seem to have the last window of opportunity for these investments. Let's **first secure fuel supplies** for vehicles on **existing** roads before we embark on **new** freeways.

Appendix 10.3: OPEC Reserve Additions in the 1980s

In the 1980s, reserves quoted by BP (as reported by Governments) experienced an unusual increase (graph below). This long known fact attracts interest and analysis now as the world starts to look for where the remaining oil is. The UK Government asked for more transparency in OPEC reserve data. In plain English: the world is flying blind as far as OPEC oil reserves are concerned. In Petroleum Review[1)], August 2004, Dr. M.G. Salameh, a consultant to the World Bank and UNIDO, tries to shed light on this question

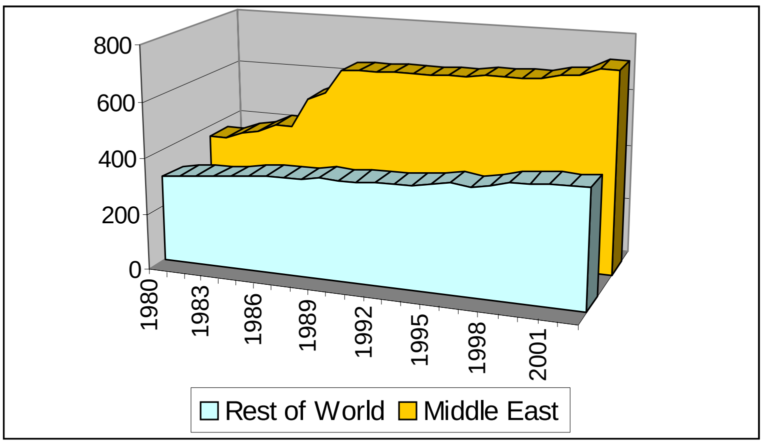


Reserve history in 6 OPEC countries: sudden jump of reported reserves between 1982 and 1988 by 293 bn barrels equivalent to 5 times the initial North Sea reserves. Source: BP Statistical Review World Energy 2004

by calculating that OPEC's reserves at the beginning of 2003 should be **520 bn rather than 820 bn barrels**, based on the following observations:

- there were no exploration or drilling efforts during that period which would have justified the size of the additions
- these are political reserves designed to position each country favourably under quota rules introduced in the early 80s which also included reserves
- upward revisions of earlier, conservative estimates of oil in place - done by oil companies before nationalization - were exaggerated
- the recovery rate applied to the oil in place was increased from 20% to 50% while the world average is rather in the order of 30%
- the reserves could result from the mixture of all of the above

Prof. Kenneth S. Deffeyes from Princeton University comes to similar conclusions



Source: BP Statistical Review World Energy2004

Middle East's implausible reserve history compared to an only slightly increasing reserve curve for the rest of the world caused by rather modest revisions and additions from small new fields (in bn barrels of oil). Another North Sea size reserve was added in 2004 to smaller ME reserves already published in 2003.

1) www.odac-info.org/welcome/documents/SALAMEH-PETREVIEW.pdf

Appendix 11: Web links on oil & gas depletion

Nov. 2001 "The World in 2020: Australia's part in it"
3 different oil production scenarios; The Seafood Directions 2001 Conference, Brisbane,
http://www.asic.org.au/seafooddirections/2001/pdf/02.pdf

Jan 2002; Matt Simmons; The World's Giant Oilfields, Hubbert Center Newsletter 2002/1
http://hubbert.mines.edu/news/Simmons_02-1.pdf.

Mar 2002: Former Woodside Petroleum CEO Akehurst on Australian oil decline:
www.woodside.com.au/NR/Woodside/ investorpack/SG3682_3_ABARE.pdf

Apr 2002: State Sustainability Strategy by Brian J. Fleay (Murdoch University) with a focus on the net energy yield of primary energy sources and including an appendix "A lot of gas, but not much oil: visions, fantasies and reality"
www.sustainability.dpc.wa.gov.au/docs/submissions/Brian_Fleay.pdf

May 2002: Matthew Simmons: „Depletion and US Energy policy", International Workshop on oil depletion, Uppsala Sweden
www.oilcrisis.com/aspo/iwood/simmons_depletion.pdf

Jun 2002: Bruce Robinson on Australia's oil vulnerability
www.stcwa.org.au/beyond**oil**/Aust_OilVulnerability.pdf

Oct 2002: CSIRO's „Future Dilemmas" highlighting serious physical constraints in Australia's economy:
www.cse.csiro.au/research/Program5/futuredilemmas/

Jan 2003: "Natural Gas – Magic Pudding or Depleting Resource" by Brian J Fleay describing how current projects in the Carnarvon basin will deplete their reserves to 75% by 2025:
www.oilcrisis.net/fleay/WA_GasFutureRevised.pdf

Feb 2003: Matt Simmons, Mahmoud Abdul Baqi, Nansen Saleri, "Global Oil supply: are we running out?" CSIS flyer for forum
www.csis.org/press/ma_2004_0224.pdf

May 2003; ASPO workshop, Paris
Matthew Simmons presentation: "Is the glass half full or half empty"; file "ASPO (B&W).pdf"

May 2003; Matt Simmons' address to the 2nd International Workshop on oil depletion, Paris
www.peakoil.net/iwood2003/MatSim.html

Feb 2004: “Future of Global Oil Supply: Saudi Arabia”, Conference at the Center for Strategic and International Studies, Washington
Matt Simmons: Slide show „The Saudian Oil Miracle“
www.csis.org/energy/040224_simmons.pdf
Abdul Baqi and Nansen Saleri: “50 year crude oil supply scenario, Saudi Aramco’s perspective”
http://www.csis.org/energy/040224_baqiandsaleni.pdf

Apr 2004: Samsam Bakhtiari’s WOCAP model cannot be simulated to peak after 2008 (article in the Oil & Gas Journal):
www.stcwa.org.au/BO2/Bakhtiari-O&GJ-April%202004.doc

May 2004: ASPO conference in Berlin
http://www.fromthewilderness.com/free/ww3/062104_berlin_peak.html

Jun 2004: Federal Government's energy white paper "Securing Australia's Energy Future" http://www.dpmc.gov.au/energy_future/

Jul 2004: International Energy Agency Workshop in Rio; K. Rehaag, editor of the monthly oil market report, asks the question “Is the World Facing a 3rd Oil Shock“ and notes that 70% of oil fields are in decline:
www.iea.org/dbtw-wpd/Textbase/speech/2004/kr_**rio**.pdf

Aug 2004: Dr. M.G. Salameh’s article in Petroleum Review „How realistic are Opec’s proven oil reserves?“, reminds us of OPEC’s 300 Gb of paper oil, a legacy of their internal quota war:
www.odac-info.org/welcome/documents/SALAMEH-PETREVIEW.pdf

Aug 2004: Chris Skrebowski’s article “Depletion now running at over 1 mb/d” in Petroleum Review, pages 42-44
http://www.odac-info.org/bulletin/documents/DepletionAnalysis.pdf

Sep 2004: Center for Strategic and International Studies, Washington, PFC Energy’s “Global crude oil and natural gas liquids supply forecast” including lists showing oil depletion levels in many countries.
www.csis.org/energy/040908_presentation.pdf

Sep 2004: Matthew Simmons: “Twilight in the desert; The Fading of Saudi Arabia’s Oil”; Hudson Institute, about water injection and future tertiary recovery in maturing Saudi fields
http://www.simmonsco-intl.com/files/Hudson%20Institute%20September.pdf

Sep 2004:Andrew McKillop: Economy restructuring and peak oil
http://www.vheadline.com/readnews.asp?id=22903

Oct 2004: Chris Skrebowski: A remarkable presentation in Washington; ASPO Newsletter #46; Revision of OPEC reserves on the basis of PFC Energy’s “Global crude oil and natural gas liquids supply forecast” published by the CSIS
http://www.asponews.org/docs/newsletter46.pdf