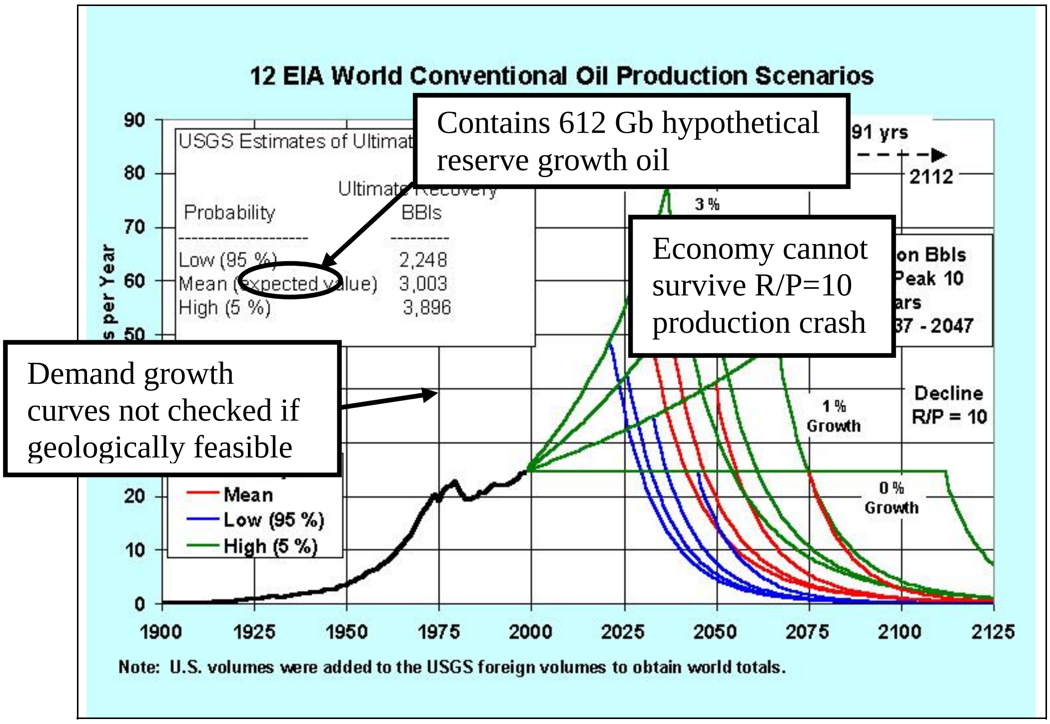
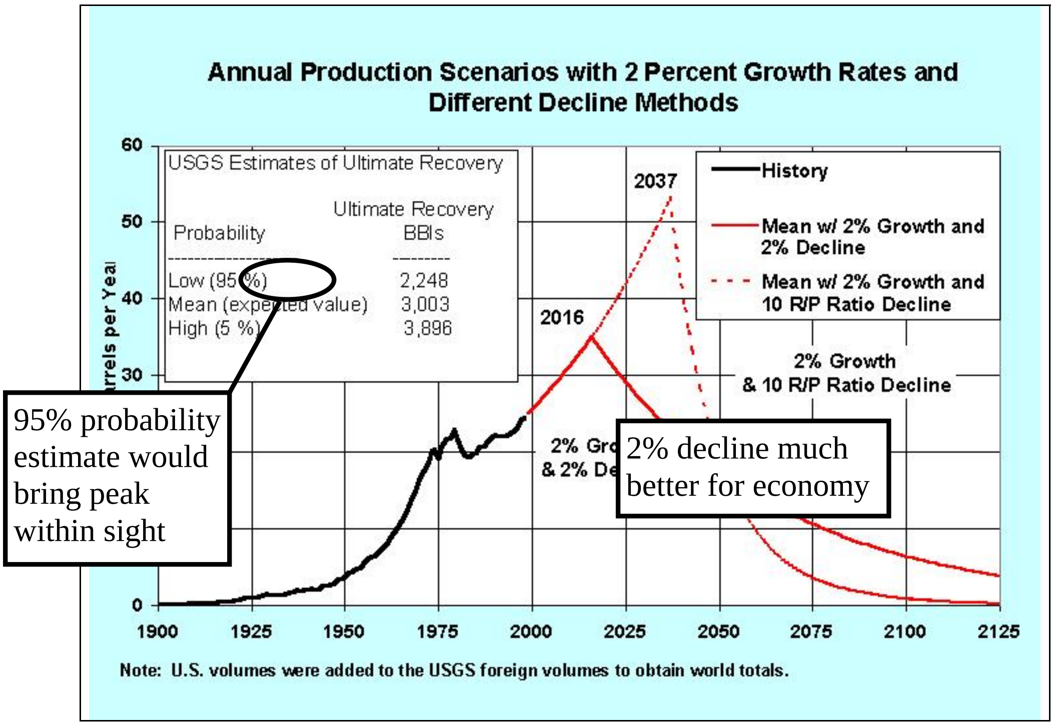
Lessons from EIA Scenarios

Using USGS oil recovery estimates





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(1) Introduction

There are Government departments who rely on oil supply scenarios from the American Energy Information Administration (EIA) in order to find the most likely period for peak oil. They pick from the available scenarios one which puts peak oil between 2030 and 2075, thereby conveniently pushing the issue far into the future. This allows them to argue that several decades down the track new energies and technologies are in place to substitute oil and that therefore there is no reason to change current business as usual policies.

The Federal Government's energy white paper states that "there are sufficient reserves to supply world demand for around 40 years" without presenting any details how that statement was arrived at. But we also find in this policy document following qualifying sentence: "In the longer term, concerns also exist about the longevity of oil supplies". Again, no further details are given and the reader is left guessing what 'long term' means in number of years. So will scenarios help?

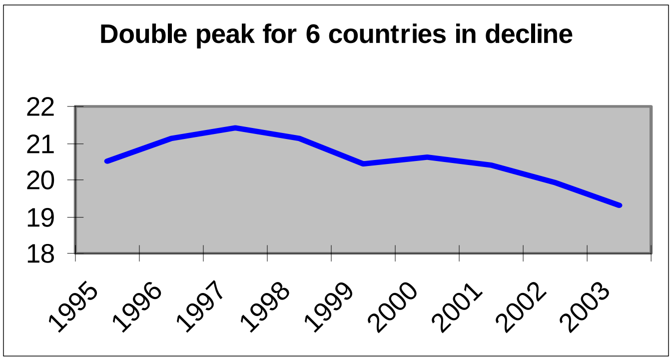
This paper describes how scenarios work generally, traces the selection process for the above peak scenario 2030-2075, finds its assumptions and limitations, checks on the validity of oil resources used in the scenarios and comes to some unexpected conclusions.

What do we want to know?

We are thriving to get reliable answers to following burning questions:

(1) In which period is peak oil likely to happen?
(2) What will be the oil production decline rates after peak oil?
(3) Which action and when has Government to take to prepare our economy for permanently declining oil production? What is the critical path for such preparations? Are there points of no return?
(4) Which risks are involved if assessments under (1) - (3) are incorrect?

Definition: peak oil is the global peaking of oil production, possibly with more than one peak and intermittent growing & declining production phases stretching over a certain period (plateau). The last of this series of peaks or the end of the plateau will be the beginning of the terminal decline, which will only be discovered a certain time after it has happened.



Zoom on the production curve > 18 Gb pa for the US, Venezuela, UK, Norway, Nigeria and Indonesia

Peak oil is not a doomsday event in itself. Human ingenuity will find solutions but society's effort must be planned & organized well ahead by Government before the crisis starts. Those countries, regions, cities will be ahead of the rest who prepare in advance.

Answers to the above questions should

i. Be on the safe side and free from wishful thinking
ii. Be based on a thorough and unbiased analysis of various data and report sources from all sides of the peak oil debate
iii. Reflect the latest international understanding of oil resource and depletion issues
iv. Establish a mechanism to continuously update findings from ii. And iii.

Now let us see whether scenarios prepared by the Energy Information Administration (EIA) can contribute towards answering at least questions (1) and (2) above.

(2) Relevant documents to be studied

The EIA web site leads us to following documents, which form a report hierarchy:

Organisation/authors	Year	Report type Methodology Strength/Weakness
(a) Long-Term World Oil Supply Scenarios The Future is Neither as Bleak or Rosy as some Assert Paper by Wood/Long/Morehouse	4/2003	Opinionated extract of (b) No new research data added
(b) Long Term World Oil Supply (A Resource Base/Production Path Analysis) EIA slide show presented at AAPG	7/2000	Oil Production Scenarios based on simple algorithm. No oil geological forecast. Future oil estimate from (c.)
(c) US Geological Survey World Petroleum Assessment 2000 Data normalized to 1/1996	4/2000	Oil geological assessment Contains hypothetical 612 Gb of reserve growth oil; no production forecast
(d) USGS World Petroleum Assessment and Analysis by C.H. Masters of 1994	1994	Idea of reserve growth rejected

(3) The peak period selection process

The starting point is a 7 page paper entitled "The Future is Neither as Bleak or Rosy as some Assert", published in April 2003 by Wood/Long/Morehouse and available on www.eia.doe.gov which we find to be an opinionated extract from an EIA slideshow called „Long Term World Oil Supply (A Resource Base/Production Path Analysis)" released in July 2000.

A cursory look at the summaries of the Wood paper and the slide show reveal a marked difference in the assessment of the most likely peak oil period:

> The slide show from 2000 summarizes in slide 3&4 that ***"conventional oil production may increase two decades or more before it begins to decline"*** and qualifies that ***"the choice of different production curve hypothesis … could change the results, perhaps substantially"***
>
> John H. Wood believes in 2003 that the world production peak ***"will be closer to the middle of the 21st century than to its beginning"***.

We try to find in Wood's paper a properly sourced reference to new research or a presentation of his own research work, which could have justified his later peak period. There is none. We come back to that later.

> Problem #1: So we have, based on the same data and from the same organisation, opinion against opinion with a difference of 30 years. Something is wrong here.

We find that all tables and graphs in the Wood paper are from the slide show and we continue therefore with EIA's original "Long Term World Oil Supply". The Federal Government adopts a reasonable middle of the road approach and selects from following table with 12 scenarios the peak period 2030 to 2075, using the USGS mean estimate of oil recovery.

WORLD OIL PRODUCTION SCENARIOS

Probability of Ultimate Recovery	Ultimate Recovery (Billion barrels)	Annual Production Growth Rate (Percent)	Estimated Peak Year	Estimated Peak Production Rate (Million barrels per year)	Estimated Peak Production Rate (Million barrels per day)
95 Percent	2,248	0.0	2045	24,580	67
	2,248	1.0	2033	34,820	95
	2,248	2.0	2026	42,794	117
	2,248	3.0	2021	48,511	133
Mean (expected value)	3,003	0.0	2075	24,580	67
	3,003	1.0	2050	41,238	113
	3,003	2.0	2037	53,209	146
	3,003	3.0	2030	63,296	173
5 Percent	3,896	0.0	2112	24,580	67
	3,896	1.0	2067	48,838	134
	3,896	2.0	2047	64,862	178
	3,896	3.0	2037	77,846	213

Slide #20 (left) from the IEA slide show with 3 USGS oil recovery estimates

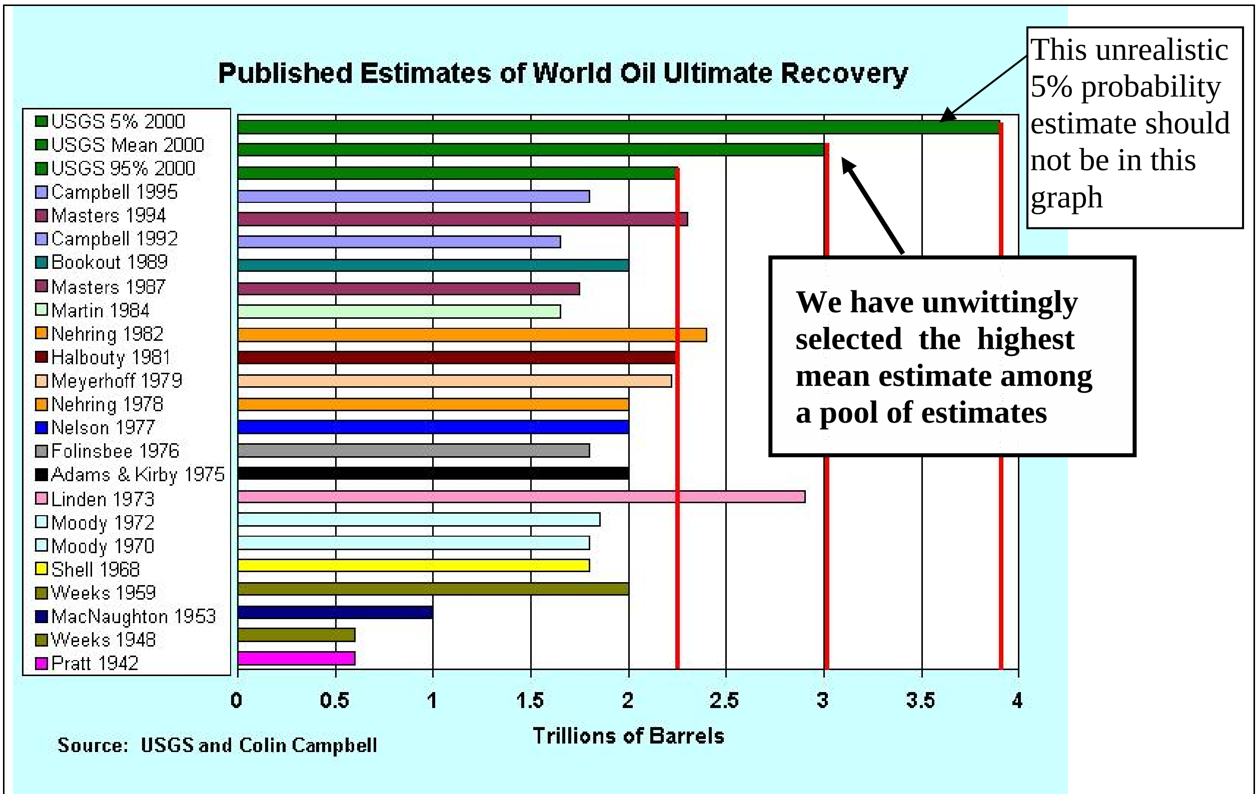
At first sight, it is reasonable to select the mean estimate suggesting that these peak periods are a 'middle of the road' approach.

But the 5% probability estimates is really very unrealistic so that these later periods are actually not available for selection.

We keep in mind that this option is rather on the high side then.

A selection of peak oil years 2030-2075 seems to suggest to the unsuspecting reader that the most likely period will we somewhere in the middle of this range around, say, 2050. So this was possibly Wood's view. But we have become suspicious and are now digging deeper to find out what's going on.

In order to get some orientation where we are with this USGS 2000 mean estimate, we have a look at a comparison with other estimates as presented in the graph below, also from the EIA slide show.



Source: EIA Long Term World Oil Supply, slide No 9

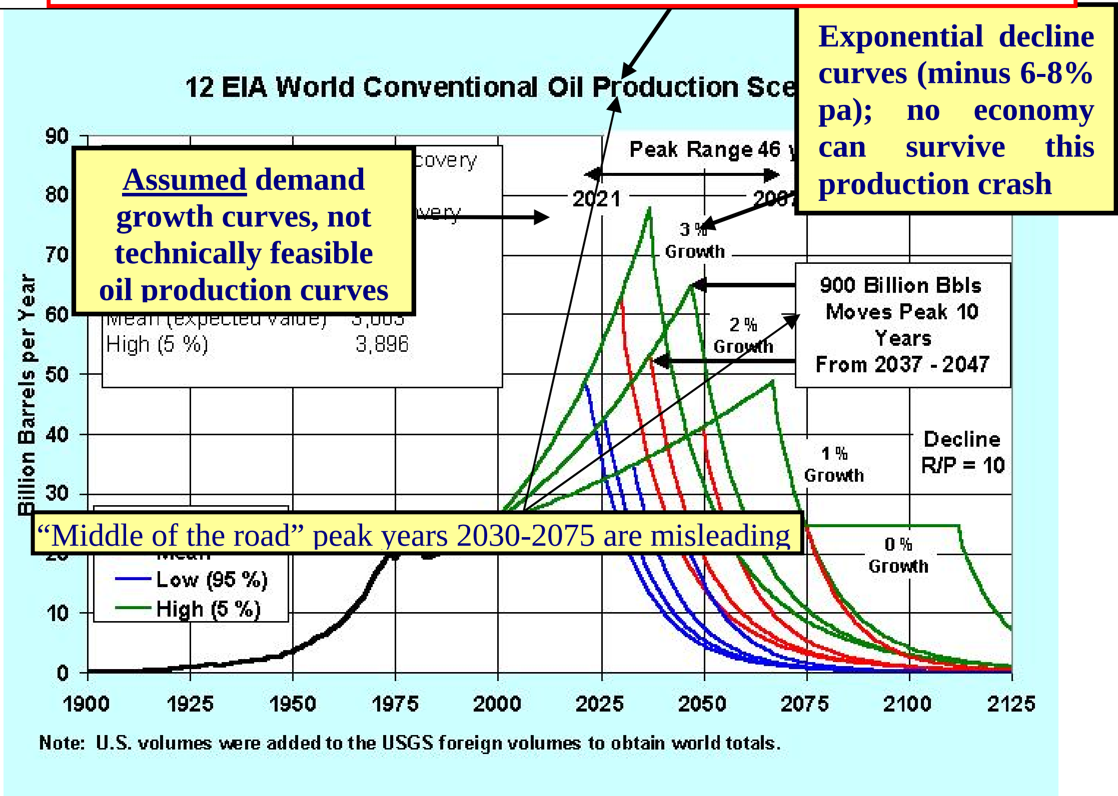
It is to be noted that the 5th estimate in this bar chart was done by a previous project director of the USGS, C.H. Masters in 1994, before the year 2000 study was published. His figure more or less corresponds to the 95% probability estimate of his successor.

Problem #2: Before using the USGS 2000 mean estimate, Government has to analyse why the USGS increased its mean estimates, especially since all other estimates are lower and therefore on the safer side.

Picking peak years from a table is not enough. Let's see how the production curves look like for these peak years. They are shown in EIA's slide 19. There are 12 rather theoretical production scenarios (not oil geological forecasts) assuming

1. four different demand growth curves (flat, 1%, 2% and 3% of **exponential growth**)
2. three different estimated ultimate recoveries (EURs): a low 2248 Gb with a 95% probability, a mean 3003 Gb and a high 3896 Gb with a -5% probability
3. a decline curve along a constant ratio of Reserve/Production = 10, meaning that in every year after peak oil, 10% of the remaining reserves is being produced, plus some reserve growth

If oil production can grow at x % pa **and if** the world's ultimate recovery of oil is y Gb, **then** peak oil occurs in year T, **assuming** an R/P ratio of 10 after the peak so that the ultimate recovery is respected.



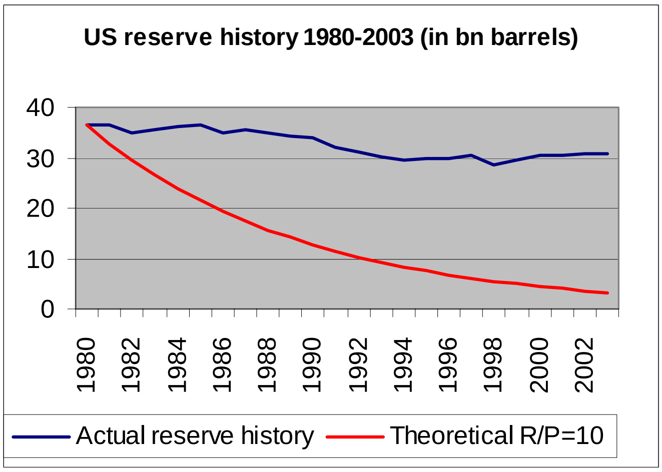
These are hypothetical scenarios, based on exponential growth and decline functions, not oil geologically and technically feasible oil production forecasts. They are of the format:

Source: EIA Long Term World Oil Supply, slide No 19

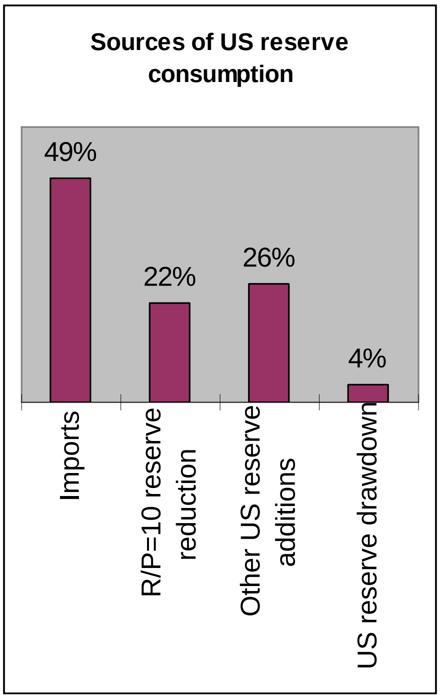
We really must understand what these scenarios do. They take the total ultimate recovery (EUR) and distribute it **freely – without regard to different oil depletion levels and profiles of different types of oil from different geological basins - with the aim to fit all oil under a growing demand curve given by economists.** It is a mathematical exercise at the level of HSC Math 3 unit and has nothing to do with the oil geological reality of discovering, producing and supplying oil.

The peaks are all followed by a sharp decline curve along an R/P value of 10, a figure which is obtained from the US experience and applied to the world by the EIA. The slide show (slide 15) argues as follows:

"The reason for setting R/P equal to 10 is based on the United States experience. The United States is a very mature producing country and has had an R/P ratio between 8 and 12 for the past 50 years. The R/P ratio was around 12 in the 1940's and 1950's, dropped below 10 in the 1960's, was around 8 in the1970's and 1980's and has been around 10 in the 1990's. Therefore, a world R/P of 10 seems a reasonable assumption to reflect a mature state of world oil production, as it does for the United States



The above graph shows how US 1980 reserves would have declined along a path of R/P=10. The reserve consumption under this curve was only 22% of the total, with other reserve additions and massive imports obscuring the real impact of such a decline.
Source of Data: BP Statistical Review of World Energy 2004



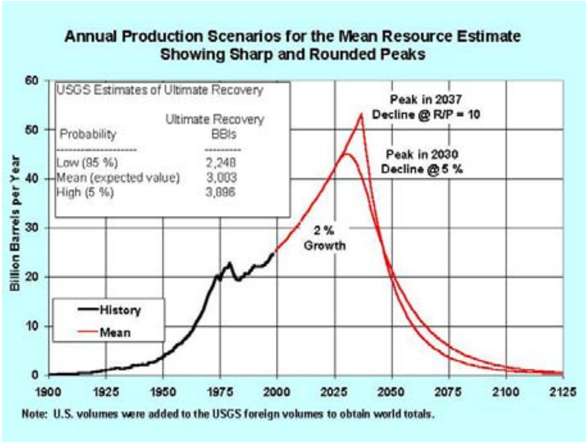
During the above mentioned decades, America experienced a 'reserve growth' mainly because of its reserve reporting system. When US oil fields are first being developed, SEC rules make sure that only conservative "proved' reserves are reported. Later, when more details are known about the field from practical production experience, more oil is found in and around the field, adding "probable" and "possible" reserve categories to proven reserves which are then updated.

This reserve growth has masked the otherwise disastrous effects of an R/P=10 which would mean a halving of production in just 6.5 years. It is more than doubtful whether the world, at the time after the global peak, would experience a similar reserve growth as in the US. Moreover, the US survives only with massive oil imports. The world, of course, cannot import oil.

Problem #3: We find that all 12 scenarios imply permanent decline rates of 6-8% after the global peak, rates which are certain to kill the world economy. These scenarios are in fact undesirable.

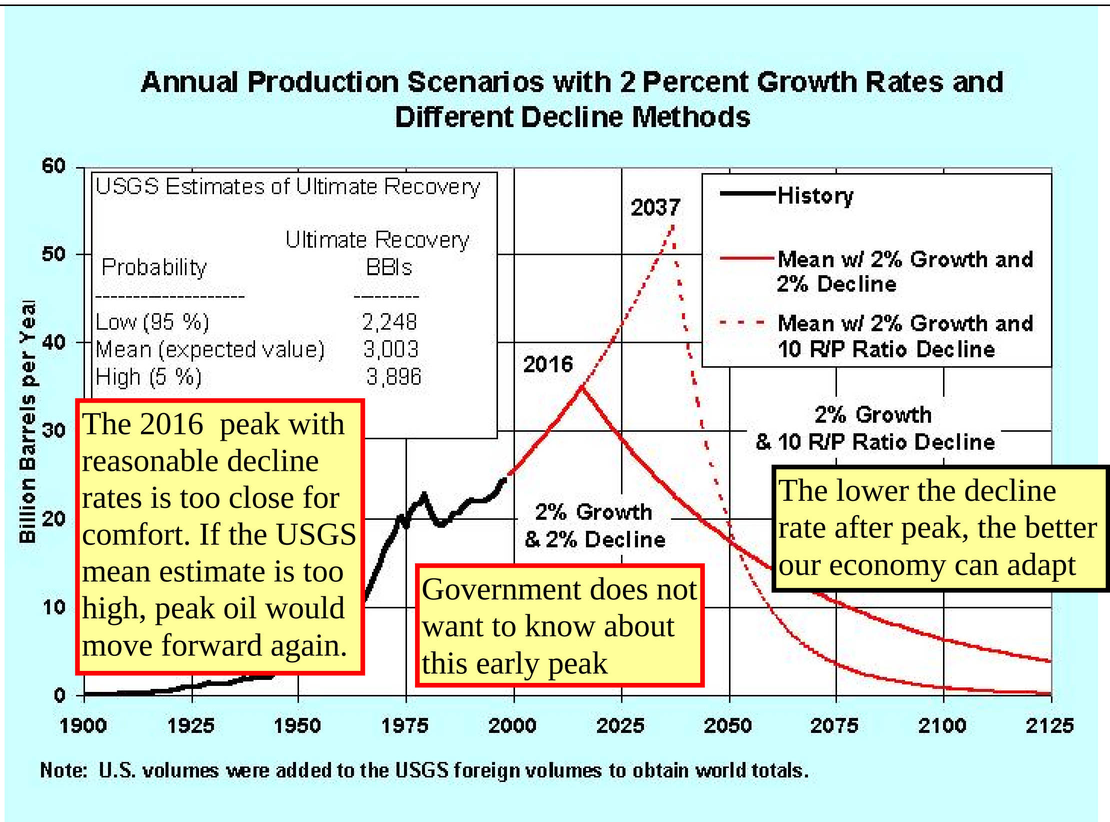
The authors of the slide show noticed of course that their scenarios with sharp peaks were somehow unrealistic. Just think of the down stream facilities. Not a single new refinery, not a single additional tanker would be built shortly before the first selected date around 2030, for a temporary peak capacity of an unbelievable 10 billion barrels pa, which would be required for a short period of less than 10 years

Therefore the slide show added another scenario with a rounded peak, bringing forward a pointed peak in 2037, for example, by seven years to 2030 (graph, right). The decline rate would be 5% pa.



Apply that same technique to a 2030 sharp peak and you could get quickly to a rounded peak around 2025. Source: EIA dto, slide 18

In order to avoid a R/P=10 production crash after peak oil, the decline curve must be flattened by producing more oil later which means bringing the peak production level down and the timing of peak oil forward. This would also be more realistic in terms of actual, physical production capacities (which is a total separate issue again and being discussed further down outside the line of scenario arguments here). So we have to look for scenarios with a lower decline rate. It’s there, right in the EIA slide show (slide #15), with a decline rate of 2% pa.



Source: EIA, dto, slide 15

We see now why in the previous 12 scenarios an R/P=10 was taken to define the decline rate. The higher the decline rate after the peak the later one can push peak into the future. We also understand now why the word “may” was used in the slide show summary.

Problem #4: One would be blind not to see this as a hidden warning. The Wood paper just ignored it. That’s one reason why there is that 30 year difference mentioned above

We conclude:

- The selection of peak years is highly sensitive to input parameters. One must be fully aware of its implications
- The peak years after 2020 will be inevitably followed by a sharp decline in oil production after the peak which will seriously damage the world economy
- A more survivable decline rate of 2% after the peak will move the peak to 2016, a year so close that we must have a more detailed look at the USGS 2000 mean estimate.
- The above scenarios cannot tell us when peak oil will happen but rather warn us what we should avoid, if oil production can indeed grow.

Compare the peak year 2016 with the time needed to introduce locally manufactured hybrid cars (very tight schedule). Saving: 4% fuel pa.		
Time for Government to act	1 year	2006
Australian car manufacturers to introduce hybrid models	3 years	2009
Mandatory transformation of car fleet: all new car sales (at 8% pa) to be hybrid	12.5 years	2021

How come it is so easy to change peak oil years in these scenarios? Because we have to do with exponential functions of growth $(1+\text{growth rate})^{\text{years}}$ and decline $(1-\text{decline rate})^{\text{years}}$ against a finite resource base. These sorts of functions are very sensitive to small changes, which accumulate to big differences over a long time (similar to the effects of compound interest rates).

So what is the lesson from these theoretical scenarios?
Assume

(1) the optimistic USGS mean estimate of an EUR=3003 Gb is correct,
(2) a growing oil production until a peak year is physically feasible

(A) THEN every peak year later than 2016 would result in decline rates after peak oil greater than 2%, rates which would damage our economy, especially if our economy and our transport systems are sliding into peak oil unprepared with current BAU policies.

(B) The 1st peak year 2030 (rounded in 2025) and every later peak would result in a 6-8% pa production crash which no economy would survive

(C) All later peaks after 2030 would be even more disastrous as we would build up high capacity oil supply systems (no longer needed after the peak) and allow our economies and physical structures to be designed and built for high oil consumption levels (no longer be maintainable after the peak)

Problem #6: In conclusion, the scenarios demonstrate that we **actually should not allow oil consumption to grow much higher, with later peaks**, as these would be followed by inevitable, precipitous oil production declines. This is just the opposite of what many wish to happen who want the problem to go out of the way and into the future.

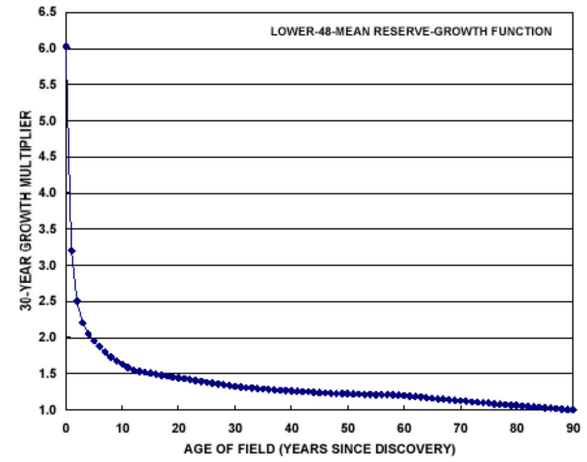
(4) USGS 2000 mean estimate

Since the 2016 scenario is quite close, we have to analyse the USGS 2000 mean estimate, which is an update of an earlier USGS study by C.H. Masters done in 1994. It is not a production forecast but a resource analysis. We find that the USGS 2000 team added a new category of oil called **'reserve growth'**.

As already mentioned, this is a reserve reporting phenomenon found in America where early, conservative estimates ("proved reserves") according to SEC rules were later consecutively revised upwards as reserve categories "probable" and "possible" were developed and produced. Only 6% of US reserve additions over the past 20 years came from new discoveries.

The USGS developed a reserve growth function (right), based on the experience in the lower 48 states, in which 30-year growth multipliers depend on the age of the fields.

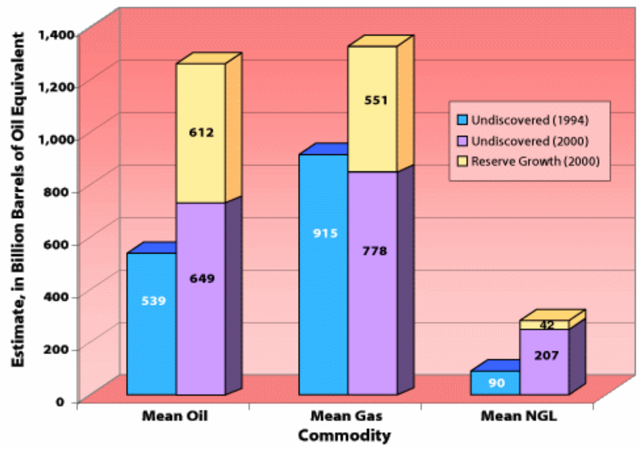
These US multipliers are now being applied to the known fields of the rest of the world though reserve reporting is different there. The aggregate formula is: (859 Gb reserves + 539 Gb past production) x 0.44 = 612 Gb of additional reserve growth oil.



From Table 1 of the USGS 2000 Executive Summary:

	Oil			
	Billion Barrels			
	F95	F50	F5	Mean
World (excluding United States)				
Undiscovered conventional	334	607	1,107	649
Reserve growth (conventional)	192	612	1,031	612
Remaining reserves*				859
Cumulative production*				539
Total				2,659
United States				
Undiscovered conventional	66		104	83
Reserve growth (conventional)				76
Remaining reserves*				32
Cumulative production*				171
Total				362
World Total (including United States)				3,012

All figures normalized to 1995



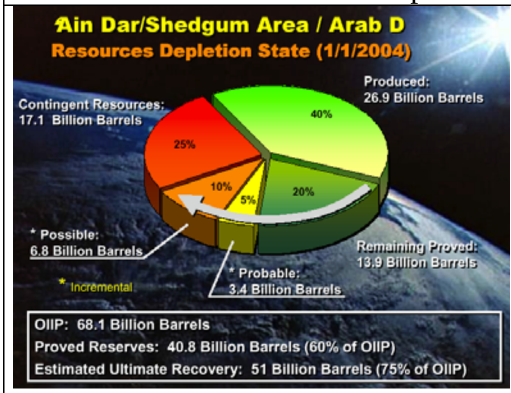
Comparison of 2 recent USGS estimates for the world (excluding US) in these column pairs: left: USGS Masters 1994; right: USGS 2000

The USGS 2000 study adds an extra 612 Gb of oil for reserve growth outside the US, increasing the undiscovered oil plus remaining reserves by 40%. It's almost like the biblical miraculous fishing.

The USGS Masters study had rejected the idea of an excessive reserve growth for the rest of the world: "we assume that many other countries are, in fact, reporting, effectively, an Identified Reserve (Proved + Probable + Possible Reserves) or some major part thereof. In particular, this is considered to be true for all OPEC countries, the Former Soviet Union (FSU), China, and Mexico. The sum total of these major producers accounts for more than 90 per cent of world oil reserves; therefore, we have some confidence that the world value herein reported for Identified Reserves is a reasonable maximum value for known fields and greatly exceeds reserves developed for production."

The following table shows a calculation of reserve growth using various interpretations of unreliable OPEC reserve data. The differences are huge.

Example of USGS reserve growth calculation



Let's have a look at this Saudi oil field (left).

oil categoryGb
produced 26.9 40%
remaining
proved res.13.9 20%
probable 3.4 5%
possible 6.8 10%
contingent17.1 25%
oil in place68.1100%

The reserve growth would be 'probable' plus 'possible':
3.4 + 6.8 =10.2 Gb

or 10.2/(26.9+13.9)=25%
of past production and remaining reserves.

The USGS would calculate: (26.9+13.9) x .44=18 Gb or 80% more than actually available.
Since the OPEC reserve reporting is not clear, there are 2 more possibilities:
If the Saudis include 'probable' and 'possible' in their published reserves , the USGS reserve growth calculation would be: 51 x .44 = 22 Gb
If the Saudis report total reserves ever found instead of remaining reserves, the USGS formula would yield: (40.8+26.9) x .44 = 30 Gb.
What an unreliable number game! And these would be calculations yielding 612 Gb for the rest of the world outside the US.
Source of graph: www.csis.org/energy/040224_baqiandsaleni.pdf

The USGS 2000 team was fully aware of this methodology problem and writes in report RG, page 4: "The forecast of world potential reserve growth described here is considered to be preliminary. Much work remains to be done on the subject of world potential reserve growth. The present study is an attempt to provide a numerical hypothesis for world potential reserve growth that is valuable in itself, and will perhaps act as a stimulus for discussion and research aimed at reducing the uncertainty of world reserve-growth estimates."

(5) USGS 95% probable estimate: safety for super-annuation funds

Now let us go just one step further. For sure we all want our super-annuation funds to re-invest our savings safely. We would insist there to be a 95% probability for good returns, not just a mean probability. A lot of super annuation funds have invested in toll ways, airport extensions and other oil dependent infrastructure. They continue to do so, relying on a statement in the Federal Government's energy white paper called "Securing Australia's Energy Future" that there are 40 years of sufficient global oil supplies.

To be on the safe side we would now have to rather take the USGS 95% estimate. Then we are very close to the other estimates and peak oil would move again forward.

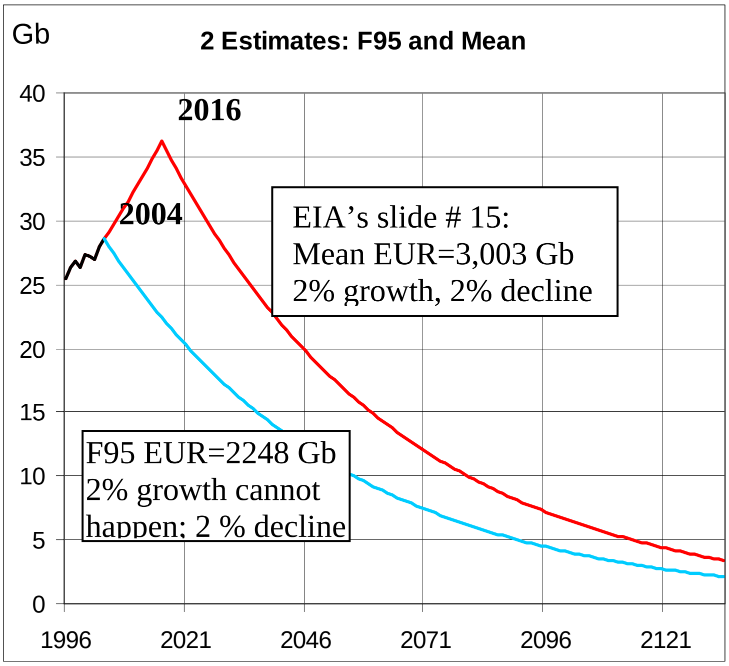
Problem #7: The Wood paper does not refer to or contain any quantitative research work which would clarify the size and status of these 612 Gb of reserve growth oil as was asked for by the USGS.

Assume a safer USGS 2000 EUR=2248 Gb with a 95% probability of occurring, there would only be 2 scenarios:

(1) A 'rounded' peak for 2-3% growth scenarios at the end of the next decade or around 2020, followed by that dreadful 6-8% decline, which is also not in the interest of investors.

(2) A 2% growth up to the peak and then a 2% decline path starting before 2016. When would it be?

Of course the EIA slide show did not include scenario (2) but it is straightforward to do. We start with 2248 Gb, deduct the past production, enter oil production data from BP up to 2003 in a spreadsheet, and then, in an iterative process, find the peak year with cumulative production not to exceed the available resources.



Believe it or not, a combination F95 EUR=2248 Gb, 2 % growth and 2 % decline will not even enter the growth part of the production curve and starts declining right in 2004.

We have clearly reached the limitations of scenarios with this parameter game. But again we can conclude: if oil production continues to grow from now on, the decline rate must be higher than 2% at some later stage if we follow the logic presented in EIA's slide #15.

Thanks god, non-conventional oil and NGLs (which are not included in the EIA slide show) come to the rescue, but for how long?

In summary, Government has – without knowing any details - selected peak oil years 2030-2075 from hypothetical scenarios disregarding the reality of oil production and based on USGS estimates containing a hypothetical amount of reserve growth oil, the approximate equivalent of 10 North Sea sized provinces. The EIA had not checked in detail whether this oil is really available though it was advised by the USGS 2000 team to do so.

Assumed growth curves in that selection would result in a production crash after the global peak which could not be survived by even the strongest economy in the world.

We found another EIA scenario – a hidden warning - which shows a 2016 peak with a more survivable 2% decline which means that any peaks after 2016 would result in decline rates greater than 2%, a big danger for our economy.

If the USGS mean estimate is too high, only peak years before 2016 would allow decline rates to be 2%.

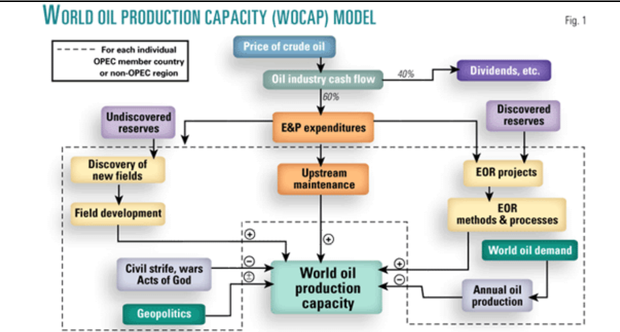
If we took the 95% probability USGS estimate to make super annuation investments in oil dependent infrastructure safe and allowed a 2% decline path which would be survivable with a big effort and proper preparation, there wouldn't be any room for growth at all and the peak would be right in front of us.

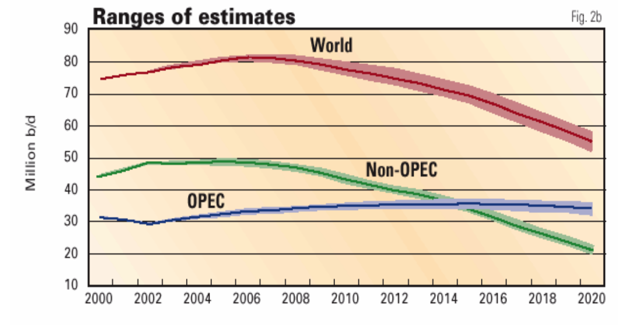
These are the only logical lessons we can learn from these scenarios.

One step further

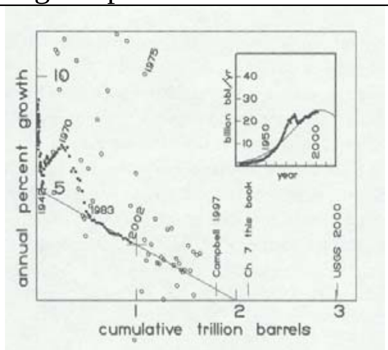
(6) Back to Square One: other forecasts

Since the scenarios tell us what should rather not happen, we have to turn to other methods of how to determine the timing of peak oil: the study of various oil production forecasts and an analysis of the oil supply situation for the next years.

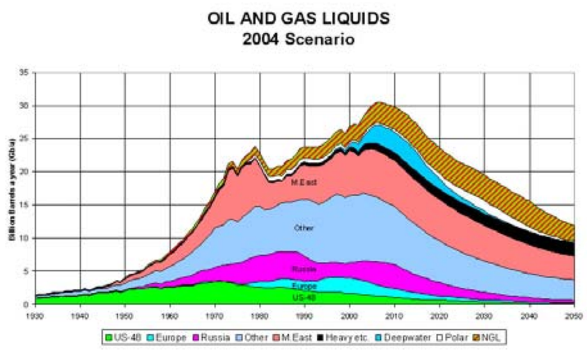




S.Bakhtiari's simulation model (up, left) uses various economic, financial and geological parameters to simulate oil production. Different assumptions for these parameters result in a range of production forecasts as shown in the graph (up, right). **Peak is around 2008.**

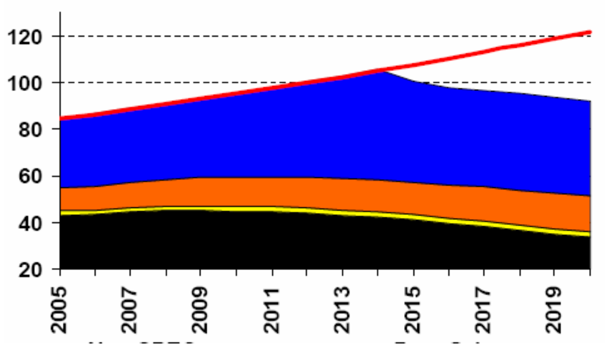


K.S. Deffeyes, who published the book "Hubbert's Peak", writes on page 158: "The mathematical peak falls at the year 2004.7; call it 2005. However, I'm not betting the farm that the actual year is 2005 and not 2003 or 2006. The top of the mathematical distribution is smoothly curved, and there is a fair amount of jitter in the year to year production….. **There is nothing plausible that could postpone the peak until 2009. Get used to it.**"



Colin Campbell from ASPO, who is almost continuously updating his model with the help of European universities (left) doesn't mix different types of oil and distributes it freely under demand curves like in the above EIA scenarios but does a forecast for each country taking into account past production and present depletion levels. As of end 2004, his figures, which also include non-conventional oil, are summarized in the following table.

ESTIMATED PRODUCTION TO 2100										End 2004
Amount			Gb	Annual Rate - Regular Oil					Gb	Peak
Regular Oil				Mb/d	2005	2010	2020	2050	Total	Date
Past	Future		Total	US-48	3.4	2.7	1.7	0.4	200	1972
Known Fields		New		Europe	5.2	3.6	1.8	0.3	75	2000
945	770	135	1850	Russia	9.1	8	5.4	1.5	210	1987
	905			ME Gulf	20	20	20	12	675	1974
All Liquids				Other	29	25	17	8	690	2004
1040	1360		2400	**World**	**66**	**60**	**46**	**22**	**1850**	2006
2004 Base Scenario				**Annual Rate - Other**						
M.East producing at capacity				Heavy etc.	2.4	4	5	4	160	2021
(anomalous reporting corrected)				Deepwater	5.6	9	4	0	58	2009
Regular Oil excludes oil from				Polar	0.9	1	2	0	52	2030
coal, shale, bitumen, heavy,				Gas Liquid	8.0	9	10	8	275	2027
deepwater, polar & gasfield NGL				Rounding		2	-2		5	
Revised 26/12/2004				**ALL**	**83**	**85**	**65**	**35**	**2400**	2007



PFC Energy's oil supply forecast, released in September 2004 in Washington, **shows a peak in 2014** under following assumptions:

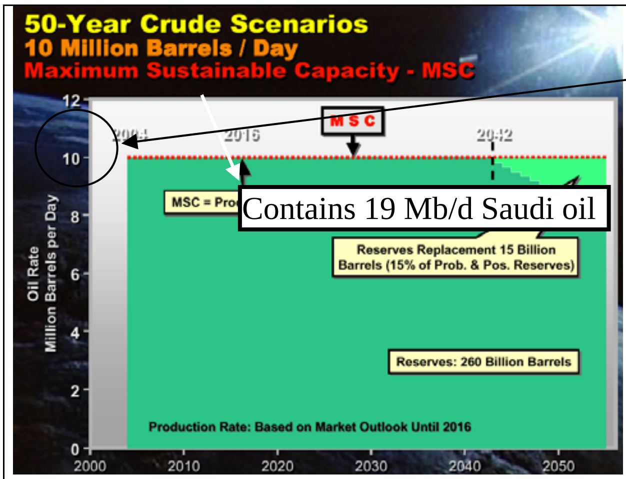
- 2.4 % demand growth
- a huge success in exploration brings Non-OPEC oil to peak in 2012, 5 years later than other forecasts.

Even with low demand growth of 1.1 %, OPEC will not be able to fill the supply gap after 2025

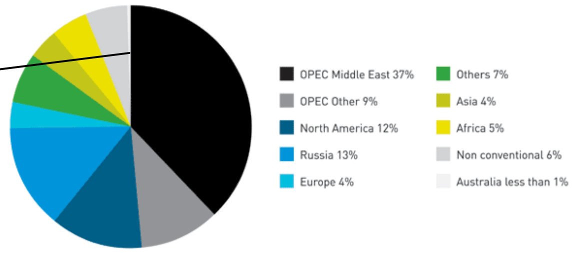
(7) Monitoring current oil supply situation as presented in conferences etc.

Problem #8: The energy white paper's 2-year interval for reviewing global oil supplies is completely insufficient. With a monitoring clock clicking at that speed, the Government will miss out on many oil depletion related studies and publications, which are vital to understand the critical oil, supply situation in the next years.

Let's start with the energy white paper itself, which was already outdated as it was released.



The energy white paper needs urgent updating to incorporate findings presented at conferences like the above Aramco slide show in Washington in February 2004.



The energy white paper, on page 120, quotes the WEO 2002 daily production of 104 Mb/d in 2020 (up), containing app. **19 Mb/d** of Saudi oil. **4 months before** the energy white paper was released, Aramco declared their maximum sustainable capacity is **10 Mb/d** (left), which could possibly be increased to **12 Mb/d** by 2016. Apparently the Saudis are concerned they could permanently damage their fields by over-production.

4.3 Growth in Road Passengers

In 2021, daily traffic volumes on the major arterial roads in northern Sydney would grow by at least 30% compared with flows in 2001. ***Figure 4.4*** presents the forecast 2021 AADT volumes on the road

Excerpt from the F3-Orbital link study (up). All traffic forecasts depend on the validity of the USGS mean estimate.

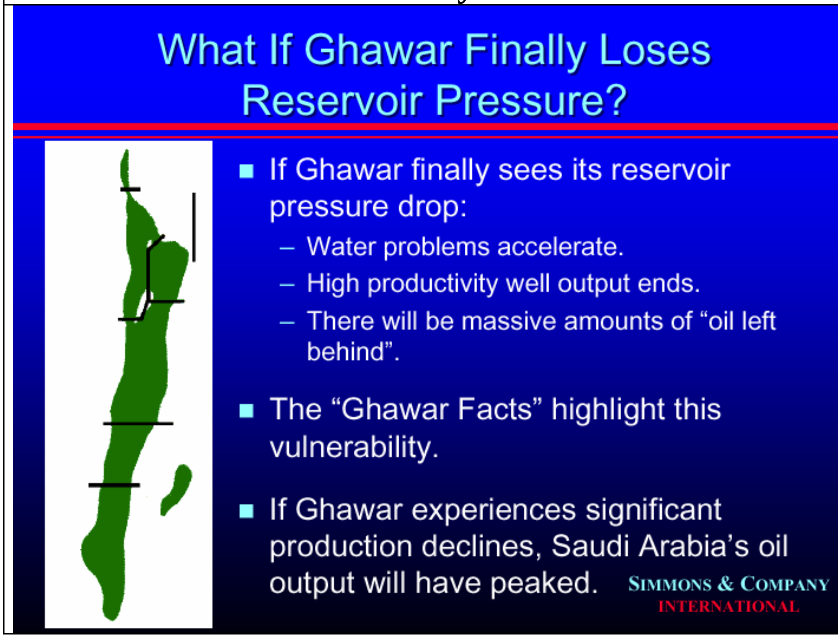
Problem #9: All CBAs (cost benefit analysis) for new road infrastructure assume growing traffic and hence growing oil production relying i.a. on the energy white paper's quoted figure of 104 million barrels/day in 2020. Aramco won't deliver those 19 Mb/day but only a maximum of 12 MB/d. How long will it take the Government to correct the white paper

The Government may also be unaware of all the slide presentations by Matt Simmons, as shown below, especially on the performance of the super giant oil field Ghawar:

Matthew Simmons, energy investment banker and former advisor to Dick Cheney's 2001 Energy Task Force

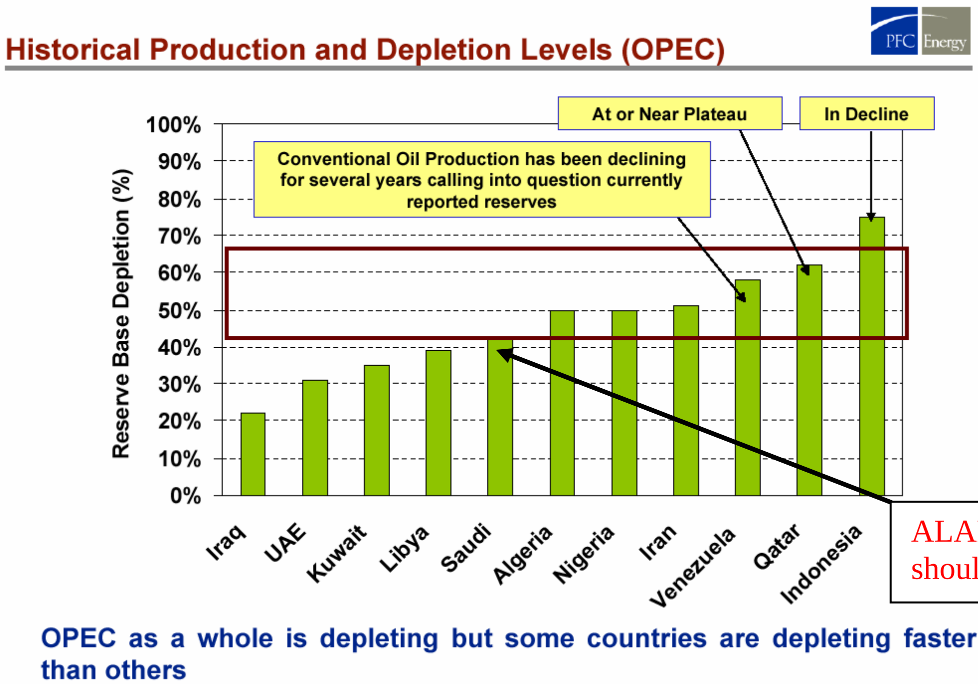
Read his articles and slides at www.simmonsco-intl.com

"But unfortunately the world has no Plan B if I'm right"



Matt Simmons did a study on giant oil fields world wide and unearthed so many problems in Saudi fields that Aramco was forced to give more details in a CSIS conference in Washington. Matt's analysis prompted him to say: "....I think basically 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"

The Government may also not have heard of the advanced depletion levels in various OPEC countries as reported in PFC Energy's "Crude oil and NGL supply forecast" in September 2004 published by the Center for Strategic and International Studies **in the heart of Washington,** not a particularly pessimistic study shortly before the US presidential elections:



annual oil production

ALARM BELLS should be ringing!

Source: www.csis.org/energy/040908_presentation.pdf
All Government Departments and Infrastructure Banks should be alarmed at the prospect of Saudi Arabia reaching a production plateau. PFC's graph implies that Saudi reserves are 134 Gb, not 263 Gb as published by BP. Saudi's easy pre-peak oil is almost gone, while Iraq holds around 30 Gb of it. Bush and Cheney have worked in the oil business. They know what peak oil means. However, limited oil production in Iraq will now flatten the plateau around the global geological peak. Please note that the USGS mean estimate implicitly applies its reserve growth multiplier of 44% to the overstated OPEC reserves.

Another example for the need of continuously monitoring and analyzing the oil supply forecasts published by various organizations is the latest World Energy Outlook released in October 2004, in which - for the first time - the IEA recognizes that OPEC's oil reserves are overstated by, according to their opinion, 228 Gb. That alone would already invalidate part of the above-mentioned EURs assumed by USGS though the IEA could not bring itself to reject the USGS assessment and come up with its own estimates.

The question of OPEC reserves is absolutely vital as the whole world depends on it. The IEA's methodology is that OPEC is to fill the gap between the demand curve and Non-OPEC production as illustrated in the following graphical presentation I have prepared on the basis of WEO 2004, table 3.5:

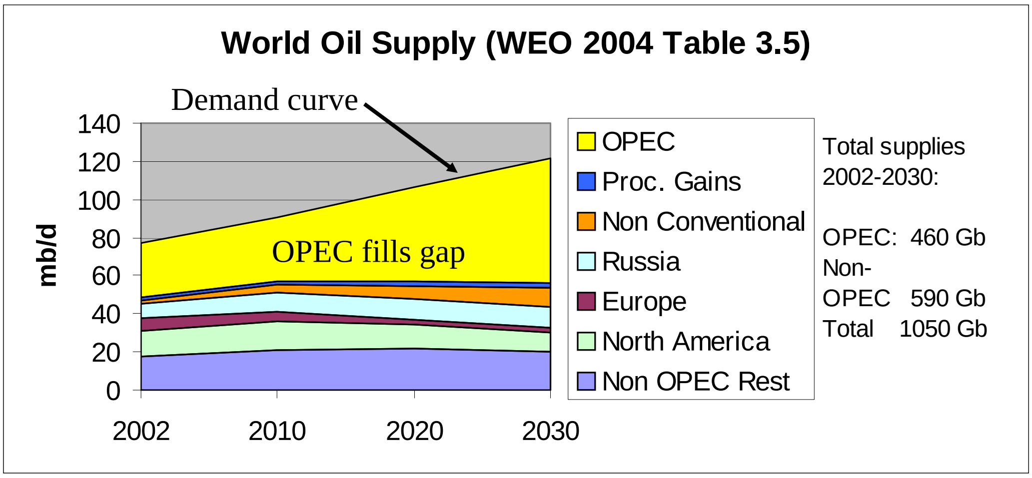
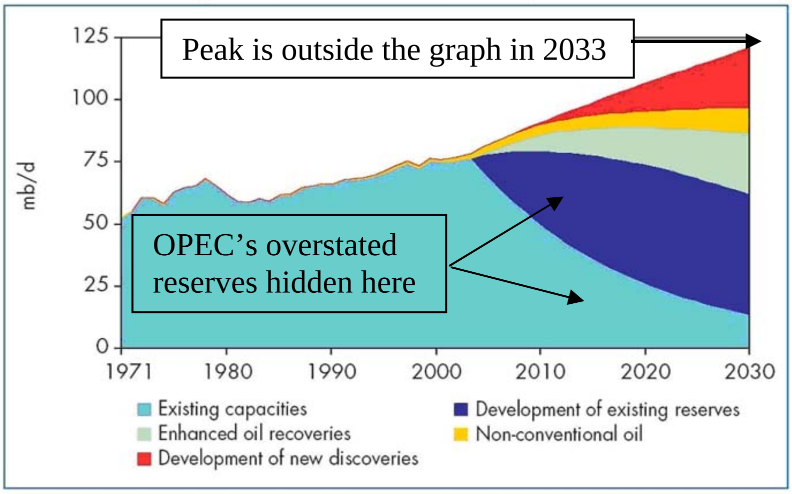


Figure 3.20 in WEO 2004 (down) depicting future production as in the previous graph but here detailing different categories of oil:



The IEA notes that the above graph holds true only if the necessary investments are made but that “**peak of production would come by 2015 or before** if the USGS mean estimate should prove too high”

The International Energy Agency’s production forecast in its WEO 2004 (left) shows the dramatic decline in existing capacities and the peaking of existing reserves around 2010. Though the IEA knows OPEC’s reserves are overstated by at least 228 Gb, it could not bring itself to adjust the USGS estimates on which the WEO 2004 is based. Deduct 228 Gb overstated OPEC reserves and a substantial part of the assumed growth in the above graph, 235 Gb out of 1050 Gb up to 2030, cannot take place.

The unsuspecting reader may get the impression that there is a perpetual oil production growth. The graph is conveniently cut off shortly before the peak in 2033, which is not shown. This is scientifically not correct.
Prof. Aleklett from Uppsala University in Sweden has prepared a critique on the WEO 2004 saying one needs to decode the hidden messages in some of IEA’s statements:

- “Production of conventional oil will not peak before 2030 **if the necessary investments are made**”
- But the “peak of production would come by 2015 or before if the USGS mean estimate should prove too high”

Other points include:

- The IEA’s political agenda does not allow oil production to decline
- There is a steady trend of falling annual oil discovery rates since the 1960s
- Drilling more will not substantially yield much higher reserves as shown in creaming curves
- The IEA fails to draw conclusions from overstated reserves and other oil depletion evidence and turns to the USGS 2000 study for help by adopting their mean estimate which is much higher than the consensus of many other studies
- Reserve growth, assumed by the IEA to be one of the most important providers of additional oil, will affect production mainly after peak oil
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(8) THE LEGAL QUESTION: Who is legally responsible for financial losses resulting from an erroneous and imprudent assessment of peak oil timings?

Problem #10: Have John H. Wood et al indemnified Governments around the world against damages arising from mis-investments in oil dependent infrastructure and omissions of adequate investments in alternative energies/fuels and oil independent public transport systems when peak oil happens much earlier than “the middle of the 21st century” as they advise?

Have they found an insurance company to take that risk? And how about the liability of the Federal Government in relation to the statement that there are sufficient oil supplies for 40 years?

The NSW Transport Minister now uses this statement to justify new toll-ways worth billions of dollars while the rail system is 30 years behind European cities. Banks rely on it. Sydney's Metro strategy depends on it. What happens when toll-way revenue collapses after peak oil? Imagine there were an inquiry pushed by the surprised public after peak oil. For sure the inquiry would find that a mere 7-page paper by Wood et al does not relieve a Government of its responsibility to check vital oil reserve data.

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Many think that peak oil is an abstract theory, which allows an endless academic debate between energy experts and adopt a neutral or reserved position while in fact peak oil is a reality.

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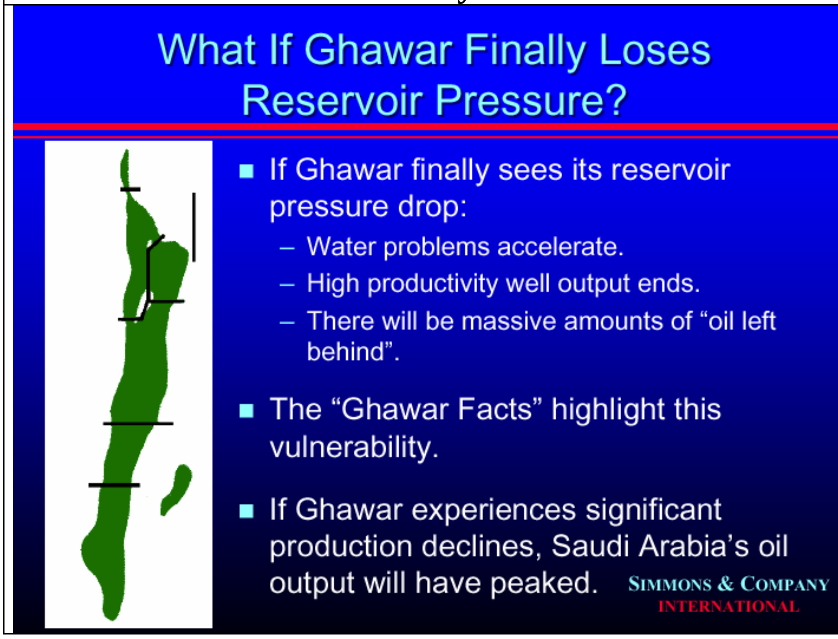

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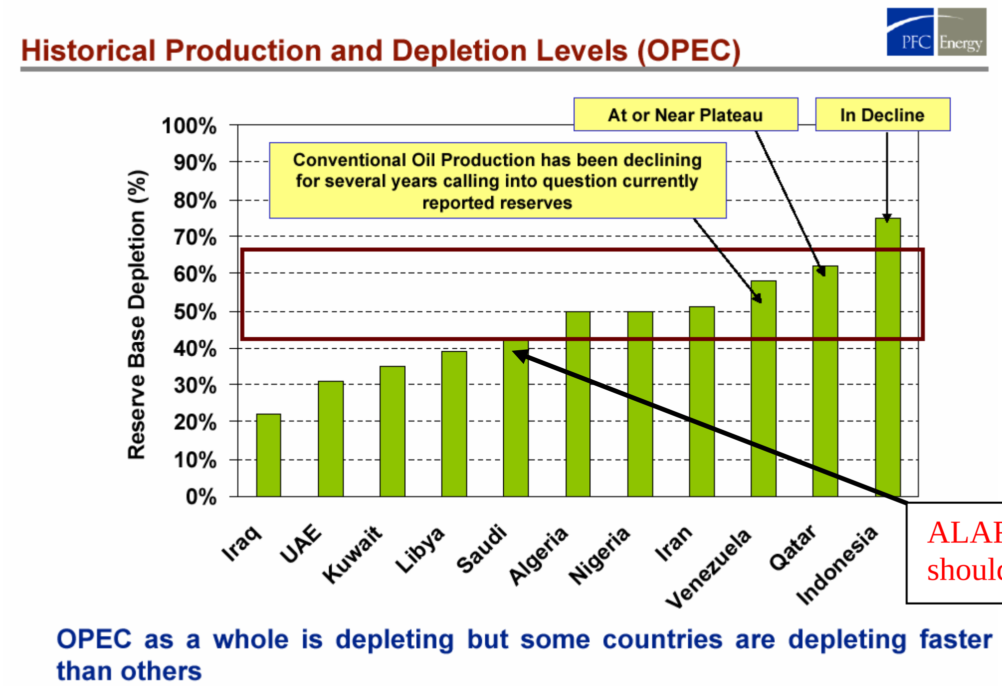

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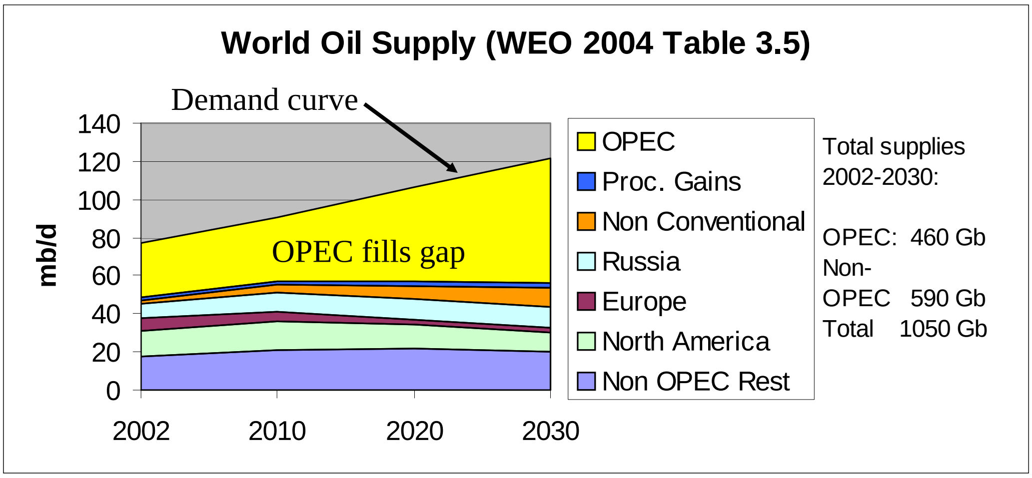

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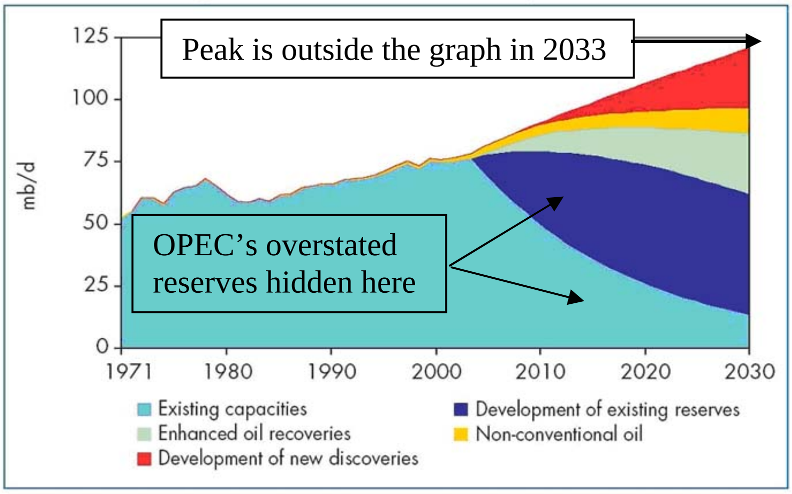

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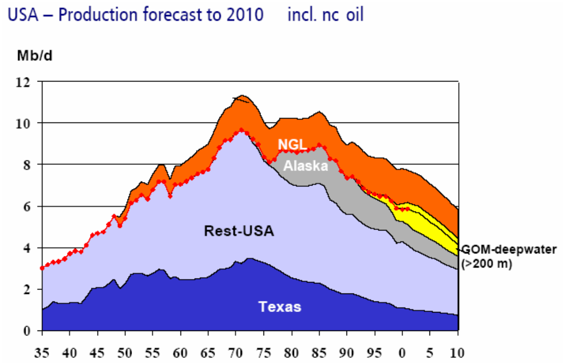
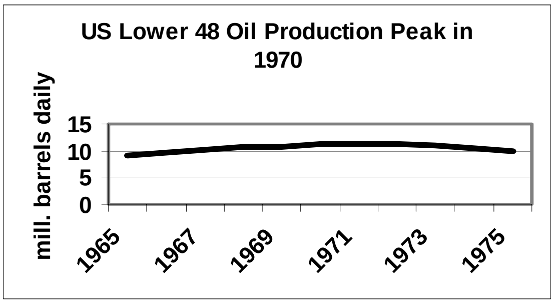
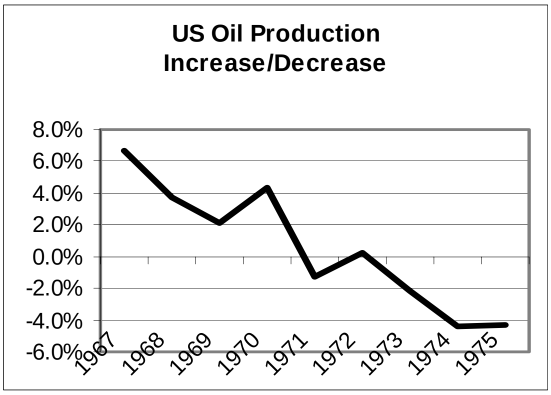
The reality of peak oil in the US



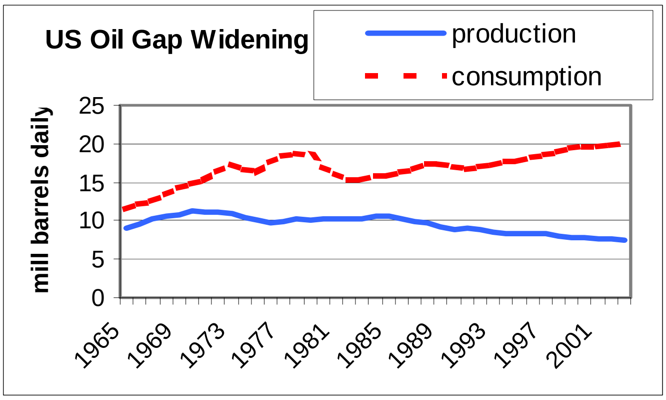
Source: „Future World oil supply" July 2002; W.Zittel
www.lbst.de

The graphs (right) are a 10-year zoom into the US peak in 1970 (up). In the peak year itself, production had still increased by 4%. Therefore, peak oil may come without warning amidst a last minute production frenzy. Decline rates after peak oil reach 4% within a couple of years. The US peak allowed OPEC to impose an embargo and exert their market power on the world.





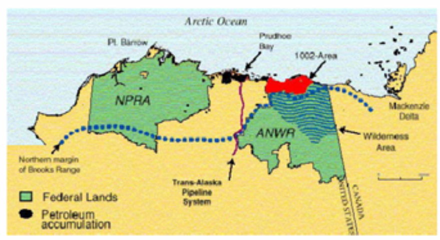
Source of data: BP Statistical Review of World Energy 2004



Increasing oil consumption in the US and declining oil production are irreconcilable.

Alaska oil is also in decline. Even oil from the Arctic National Wildlife Refuge (ANWR, 10.7 Gb) would only be the equivalent of 1.5 years of US consumption.

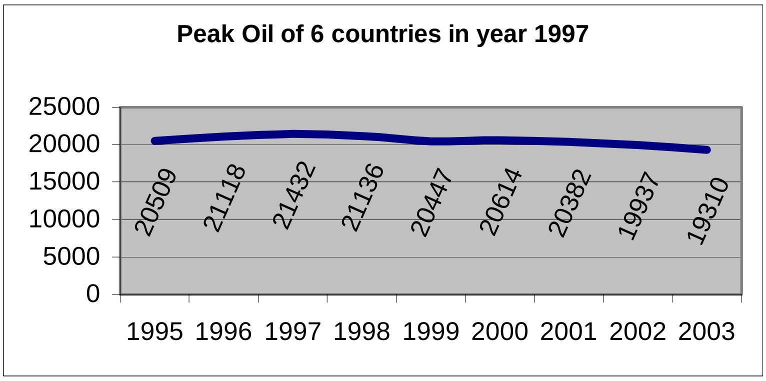
Figure 1. Map of Northern Alaska Showing ANWR and the Coastal Plain Area



Source: Energy Information Administration, Potential Oil Production from the Coastal Plain of the Arctic National Wildlife Refuge: Updated Assessment, SR/O&G/2000-02, May 2000.

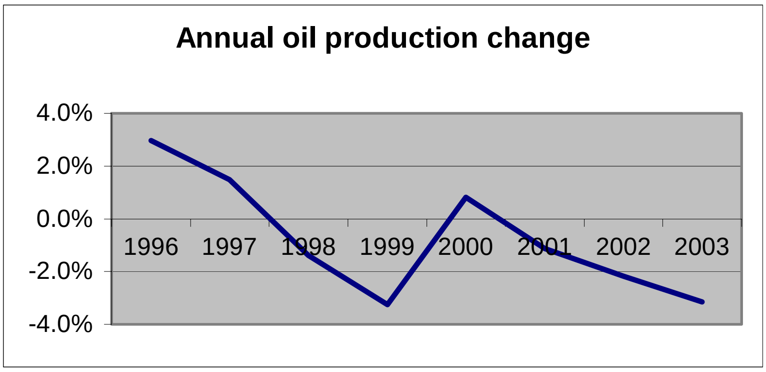
(10) Market forces and oil prices

At present, oil prices do not reflect the scarcity of oil but are influenced by many other parameters. It is only after peak oil that permanent shortages will define the price of oil.
Unfortunately we do not know exactly how the peak will look like when it occurs globally. But here is an example of 6 countries with production >1 million barrels/day which peaked in 1997 and are now in decline (US, Venezuela, Norway, UK, Nigeria and Indonesia)



There are 2 peaks here with the derivative crossing the 0% line twice into the negative decline area.

The superimposition of several production curves from different countries in various stages of depletion will always result in a bumpy plateau around the



peak

Nigeria is a special case but many countries will be special cases where production is subject to civil unrest and other problems.

Source of data: BP Statistical Review of World Energy 2004

In any event, the production curve shows that price signals before the final peak, that is the start of the terminal decline, will not be one-directional as production goes up and down. The market vision into the future is restricted, not only because of lack of good data but also because of the mindset of uninformed market participants who have seen many years of oil production growth and who never experienced any physical oil shortages. Due to this shortsightedness of market vision and inconsistent price signals, market forces will not automatically bring about the introduction of alternative fuels and energies in the required quantities, at current cheap oil prices and in time to fill the supply gap.

The ultimate indicator for peak oil to have happened will be that prices will not go down for x number of months. From that moment on, market forces, now the holy grail of economists and the easy means to solve all market problems, will be hated.

(11) Peak oil years

Here is the latest table of estimates based on various forecasting techniques:

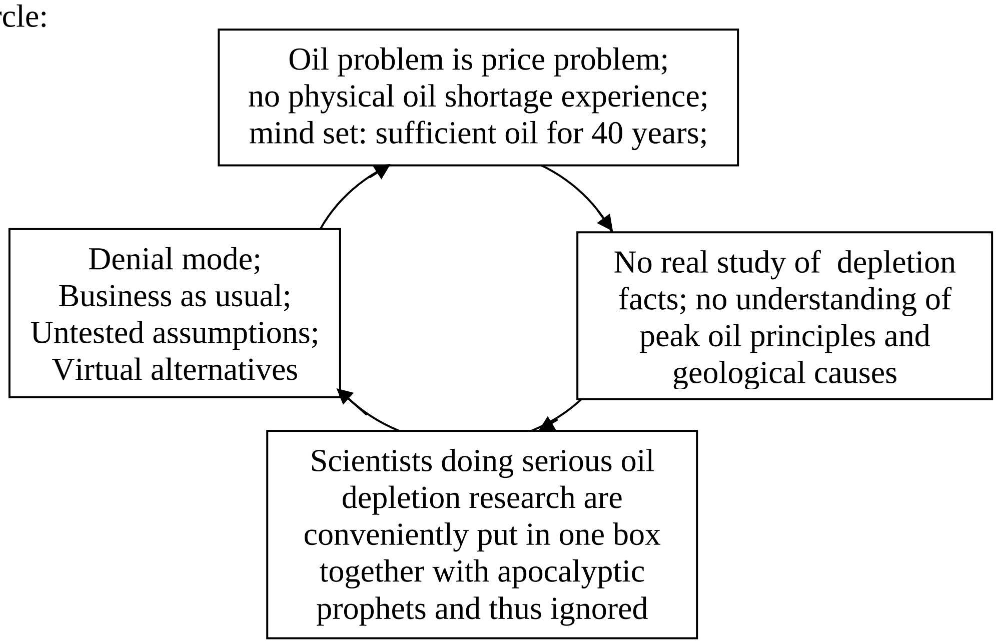
Author	Important points	Peak period
Matthew Simmons	Worried about giant oil fields in Saudi Arabia	Peak at hand
Colin Campbell	ME anomalous reporting corrected	Regular oil: 2006; All liquids: 2007
S. Bakhtiari	WOCAP model	2008
Chris Skrebowski, Editor Petroleum Review	Considering next Mega projects	Not later than 2008
K. Deffeyes	Uses Hubbert's peak	2005 - 2009
PFC Energy, Washington	Huge exploration effort assumed	1.1% demand growth: 2020 1.8% demand growth: 2018 2.4% demand growth: 2014
IEA WEO 2004	Based on USGS 2000; contains 612 Gb hypothetical reserve growth and 228 Gb overstated OPEC oil	2033 if necessary investments are made (and successful); 2015 or earlier if USGS mean estimate is too high

(11) Recommendations

It is clear from the above that scenarios should not be misused to conveniently pick options, which push the issue of peak oil out of the way and into the future without understanding the underlying assumptions. Such an approach is irresponsible. Trying to find answers to the questions raised at the beginning of this paper involve hard, number crunching work of many oil depletion reports. The mind set of an auditor is called for here.

Loss of a (Canberra) cappuccino the only impact of peak oil?

In October 2004, at the Australasian Transport Research Forum in Adelaide, the BTRE presented a paper called “Are we running out of oil?” describing the match between the “peak oil theorists” and the International Agencies, which ends in a draw as far as the author is concerned. The ill-defined question is not answered and at the end, when it was time to give advice to the undecided Government what to do, the author calculated that a 10 cent jump in petrol prices would equate to the negligible cost of a (Canberra) cappuccino at $3 a week. Small world. Consequently, he felt it wouldn’t matter what view the Government endorsed. This attitude is not un-typical for many Government departments. We must come out of following vicious circle:



This paper urges Governments on all levels to abandon their position of indifference by establishing peak oil task force teams in all Ministries and Departments with the job of:

- Studying peak oil facts
- Creating awareness among staff of peak oil
- identifying in which particular way each department is affected by peak oil
- and how to prepare for it.

Prepared by Matt Mushalik (MIEAust) Last update: 16/1/2005