



**27th Australasian Transport Research Forum, Adelaide, 29 September – 1 October 2004**

**Paper title:** Are we running out of oil? <sup>1</sup>

**Author(s) name(s):** Lyn Martin

**Organisation(s):** Bureau of Transport and Regional Economics

**Contact details:**

*Postal address:* GPO Box 501  
Canberra ACT 2601

*Telephone:* 02 6274 7594

*Facsimile:*

*email:* lyn.martin@dotars.gov.au

**Abstract (200 words):**

The world is currently using up oil at somewhere between four and nine times the rate it is being discovered. There are two schools of thought regarding the seriousness of the situation and the appropriate policy responses. The ‘depletionists’ (or peak theorists) maintain that a sudden downturn in oil output is imminent, resulting in sharp price increases that, in an unprepared world, will lead to economic and social turmoil. The peak of production, they argue, is predictable from the discovery pattern, occurring half-way through depletion of oil deposits. Output is likely to fall rapidly following the peak. In contrast, the anti-depletionists (represented by international energy agencies, major producers and the oil companies) is that rather than having used half the world’s oil reserves, we have used closer to one quarter and that the outlook to 2030 represents no cause for concern. Oil supplies, it is argued, will keep pace with demand, despite the forecast growth in countries such as China. Prices, which the antidepletionists argue signal an impending shortage of oil, have not shown a long-term upward trend. While there have been dramatic price rises in the past, these have reflected market control by OPEC countries rather than a gradually exhausting resource. This paper reviews the main areas of debate between the depletionists and antidepletionists, with particular emphasis on the policy implications of both approaches.

---

<sup>1</sup> The views expressed in this paper do not necessarily reflect those of the Bureau of Transport and Regional Economics, the Department of Transport and Regional Services or other organisations.

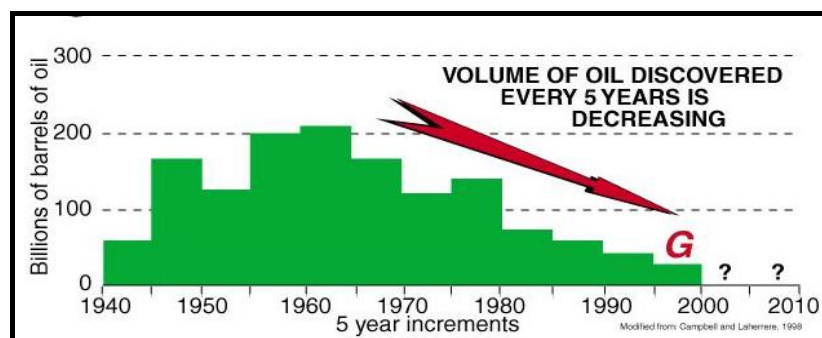
## Are we running out of oil?

The oil depletion debate tends to incite passions, polarise the scientific community and leave the casual observer bewildered. Are we on the verge of a 'world energy cataclysm' or is there 'absolutely no reason to worry about running out of energy in the coming decades'? Is world oil production about to peak, leading to dwindling supplies while demand increases inexorably or, due to advances in exploration technology, are there more proven reserves of conventional oil today than there were three decades ago?

This paper presents no new information but rather provides a different view of the information that is available by distilling the fundamental differences between the two groups of protagonists. However, its main contribution is in reviewing the policy implications of the disparate views, concluding that much of the energy of the debate is misdirected.

### The Depletionists/Peak oil theorists

'Peak oil' has its foundations in the work by Dr M King Hubbert and, more recently, by C J Campbell and J H Laherrère.<sup>1</sup> The focus is on the production peak, which is reasoned to follow the discovery peak with a predictable time lag. Figure 1, illustrates the Peak Theorists argument that a dramatic decline in oil production is imminent.



**Figure 1 Declining oil discoveries (as illustrated by Peak theorists)**

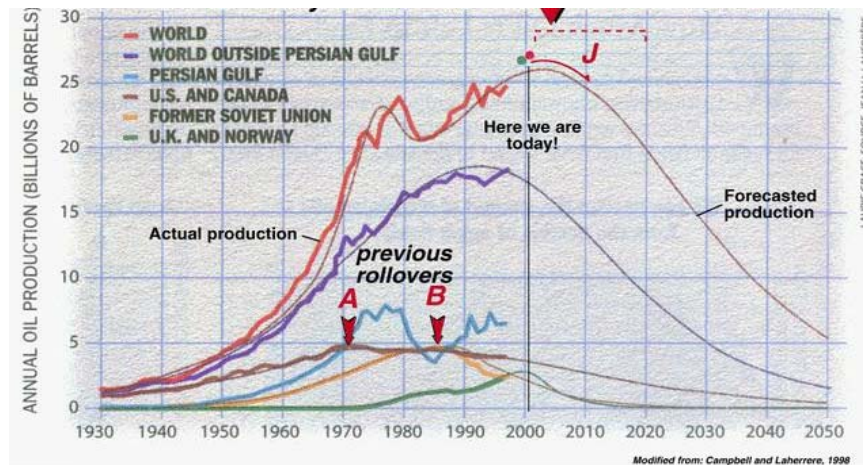
Source: <http://www.oilcrisis.com/magoon/>

Lindgren (2004) estimates that of the world's 42 top oil-producing nations, production wells in 15 are already in decline, 14 will go into decline within three years, and only wells in six countries (Iraq, Brazil, Saudi Arabia, Colombia, the United Arab Emirates and Kuwait) will pass 2010 without peaking. Of those six, Saudi Arabia is probably the only nation with a substantial level of spare production capacity.

The term 'the big rollover' refers to the peak of production of conventional oil, generally believed to come close to the midpoint of depletion, when half the total oil has been used, as illustrated in figure 2 below. The significance of the halfway point derives from the reported strong historical evidence for many oil basins that show that oil production peaks and then starts to decline when about half the recoverable resource has been consumed. The Peak Theorists maintain that this is a matter of oil reservoir physics rather than production technology or economics.

An important issue is the abruptness of the rollover. The general tenor of the Peak Theorists' warnings is that the decline in production it is likely to be quite sudden, leaving the world unprepared to respond to the shortage of oil, possibly resulting in chaos and disorder. Hence,

it is concluded; since adaptation to lower hydrocarbon use is inevitable, then we should be already moving in this direction.



**Figure 2 The 'Big Rollover' in the Production of Conventional Oil**

Source: <http://www.oilcrisis.com/magoon/> (adapted from Campbell, C. and Laherrère 1998)

World population growth and high rates of growth from increasingly-industrialised nations (such as China and India) is expected to exacerbate the situation. As Duncan and Youngquist noted:

Present world oil production is about 25 Gb [Giga barrels, or thousand million barrels] a year. The 2040 production will be less than one-half the present oil consumption, and will face a demand from a world population which is estimated to be 50 to 70 per cent greater than at present. Compounding world energy demands will be the increasingly industrialized nations (particularly Southeast Asia, China, and India) wanting more energy per capita (Duncan and Youngquist 1999).

### The Anti-Depletionists/International Agencies

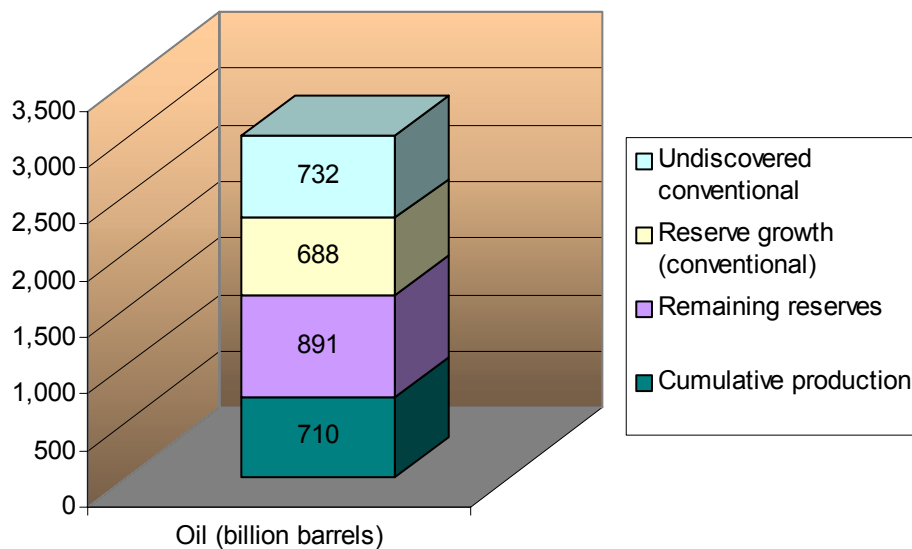
The main international agencies, U.S. Energy Information Agency (within the Department of Energy), the U.S. Geological Survey (USGS), the International Energy Agency (IEA, composed of the major oil-using nations) and the European Commission do not share the Peak Theorists' concern for the future of world oil supplies. While the Peak Theorists estimate ultimately recoverable resource (URR) of around 1.8 trillion barrels, the agencies estimates can be up to 70 per cent higher, at around 3 trillion barrels (EIA 2004 table 5 p. 36).

With slight variations, the agencies' forecasts reflect a view that supply growth will, at worse, lag demand growth slightly. In the words of the IEA, there is 'absolutely no reason to worry about running out of energy in the coming decades'.<sup>ii</sup>

Rather than focussing on the extraction rate relative to the discovery rate, the agencies tend to highlight the extent of the remaining reserves and the continuing growth in world supply. The latest USGS assessment resulted in an *upward* revision of oil resources by 20 per cent, due to new discoveries and technological progress allowing access to reserves that were previously uneconomic. As depicted in Figure 3 below, it is estimated that cumulative production represents only around 24 per cent of the world's conventional oil endowment.<sup>iii</sup>

#### 4 Are we running out of oil?

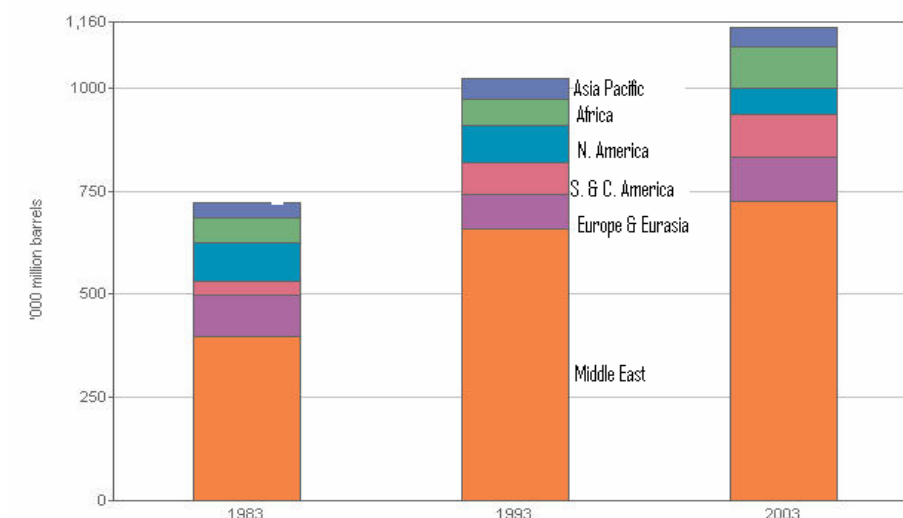
Of the estimated total world endowment of 3021 billion barrels, almost half is accounted for by the ‘undiscovered’ and ‘reserve growth’ categories. ‘Reserve growth’ is a relatively new addition to the USGS methodology and describes the process by which technical improvements and correction of earlier conservative estimates increase the projected recovery from existing fields—based on experience in the US and a few other well-documented regions.<sup>iv</sup>



**Figure 3 World Conventional Endowment of Oil (including U.S.)**

Source: USGS 2000 Table 1 <http://energy.cr.usgs.gov/WEcont/chaps/ES.pdf>

Other organisations have also included a growth in oil supply in their analysis. BP Statistical Review of World Energy estimates that proved oil reserves have increased almost 60 per cent over the two decades to 2003—see figure 4 below.<sup>v</sup> The Energy Information Agency (2004) projected a significant increase in world oil supply, estimating that in 2025 it will exceed the 2001 level by 53 per cent.<sup>vi</sup>



**Figure 4 Proved World Oil Reserves 1983, 1993, 2003**

Source: BP Statistical Review of World Energy 2004 <http://www.bp.com/subsection.do?categoryId=95&contentId=2006480>

Fumento (2004) supports the agencies with the observation that proved oil reserves increased 55 per cent in the two decades to 2002 while worldwide consumption increased only 13 per cent. He calculates that ‘if consumption continues to increase at an average rate of 1.4 percent a year we still won’t exhaust proved reserves until 2056’ even if not a single new drop is found.

David Deming, professor of geology and geophysics at the University of Oklahoma estimates that oil sands worldwide (generally not included in the ‘conventional oil estimates) could provide more than 500 years of oil at current usage rates.<sup>vii</sup> Deming (2000) concludes that the history of resource assessments shows that over the last 50 years estimates of ultimate oil reserves have risen as fast as or faster than cumulative oil production.

### Previous predictions

The antidepletionists also note that history seems to be littered with gloomy predictions of running out of oil (see Table 2 below), quite apart from general doomsday warnings, such as the Limits to Growth. Fumento (2004) observed that ‘the earliest claim that we [U.S.] were running out of oil dates back to 1855—four years before the first well was drilled. In 1920, the U.S. Geological Survey estimated the total amount of oil remaining in the world amounted to only 20 billion barrels.<sup>viii</sup>

The Economist (February 2001) notes the series of wildly inaccurate oil price forecasts and comments that ‘even Exxon says it has learned one crucial lesson from earlier forecasting mistakes: It greatly underestimated the power of technology. Thanks to advances in exploration and production technology, the amount of oil available has increased enormously.<sup>ix</sup>

**Table 1 History of Oil Depletion Projections**

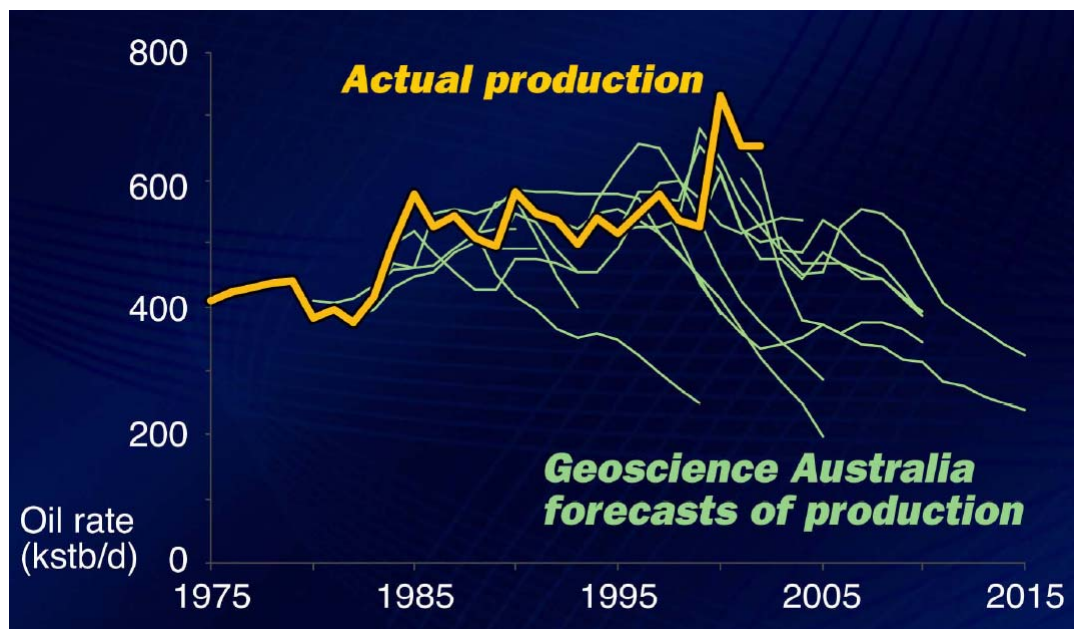
<i>Year</i>	<i>Prediction</i>	<i>Source</i>
1914	Oil would last a decade	Bureau of Mines (U.S.)
1920	20 billion barrels - total oil remaining in the world	U.S. Geological Survey
1922	US only has energy oil supply to last 20 years.	U.S. Geological Survey
1926	4.5 billion barrels remain	Federal Oil Conservation Board (U.S.)
1932	10 billion barrels of oil remain	Federal Oil Conservation Board (U.S.)
1939	13 years supply	Interior Department (U.S.)
1944	20 billion barrels of oil remain	Petroleum Administrator for War (U.S.)
1950	world oil reserves are at 100 billion barrels	American Petroleum Institute
1951	13 years supply	Interior Department (U.S.)
1977	‘could use up all of the proven reserves of oil in the entire world by the end of the next decade’	U.S. President Jimmy Carter

Sources: Fumento, M. 2004 [http://www.capitolhillblue.com/artman/publish/article\\_4525.shtml](http://www.capitolhillblue.com/artman/publish/article_4525.shtml)  
 Energy Time Line at [http://www.energyquest.ca.gov/time\\_machine/1920ce-1930ce.html](http://www.energyquest.ca.gov/time_machine/1920ce-1930ce.html),  
<http://www.ncpa.org/abo/inthenews/Petroleum.html>

Lynch (1998) argues that the poor record of oil supply forecasts is due mainly to certain repetitive errors:

- bias, and especially pessimism, since nearly every forecast has been too low since 1978, despite relying on price assumptions that were much too high;
- similar forecasts for every region, despite different fiscal systems, drilling levels and/or the maturity of the industry, suggesting omitted variables;
- misinterpretation of recoverable resources as total resources by using a point estimate instead of a dynamic variable, growing with technology change, infrastructure improvements, etc.; and
- a tendency for all national, regional or non-OPEC production forecasts to show a near-term peak and decline, which was always moved outward and higher in later forecasts (the opposite of price forecasts).<sup>x</sup>

Closer to home, ABARE (2004) identified ‘forecasters’ droop’ in Geoscience’s Australia propensity to be produce pessimistic forecasts of future production of oil (see Figure 5).



**Figure 5 Forecasts vs. Actual Production of Oil (Australia)**

Source: Tulpulé 2004

Antidepletionists often cite the Paul Ehrlich’s misplaced fears of world mineral shortages as an illustration of the failure of the depletionists to appreciate the relatively insignificant role of the physical limit to resources in determining ‘scarcity’—see box below for details.



In 1980, U.S. economist Julian Simon challenged biologist Paul Ehrlich's continual predictions of massive shortages in various natural resources. Simon offered Ehrlich a bet that, despite continued mining and depletion of mineral, prices would fall rather than rise. Ehrlich selected a quantity of any five metals worth \$1,000 in 1980. Simon bet that the 1990 price of the metals, after adjusting for inflation, would be less than \$1,000 indicating that, despite declining physical resources, the metals had not become more scarce. The loser would mail the winner a check for the change in price.

Ehrlich agreed to the bet and chose copper, chrome, nickel, tin and tungsten. By 1990, all five metals were below their inflation-adjusted price level in 1980. Ehrlich lost the bet and sent Simon a check for \$576.07.

[http://www.overpopulation.com/faq/People/julian\\_simon.html](http://www.overpopulation.com/faq/People/julian_simon.html)

## Main areas of conflict

### Terminology and data

Laherrère (2003), a peak theorist, maintains that the lack of consensus on reserve numbers and ambiguous use of basic terms (such as oil, gas, conventional, unconventional, reserves) makes it difficult to compare like with like and represents the major source of disagreement between the two groups.<sup>xi</sup> In particular that U.S. practice is completely different from that in the rest of the world, being conservative to satisfy bankers and the stock market. The US Securities and Exchange Commission (SEC) rules require 'proved' reserves to be reported while practice elsewhere allows 'proved and probable'. The former Soviet Union (FSU) definition appears to have an optimism bias being based on the maximum theoretical recovery, free of technological or economic constraints.

### Reserves versus resources

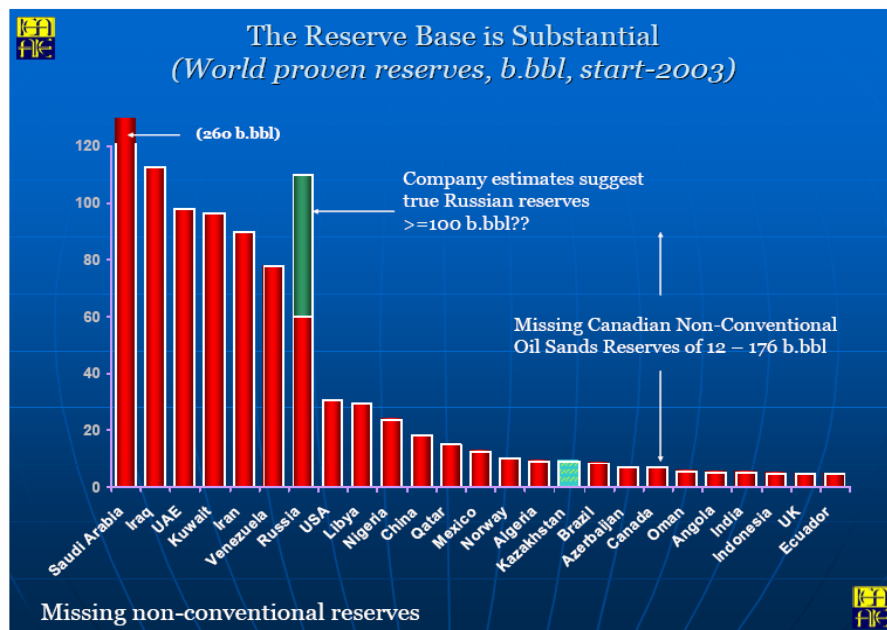
The distinction between *reserves* and *resources* is crucial to the debate. Resources are the finite amount of oil that has been bestowed on the world. Reserves represent the amount of oil that can be recovered commercially with current technology. In other words, if extraction costs decline or oil prices rise, reserves will increase. The P90 reserve i.e. the amount of oil which can be extracted with a 90 per cent probability is usually referred to as *proved* reserves. Similarly, with the P50 and P10 reserves, labelled *probable* and *possible*, respectively. The sum of proved and probable reserves is commonly taken to mean the best scientific estimate of the size of the field as a whole.<sup>xii</sup>

Both sides agree that the amount of oil is unknown. However, the Peak Theorists maintain that the total amount of reserves can be estimated by noting that the biggest fields are found and developed first after which increasingly smaller fields are found and brought into production. Eventually the new fields will be small and hard to find.

The Peak Theorists reject the concept that oil reserves can be a function of market prices, pointing out that Peak Oil involves the observation of the 'factors that control oil accumulation in Nature and applies immutable physical laws to the process of depletion'. (Alekklett and Campbell 2003)

The antidepletionists' basic hypothesis is that the prime consideration is not whether we can find more oil but rather that technological improvements will result in reserve growth and that any rise in oil prices will encourage exploration and extraction from previously uneconomic

wells. Location of proven reserves (not including non-traditional reserves) is depicted in Figure 6 below.



**Figure 6 World Proven Reserves (IEA 2004)**

Source: [http://www.iea.org/dbtw-wpd/Textbase/speech/2004/kr\\_rio.pdf](http://www.iea.org/dbtw-wpd/Textbase/speech/2004/kr_rio.pdf)

### Ultimately recoverable resource (URR)

The URR is an estimate of the total quantity of oil that will ever be produced, including the nearly 1 trillion barrels extracted to date. The depletionists estimate a URR of 1.8 trillion barrels compared to around 3 trillion barrels estimated by the antidepletionists (EIA 2004 table 5 p. 36).

### Data

Aleklett and Campbell (2003) criticise the quality of the data on which the antidepletionists base their conclusions, observing that the most widely used public source of information comes from two trade journals (Oil & Gas Journal and World Oil), the data sets of which differ greatly, despite being compiled in a similar fashion from government and industry sources. Further, that another widely used source, the BP Statistical Report of World Energy, 'simply reproduces the Oil & Gas Journal material'. The industry database, according to the depletionists, is relatively reliable but too expensive for most analysts to access.

Aleklett and Campbell point out that the task of estimating the size of an oilfield poses no great technological challenge, although with a quantifiable range of uncertainty. However, they contrast this with the *reporting* of the results, which they claim 'are clouded by ambiguous definitions and lax reporting practices', concluding that

*...the atrociously unreliable nature of public data has given much latitude when it comes to interpreting the status of depletion and the impact of economic and political factors on production. This has allowed two conflicting views of the subject to develop (Aleklett and Campbell 2002).*

Campbell argues that strategic considerations are involved in data provision—that the industry systematically under-reports the size of discovery (mainly to smooth their assets,



thereby presenting a better commercial image) and that governments variously under-report or over-report, or simply fail to update their estimates.<sup>xiii</sup>

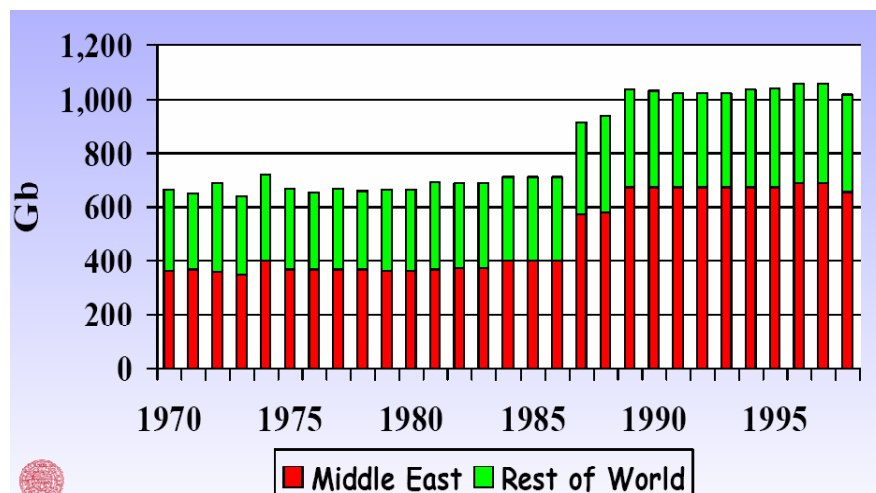
We might almost call some of them conspiracies of denial and obfuscation. The United States seeks to exaggerate the world's oil endowment to reduce OPEC's confidence. It pretends that it does not depend on Middle East oil. It puts out very flawed studies by the US Geological Survey and the Department of Energy. OPEC, for its part, exaggerates its resource base to inhibit non-OPEC investments and moves to energy savings or renewables. It fears losing its oil market on which it utterly depends, with its rapidly rising population. Companies conceal depletion because it sits badly on the investment community (Campbell 2002a).

However, the USGS, prominent among the antidepletionists, develops its own extensive database and purports to use 'thorough and methodologically sound assessment of worldwide petroleum resources'.

### OPEC Upward Revision

Between 1985 and 1990 OPEC countries added 300 Gb to their reserves despite discoveries of only about 10 Gb (see Figure 7 below). The depletionists argue that no credence can be placed in the reserves reported by the five Middle East key countries, declaring them to be arbitrary revisions aimed at achieving a higher the allocation of the OPEC quota.

The antidepletionists counter with the observation that there was little exploration in the Middle East during the 1980s (there was no need in view of the huge reserves discovered up to that time) and hence that it was reasonable to shift these reserves to the booked category. Furthermore, they argue that these countries URRs may, in fact, be understated.<sup>xiv</sup>



**Figure 7 OPEC's Upward Revision of Reserves**

Source: Aleklett 2003 <http://www.isv.uu.se/UHDSG/articles/LisbonPDF.pdf>

Campbell partly endorses this view, observing that 'the early numbers were too low, having been inherited from the companies before they were expropriated'. However, he goes on to argue that while some of the increase was justified it has to be backdated to the discovery of the fields concerned that had been found up to 50 years before (Campbell 2002).

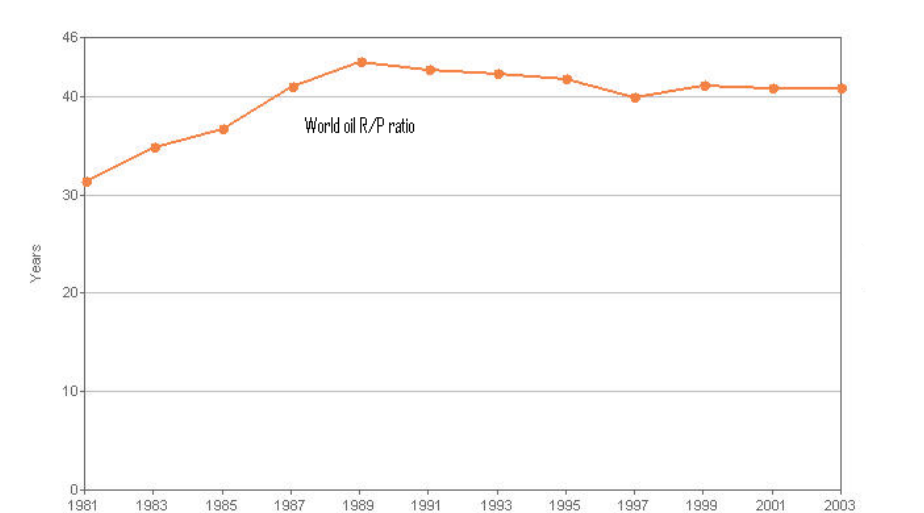
## 10 *Are we running out of oil?*

### Backdating

The Depletionists argue that the failure to assign 'revisions' to the original discovery (backdating) gives the illusion that more is being found than is the case.<sup>xv</sup> The Antidepletionists respond that the revisions are properly attributed to the date on which they are announced and that the approach of the depletionists amounts to 'rewriting history'.

### Reserves to production ratio

The reserves to production (R/P) ratio is used by the international agencies to indicate the number of years that those remaining reserves would last if production were to continue at that current levels. The R/P ratio for the world has increased over the past decade and was around 40 at the end of 2002 (see figure 8 below).<sup>xvi</sup>



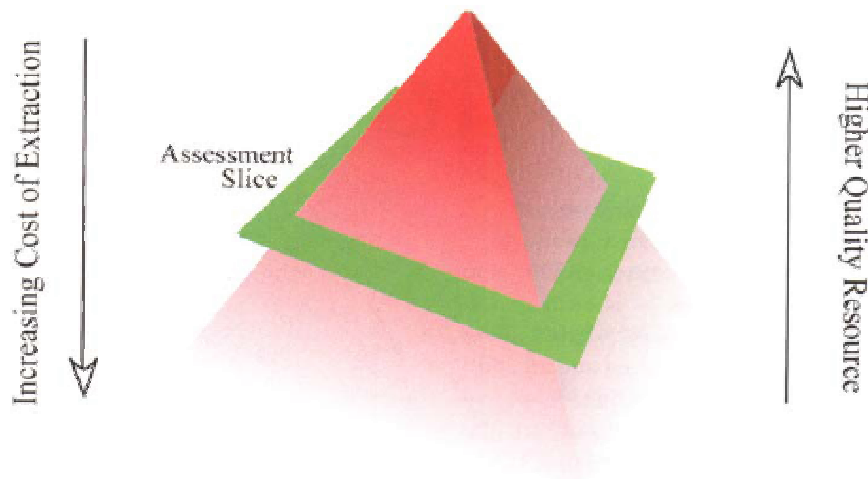
**Figure 8 BP World Oil Reserves to Production Ratio (1980-2002)**

Source: BP Statistical Review of World Energy 2004 <http://www.bp.com/subsection.do?categoryId=95&contentId=2006480>

However, the depletionists dismiss the use of this figure, countering that the R/P is meaningless because the important question is not how long will the reserves last, but whether production can be maintained at the current level.<sup>xvii</sup>

### Resource pyramid

The resource pyramid charts the 'economic feasibility of an area' petroleum reserves. It shows a small volume of prime resource at top and, at bottom, larger volumes of low quality resources that are more expensive to extract' (Ahlbrandt & McCabe 2002 p. 5). Depletion leads to scarcity, which in turn leads to higher prices. Consequently, those resources that were once classified as 'nonconventional' because they could not be produced economically at prevailing prices and technology can become conventional with higher prices and improved technology.



**Figure 9 The Resource Pyramid**

Source: Ahlbrandt. & McCabe. (2002) p. 5

Figure 9 illustrates a geologist's view of the resource pyramid. According to Ahlbrandt and McCabe, 'the upper part of the pyramid is well defined, as these resources are mostly known and are generally considered "conventional". The lower part of the pyramid is less well understood'. It is this lower part where that provides the source of greatest conflict.

#### Technology's role in the resource pyramid

Technology plays a major role in ensuring future affordable oil supplies, making it possible to draw upon petroleum resources whose extraction was once unthinkable.

We can now drill wells up to 30,000 feet deep. The amount of oil that can be recovered from a single well has been enhanced by a technology that allows multiple horizontal shafts to be branched off from one vertical borehole. The ability to drill offshore in water depths of up to 9,000 feet has opened up the vast petroleum resources of the world's submerged continental margins. The world also contains immense amounts of unconventional oil resources that we have not yet begun to tap. For example, tar sands found in Canada and South America contain 600 billion barrels of oil, enough to supply the U.S. with 84 years of oil at the current consumption rate. Worldwide, the amount of oil that can be extracted from oil shales could be as large as 14,000 billion barrels - enough to supply the world for 500 years (Deming 2003).

The EIA estimated that 'enhanced supplies' made possible through technological gains will provide 25 per cent of oil production in 2025.<sup>xviii</sup> Professor Peter Odell, author of *Oil & Gas: Crises and Controversies 1961-2000*, proposed that higher exploitation and extraction costs will be offset by technologically-derived savings, and hence there will be little or no pressure of demand on supply for at least the next 20 years. He also argued that, for this period, there is thus no reason why oil prices in real terms should rise much nor any reason why the world will need to resort to the higher cost oil reserves (Odell 2000 and 2003).

Recent comments by Alan Greenspan, Chairman of the U.S. Federal Reserve, also ascribe a major role for technology in enhancing oil supplies:

*Seismic techniques and satellite imaging, which are facilitating the discovery of promising new reservoirs of crude oil and natural gas worldwide...new techniques allow far deeper drilling of promising fields, especially offshore. The newer innovations in recovery are reported to have increased significantly the average proportion of oil.*<sup>xix</sup>

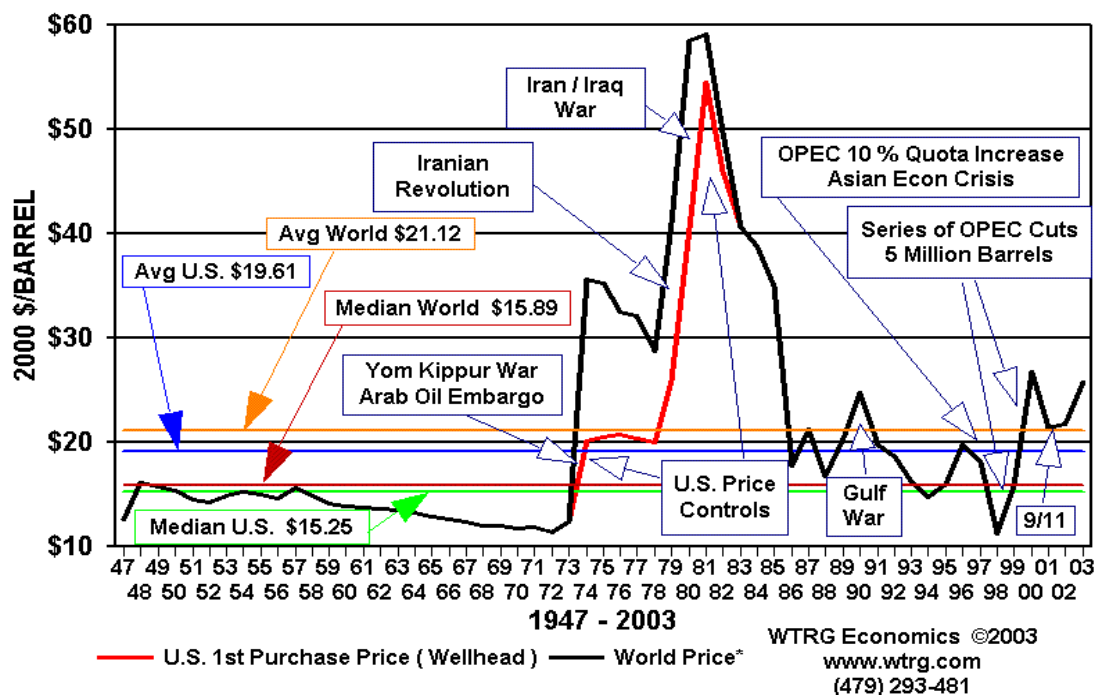
The Depletionists counter that the technology is not new, and while it allows cheaper and faster production it does not add to the reserves themselves in conventional fields' (Laherrère

2003). Campbell (2002) accuses the adherents of the 'resource pyramid' philosophy as failing grasp the polarity of oil which is normally either there in profitable abundance or not there at all. He elaborates, 'that the oil-water contact in a reservoir is abrupt giving virtually no possibility of tapping lower concentrations and that the heavy oil and bitumen deposits, which could be considered as the lower part of the pyramid, are present in large quantities only in western Canada and eastern Venezuela.'

Furthermore, that in some situations, Campbell (2002a) points out that through enhancing the knowledge of the resource, the technology has *reduced* (rather than enhanced) the perceived potential, because it shows a dearth of large prospects.

### Role of prices

A crucial difference between the two schools of thought is the role of prices play in signalling depleting oil supplies. Prices generally provide a quantitative summary of factors that will impact on future demand and supply projections. However, short term fluctuations may reveal little about long term supplies, as illustrated in Figure 10 below where prices have been adjusted for inflation.



**Figure 10 Crude Oil Prices 1947-2003 (US\$ 2000 per barrel)**

Source: Energy Economics Newsletter <http://www.wtrg.com/prices.htm>

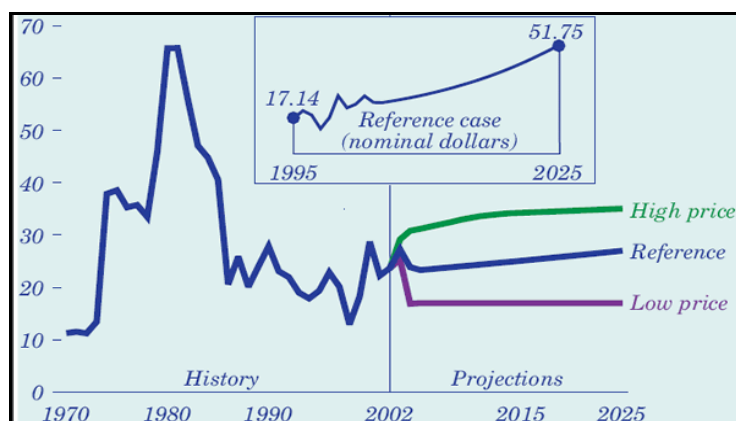
The Depletionists dismiss the role of market prices as harbingers of a collapse in oil supplies, since the production decline will be too dramatic for the market to anticipate, particularly given the short-sightedness of the market and lack of reliable industry data.

The Antidepletionists view projected prices as one of the three means of assessing the extent of the oil resource base, the others being proved reserves and URR, with prices being a more accurate indicator of relative resource scarcity.

Oil prices have fallen 35 per cent in real terms since the high of 1980 and (short term fluctuations aside) are generally projected to rise only gradually to 2025—the end of the

current long-term projection period. The EIA forecasts world oil demand to increase by just over 50 per cent between 2002 and 2025—an average annual growth in demand of 1.9 per cent per year (EIA 2004 p. 2). OPEC producers are expected to be the major suppliers of increased production requirements, with production up 80 per cent over this period. Offshore resources are anticipated to be competitive, especially in the Caspian Basin, Latin America, and deepwater West Africa. More oil will become available from Russia and the Caspian region.<sup>xx</sup>

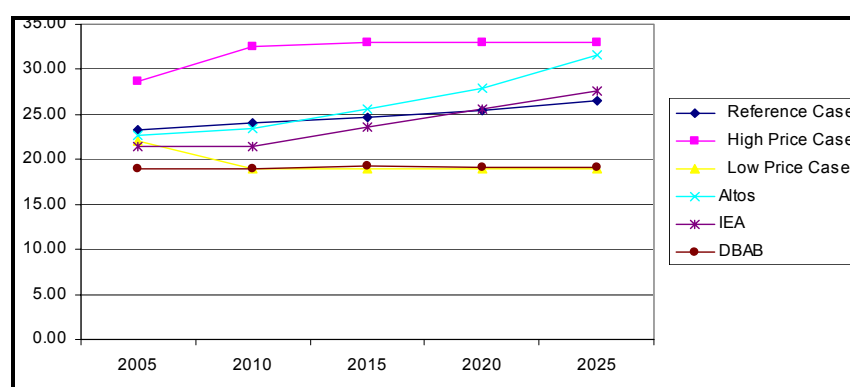
In Figure 11 below the EIA's reference case depicts only gradually increasing oil prices in real terms.



**Figure 11 EIA World Oil Prices in Three Cases: 1970 to 2025 (US\$2002 per barrel)**

Source: International Energy Outlook 2003 [http://www.eia.doe.gov/oiaf/aeo/figure\\_43.html](http://www.eia.doe.gov/oiaf/aeo/figure_43.html)

The IEA has compared the world oil price projections from a number of sources, noting a range for 2025 from \$19.18 (Deutsche Banc) to \$31.61 (Altos) in 2001 dollars. The similarity of the projections is illustrated in figure 12 below, noting that the main outlier is the high price case.<sup>xxi</sup>



**Figure 12 IEO2003 and Other World Oil Price Projections, 2005-2025 (US\$2001 per barrel)**

Source: International Energy Outlook 2003 [http://www.eia.doe.gov/oiaf/ieo/tbl\\_15.html](http://www.eia.doe.gov/oiaf/ieo/tbl_15.html)

The European Commission has projected oil prices to be around \$33.50 a barrel in 2030, slightly higher than prices forecast by the IEA or the US -DOE.<sup>xxii</sup>

An important assumption of the EIA model is that the Persian Gulf OPEC producers can expand capacity at a cost that is a relatively small percentage of projected gross revenues (EIA 2004 p. 37). The public statements from Saudi Arabia, the major OPEC producer support the Antidepletionists. Saudi Aramco [Saudi government-owned oil company]:

*...we stand upon a firm foundation of 260 billion barrels of crude. Those reserves are spread across 85 fields and 320 different reservoirs, and represent a conservative accounting of our total reserve base, given our cautious assumptions about ultimate recovery rates. We are also working hard to identify new reserves through additional discoveries, enhanced recovery techniques...for many years we have been able to make healthy additions to our reserves, or at the very least to replace our production, meaning that despite our prolific output, we have not had to draw down our total reserves. ... At the moment, we account for about 11 percent of the world's production of crude oil. Depending on market demand, we can now produce 10 million barrels of oil daily, and easily sustain that production level for the next five decades...we have developed a range of long-term crude development scenarios that would raise our production capacity to 12 or even 15 million barrels a day.*<sup>xxiii</sup>

The Global Investor (May-July 2004) concluded that OPEC will endeavour to keep oil prices within its desired band, because they are fully aware that high oil prices are not conducive to long-term economic stability and world markets and that higher prices also provide incentives toward seeking alternative energy sources. The BBC supports this interpretation of OPEC's assumed responsibility for price stability, noting recently noted that 'the west is gradually waking up to the fact that in recent years OPEC has been trying to ensure market stability through its price range mechanism.'<sup>xxiv</sup>

## **Conclusions and policy implications**

Forecasting oil prices is probably best left to those that pay the price for being wrong. Sudden price spikes can engender panic amongst observers and the resultant debate often confuses long-term and short-term trends. Prices approached US\$50 a barrel late August 2004 in response to a combination of strong demand, scarce production capacity, concerns about continuity of supplies event of output disruptions in Iraq, Saudi Arabia, Russia and Venezuela and jittery speculator activity. None of these factors touch on the key elements of the debate between the Peak Theorists and the international institutions: the estimate of recoverable resources, the role of prices, and the appropriate role for the government.

Part of the difference in the URR estimates can be attributed to the use of different recovery factors and the inclusion of reserve growth by the international agencies in formulating their estimates. Hence, these differences stem more from differing economic and technological assumptions than from disagreements about geology. Both sides of the debate recognise that resource assessments are never 'correct' in an absolute sense, but evolve through time as knowledge, technology, and economics change<sup>xxv</sup> and that: 'nobody knows how much oil exists under the earth's surface or how much it will be possible to produce in the future. All numbers are, at best, informed estimates'.<sup>xxvi</sup>

There is less agreement on the role of prices. The Antidepletionists generally view the role of prices as two-fold: to signal changes in scarcity/abundance and to encourage the market to adapt to these changes. Future price expectations quantify the net effect of a mass of information including the current state of existing reserves and of the investment needed at the margin to install an additional unit of capacity. As observed by the EIA (2004 p. 37):

*Resources are defined as 'nonconventional' when they cannot be produced economically at today's prices and with today's technology. With higher prices, however, the gap between conventional and nonconventional oil resources narrows. Ultimately, a combination of*



*escalating prices and technological enhancements can transform the nonconventional into the conventional.*

In contrast, the Peak Theorists express serious doubts over the reliability of oil prices to signal increasing scarcity and in the role of economics, in general, in determining oil reserves and influencing usage. Currently, the institutional long-term price projections are not consistent with the Peak Theorists' view that oil is soon to become ever more scarce and expensive. The price spikes of August 2004 combined with the higher long-term price forecasts floated by some of the financial institutions are greeted warmly by the Peak Theorists.<sup>xxvii</sup>

While the Peak Theorists case that oil prices are destined to rise after the 'low hanging fruit' has been exhausted (identified as the Big Rollover) is appealing, such diminishing returns are only one factor that influences oil prices, and may not be the determining factor:

*...what we observe is the net result of two contrary forces: diminishing returns, as the industry moves from larger to smaller deposits and from better to poorer quality, versus increasing knowledge—of science and technology generally, and of local geological structures. So far increasing knowledge has won, but nobody can say how long this will continue (Adelman 1995 p. 292).*

When focussing on prices it is important to use *real* rather than *nominal*. While current prices seem high, in real terms they are well below the peaks of the early and mid eighties (see Figure 10). Claims that 'allowing for inflation, real oil prices are almost as high as during the last Gulf War in 1990-91 and higher than during the world's first oil shock in the early 1970s' ignore the fact that prices in those two periods were not particularly high (Bassanese 2004).

However, the crucial message of this paper is that the debate regarding future oil supplies threatens to distract policy makers from the key issue, which is to determine the appropriate role for the government. When approached from a policy framework it appears that disagreements over terminology, estimation techniques and motivations of the protagonists are likely to be irrelevant.

The sub-text in the Peak Theorists' argument is the view that governments should divert more taxpayer funds into alternatives to oil and into measures aimed at reducing 'oil dependency' in general because the market cannot be trusted to find the right solutions. Such intervention may take a variety of forms but generally translates into subsidies that would not normally be warranted.

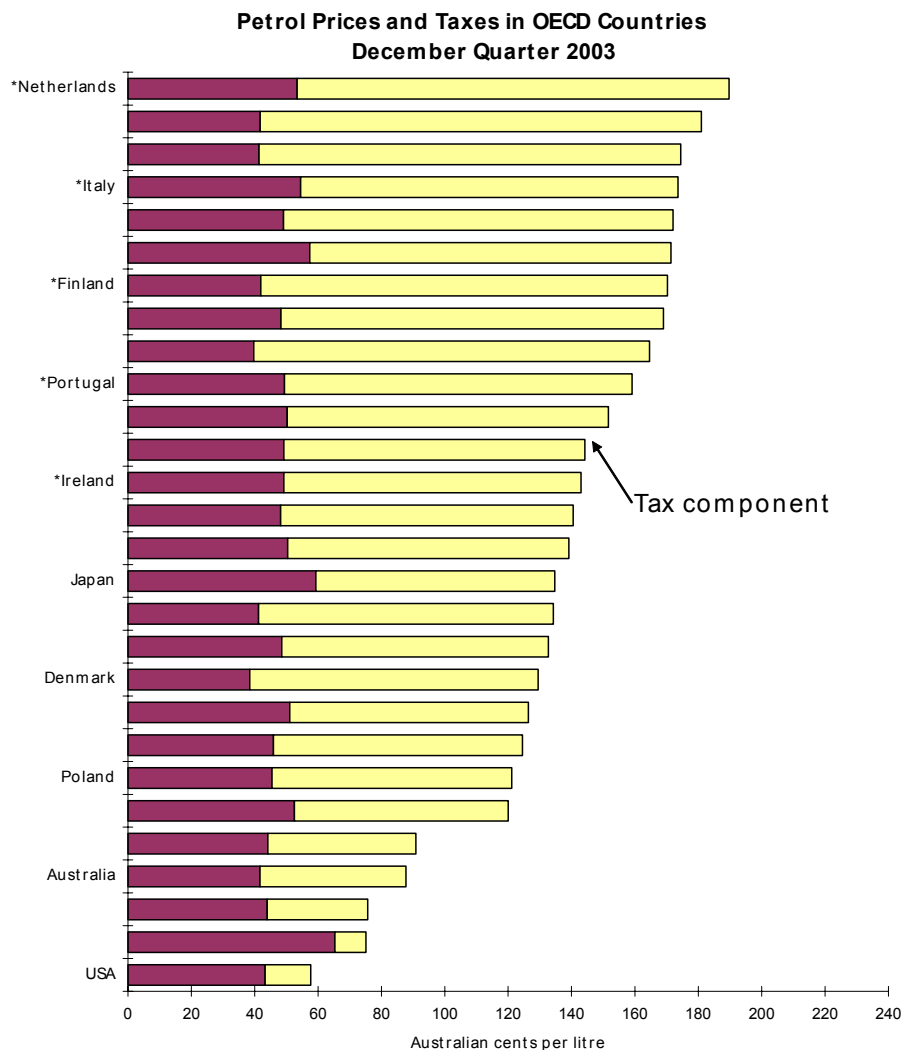
However, a basic rule of government intervention is to treat market failure at its source. If, as is implied, the absence of reliable data is the source of the problem, then options for treating the problem directly (say through government action to ensure the provision of reliable data) should be explored. Some progress has been made in the U.S. in requiring independent auditing—a major step towards more accurate data. Also, the key 'swing' producer, Saudi Arabia, has agreed to improve the access to information regarding their reserves.

Since data is not costless, it would be unrealistic to aim to remove all uncertainty regarding future oil supplies. However, improving the reliability of market intelligence would be the first logical step for government intervention if inaccurate market signals were identified as the source of market failure. Regardless of which side of the argument the policymakers find more convincing, any policy response would require sound data. If it were to be collected as a prelude to direct government intervention then arguably a case could be made to take the step of better informing the market (treating the problem at its source) before embarking on the next stage of overriding market preferences.<sup>xxviii</sup>

If, after ensuring more accurate market intelligence, governments were persuaded by the Peak Theorists' that the market was still undervaluing oil, then the most direct and efficient way of

dealing with the perceived problem would be to ‘correct’ oil prices. As it turns out, most developed countries have already gone a long way to increasing the fuel prices above the market price. Within the OECD average fuel excise rates are significantly greater than 100 per cent. (see Figure 13 below). Further assistance in achieving this (non) goal has been provided by the OPEC semi-cartel which limits supply to achieve higher prices, serendipitously resulting in a slower extraction rate than otherwise.

Furthermore, these measures have been put in place with no regard to the possibility that oil prices could be *too high* and hence encourage greater conservation than is in the community’s long term interest.



**Figure 13 Petrol Prices and Taxes in OECD Countries (Dec Quarter 2003)**

Source – IEA 2003 Energy Prices and Taxes 2003

From a policy perspective, the main issue is not so much one of the physical quantities of oil remaining, nor of the dynamic measure of oil supplies resulting from the overlay of economic factors, but of the efficient operation of the oil market and the factors that may inhibit that operation. Is oil being depleted at an optimal rate, taking into account future estimates of

supply and demand, exploration and extraction costs and technological improvements? If not, why not and what can governments do, if anything, to correct the problem?

It is a little difficult not to suspect that the Peak Theorists regard the ‘oil crisis’ as an opportunity to encourage governments to override individual choice and personal responsibility when Campbell (2002a) concludes that ‘the transition to decline is a period of great tension when priorities shift to self-sufficiency and sustainability. It may end up a better world, freed from the widespread gross excesses of today’.

Self-sufficiency may have intrinsic appeal, but it is important to recognise that it comes at a significant cost—a cost that may be more difficult to bear if the world economies are in a decline due to a long period of high oil prices.

The threshold question is ‘what is the role of the government in the area of resource security?’ Welfare economists would argue that a soundly operating market is more likely to deal effectively with the timely and efficient allocation of scarce oil reserves than government planners who, in the words of one U.S. Congressional witness ‘simply do not have a very good track record when it comes to the centralized allocation of resources’.<sup>xxix</sup> Seltzer also noted that supply shortages are often not the main problem:

*Often ignored, however, is that the price spikes experienced in 1973, 1979, and 1990 were not caused primarily by international oil shortages...Rationing, punishing taxation, trade restrictions, and political embargoes—not dramatic supply cutbacks by producing nations—are what caused the price increases of those years.*

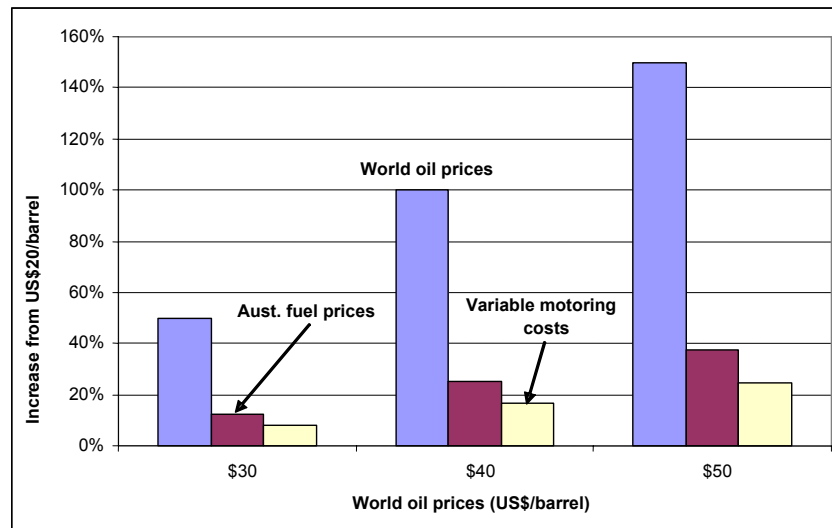
Should governments have in place emergency plans in case of dramatic increases in the price of oil? It needs to be recognised that Australia wins and loses from rising world oil prices: benefiting from the resultant rise in the value of energy exports but losing higher domestic energy prices and through the world economic slump that may result. The net impact would depend on many factors, including the value of the Australian dollar. However, the chances of a net loss would increase if governments were to embark on a program of subsidising non-viable energy sources and thereby producing negative returns for the taxpayer.<sup>xxx</sup>

While views are mixed on the economic impact of sustained high oil prices, there seems to be no signs of panic amongst analysts. Conclusions (albeit qualified) of the Royal Bank of Scotland Group seem typical:

*...even if oil prices were to rise to \$80 per barrel in early 2005 and remain high for the following two years, the impact on the world economy would be serious but not catastrophic (RBS 2004).*

In Australia, motorists’ sensitivity to rising petrol prices can become a political issue. So what is the likely impact of a steep rise in oil prices on the price of petrol at the bowser? The cost of crude oil is only one component of the retail price of petrol. Also, petrol accounts for around two thirds of vehicle operating costs (Holden Commodore 3.8 litre see BTRE 2003). The cushioning effect of the taxes on fuel also serves to soften the impact of increasing oil prices.

As a result, the answer is ‘not as significant as it might first appear’. A jump in oil prices from \$20 to \$50 a barrel (representing a 150 per cent increase in price) would increase the price of petrol around 38 per cent and the cost of motoring somewhere closer to 25 per cent. This is illustrated by Figure 14 below. A doubling of world oil prices (from \$20-\$40 a barrel) increases variable motoring costs less than 20 per cent.



**Figure 14 Impact of world price of oil on fuel price and variable motoring costs in Australia**

Sources: BTRE 2003, Table VII.1 and <http://www.shell.com.au/petrolpricing/>

There is another way of evaluating the impact of rising world oil prices. If, as the BTRE estimates, the average motorist uses 1500 litres of fuel a year, then each 10 cent jump in the per litre price of petrol would be equivalent to the cost of one (Canberra) cappuccino a week—about \$3.

In brief, the debate is important, with far-reaching ramifications. However, the policy implications are likely to be the same regardless of which view of the future that governments endorse.

## References

Adelman, M. 1995, Trends in the Price and Supply of Oil, in *The State of Humanity*, J. Simon (ed), Blackwell Publishers Inc, Cambridge, U.S., ISBN I 55786 119 6.

Ahlbrandt, H. and McCabe, P. 2002, *Global Petroleum Resources: a View to the Future*, Geotimes, November, <http://cima.uprm.edu/~morelock/pdfdoc/usgsoil.pdf>

Aleklett, K and Campbell, C. 2003, *The Peak and Decline of World Oil and Gas Production*, (Uppsala University, Sweden)  
<http://www.isv.uu.se/UHDSG/articles/OilpeakMineralsEnergy.doc>

Aleklett, K. 2004 3rd European Congress on Economics and Management of Energy in Industry, Lisbon, Portugal, 6-9 April 2004,  
<http://www.isv.uu.se/UHDSG/articles/LisbonPDF.pdf>

Aleklett, K. and Campbell, C. 2002 (eds), *ASPO Statistical Review of Oil and Gas*, Proceedings of the 1st International Workshop on Oil Depletion, Uppsala, Sweden, 23-25 May, [www.isv.uu.se/iwood2002](http://www.isv.uu.se/iwood2002)

Bassanese, D 2004, *Is this the end of cheap oil?* The Weekend Australian Financial Review, Aug 21-22, Perspective p. 22.

Bakhtiari, S., 2004, World oil production capacity model suggests output peak by 2006-07, *Oil & Gas Journal* April 26, <http://stewa.org.au/BO2/Bakhtiari-O&GJ-April%202004.doc>

- British Petroleum 2003, *Statistical review of world energy 2003*,  
[http://www.bp.com/liveassets/bp\\_internet/globalbp/STAGING/global\\_assets/downloads/B/B\\_P\\_statistical\\_review\\_of\\_world\\_energy\\_2003\\_print\\_version.pdf](http://www.bp.com/liveassets/bp_internet/globalbp/STAGING/global_assets/downloads/B/B_P_statistical_review_of_world_energy_2003_print_version.pdf)
- British Petroleum 2004, *Statistical review of world energy 2004*  
<http://www.bp.com/subsection.do?categoryId=95&contentId=2006480>
- Bureau of Transport and Regional Economics (BTRE) 2003, *Regional Public Transport in Australia: Long-distance Services, Trends and Projections*, Working Paper 51,  
[http://www.btre.gov.au/docs/wp\\_51/index.htm](http://www.btre.gov.au/docs/wp_51/index.htm)
- Campbell C. 2003, *Reserve growth isn't quite what it seems*, ASPO Newsletter 36, December,  
<http://www.asponews.org/docs/Newsletter36.doc>
- Campbell, C. 2002a, *Peak Oil: an Outlook on Crude Oil Depletion*, February  
[http://greatchange.org/ov-campbell\\_outlook.html](http://greatchange.org/ov-campbell_outlook.html)
- Campbell, C. 2002b, *International Workshop on Oil Depletion*, Uppsala, Sweden, May 23-25,  
<http://www.isv.uu.se/iwood2002/abstractCC.html>
- Campbell, C. and Laherrère, J 1998, *The end of cheap oil*, Scientific American March  
 available at <http://dieoff.org/page140.htm>
- Campbell, C. and Laherrère, J. 1995. *The World's Oil Supply 1930-2050*, Vol. 1.  
 Petroconsultants S.A., Geneva, October.
- Deming, D. 2000, *Oil: Are We Running Out?* Second Wallace E. Pratt Memorial Conference  
 'Petroleum Provinces of the 21st Century', January 12-15, San Diego, California,  
[http://geology.ou.edu/library/aapg\\_oil.pdf](http://geology.ou.edu/library/aapg_oil.pdf)
- Deming, D. 2003, *The Petroleum Age is Just Beginning*,  
<http://www.ncpa.org/abo/quarterly/20033rd/clips/Petroleum.html>
- Duncan, R. 2001, *World Energy Production, Population Growth and the Road to the Olduvai Gorge*, Population and Environment, Vol. 22 No. 5, May-June
- Duncan. R. 2001, *Review of USGS World Oil Outlook 2000* USGS Assessment 2000
- Duncan. R. and Youngquist, W. 1999, *Encircling the Peak of World Oil Production*,  
[http://www.mnforsustain.org/duncan\\_and\\_youngquist\\_encircling\\_oil.htm](http://www.mnforsustain.org/duncan_and_youngquist_encircling_oil.htm)
- Energy Information Agency 2004, *International Energy Outlook 2004*, May  
[ftp://ftp.eia.doe.gov/pub/pdf/international/0484\(2004\).pdf](ftp://ftp.eia.doe.gov/pub/pdf/international/0484(2004).pdf)
- Fleay, B. 1998, *Climaxing oil: how will transport adapt?* Paper presented at the Chartered  
 Institute of Transport in Australia National Symposium, Launceston Tasmania 6-7 November,  
<http://www.wistp.murdoch.edu.au/teaching/N212/n212content/topics/topic5/00content.html>
- Fumento, M. 2004 *Are We, Or Are We Not, Running Out of Oil?*  
[http://www.capitolhillblue.com/artman/publish/article\\_4525.shtml](http://www.capitolhillblue.com/artman/publish/article_4525.shtml)
- Global Investor, May-July 2004, [http://research.credit-suisse.ch/globalinv/globalinv\\_1.pdf](http://research.credit-suisse.ch/globalinv/globalinv_1.pdf)
- Greene, D., Hopson, J. and Li, J, 2003, *Running out of and into oil: analyzing global oil  
 depletion and transition through 2050*, October, [http://www-  
 cta.ornl.gov/cta/Publications/pdf/ORNL\\_TM\\_2003\\_259.pdf](http://www-cta.ornl.gov/cta/Publications/pdf/ORNL_TM_2003_259.pdf).
- Hall, C., Tharakan, P., Hallock, J., Cleveland, C. and Jefferson, M. 2003, Hydrocarbons and  
 the evolution of human culture, in *Nature*, vol. 26, 20 November,  
<http://www.hubbertpeak.com/cleveland/OilAndCulture.pdf>

International Energy Agency 2000, *Long term world oil supply: (a resource base/production path analysis)*

[http://www.eia.doe.gov/pub/oil\\_gas/petroleum/presentations/2000/long\\_term\\_supply/sld001.htm](http://www.eia.doe.gov/pub/oil_gas/petroleum/presentations/2000/long_term_supply/sld001.htm)

International Energy Agency 2004, *Impact of energy prices on the world economy*

[http://www.iea.org/Textbase/Papers/2004/High\\_Oil\\_Prices.pdf](http://www.iea.org/Textbase/Papers/2004/High_Oil_Prices.pdf)

International Petroleum Encyclopedia 1998, *Reserves growth: What does it mean for oil supply?*

[http://orc.pennnet.com/Articles/Article\\_Display.cfm?Section=Articles&ARTICLE\\_ID=115013](http://orc.pennnet.com/Articles/Article_Display.cfm?Section=Articles&ARTICLE_ID=115013)

Klaus, R. 2004, *Is The World Facing a 3rd Oil Shock?* International Energy Agency 12 July,

[http://www.iea.org/dbtw-wpd/Textbase/speech/2004/kr\\_rio.pdf](http://www.iea.org/dbtw-wpd/Textbase/speech/2004/kr_rio.pdf)

Laherrère, J. 2002, *Is FSU Oil Growth Sustainable*, Petroleum Review April per cent. 29-35,

<http://www.hubbertpeak.com/laherrere/PetRev200204.pdf>

Laherrère, J., 2003 *Future of oil supplies* Seminar Center of Energy Conversion Zurich May

7, <http://www.oilcrisis.com/laherrere/zurich.pdf>

Lindgren, G. 2004, *Oil's 'Big Rollover' Could Happen This Decade*,

<http://www.gunnarlindgren.com/rollover1.PDF>

Longwell, H. 2002, *The Future of the Oil and Gas Industry: Past Approaches, New Challenges*, World Energy vol. 5 no. 3,

[http://www.worldenergysource.com/articles/pdf/longwell\\_WE\\_v5n3.pdf](http://www.worldenergysource.com/articles/pdf/longwell_WE_v5n3.pdf)

Lynch, M. 1998, *Crying wolf: warnings about oil supply*, Massachusetts Institute of

Technology <http://sepwww.stanford.edu/sep/jon/world-oil.dir/lynch/worldoil.html>

Monbiot, G. 2003 *The Bottom of the Barrel*, The Guardian 2nd December, available at

[http://www.monbiot.com/dsp\\_article.cfm?article\\_id=625](http://www.monbiot.com/dsp_article.cfm?article_id=625)

Odell, P. 2000, *The Global Energy Market in the Long Term: The Continuing Dominance of Affordable Non-Renewable Resources* <http://www.kkrva.se/sve/energi/odell.shtml>

Odell, P. 2003, *The Global Energy Outlook for the 21st Century*,

[http://www.clingendael.nl/ciep/lectures/lecture\\_2003\\_05\\_21.htm](http://www.clingendael.nl/ciep/lectures/lecture_2003_05_21.htm)

Robinson, C. 2004, Markets, imperfections and the dangers of over-regulating energy

markets, *Economic Affairs* vol. 24 no. 2 June, available through <http://www.blackwell-synergy.com/servlet/useragent?func=callWizard&wizardKey=salesAgent:1093302208240&action=show>

The Hubert Peak of Oil Production – this website has links to many articles supporting the peak oil case <http://www.hubbertpeak.com/>.

Tulpulé, V. 2004, *Oil Price Projections*, presentation to Bureau of Transport and Regional Economics Oil Outlook Forum 11 August (available on request from BTRE).

U.S. Geological Survey World Energy Assessment Team, *U.S. Geological Survey World Petroleum Assessment 2000* <http://pubs.usgs.gov/dds/dds-060/>

Zittel, W. and Schindler, J. 2002, *Future world oil supply*, International Summer School on the Politics and Economics of Renewable Energy, Salzburg July.



## List of Acronyms And Abbreviations

<b>P1</b>	proved reserves > 90 % certainty
<b>P2</b>	probable reserves > 50 % certainty
<b>P3</b>	possible reserves > 10 % certainty
<b>Bl</b>	Barrel
<b>EIA</b>	Energy Information Agency (within the U.S. Department of Energy and producers of the International Energy Outlook (IEO))
<b>Gb</b>	Gigabarrel, or billion barrels
<b>Gt</b>	Billion of tons
<b>Gtoe</b>	Billion of tons oil equivalent
<b>IEA</b>	International Energy Agency
<b>Mt</b>	Million tons
<b>Mtoe</b>	Million ton oil equivalent
<b>OPEC</b>	Organisation of Petroleum Exporting Countries

## Conventional Oil

There is no universal agreement on how to define it. Campbell defines it to exclude oil from coal and “shale” and bitumen and extra-heavy oil

## Grown Conventional Petroleum Endowment

Sum of the known petroleum volume (cumulative production plus remaining reserves), the mean of the undiscovered volume, and additions to reserves by reserve growth

## Grown Petroleum Volume

Known petroleum volume adjusted upward to account for future reserve growth. For the USGS2000 assessment, 30 years of reserve growth is considered

## Known Petroleum Volume

Sum of cumulative production and remaining reserves as reported in the databases used in the USGS2000 assessment. Also called estimated total recoverable volume or *ultimate recoverable reserves*

## Remaining Petroleum Reserves

Volume of petroleum in discovered fields that have not yet been produced. For this assessment, remaining reserves were calculated by subtracting cumulative production from known volumes.

**Reserves** oil that can be recovered commercially with current technology

## Reserve Growth

Increases in known petroleum volume that commonly occur as oil and gas fields are developed and produced. This term describes the process by which technical improvements and correction of earlier conservative estimates increase the projected recovery from existing fields. This relatively new addition to the USGS methodology is based on experience in the US and a few other well documented regions (Hall *et al* 2002). The terms reserve growth and field growth are often used interchangeably.

## Undiscovered Recoverable Reserves

## 22 Are we running out of oil?

Those economic resources of crude oil yet discovered, but that are estimated to exist in favourable geologic settings.

**URR** ultimate recoverable resource is the total quantity of oil that will ever be produced, including the nearly 1 trillion barrels extracted to date

### USGS Assessed Petroleum Volumes

The quantities of oil, gas, and natural gas liquids that have the potential to be added to reserves within some future time frame. For this assessment, the time frame is 30 years. The USGS assessed petroleum volumes includes those from undiscovered fields, whose sizes are greater than or equal to the stated minimum field or pool sizes, and from the reserve growth of fields already discovered.

**Sources:** USGS 2000 <http://energy.cr.usgs.gov/WEcont/chaps/GL.pdf>, [http://www.eia.doe.gov/glossary/glossary\\_g.htm](http://www.eia.doe.gov/glossary/glossary_g.htm), <http://www.isv.uu.se/UHDSG/articles/LisbonPDF.pdf>, <http://greatchange.org/ov-campbell,outlook.html>

### Endnotes

- 
- i For more background on Hubbert see <http://www.hubbertpeak.com/hubbert/>.
- ii [http://www.iea.org/dbtw-wpd/textbase/press/pressdetail.asp?PRESS\\_REL\\_ID=97](http://www.iea.org/dbtw-wpd/textbase/press/pressdetail.asp?PRESS_REL_ID=97)
- iii USGS 2000, <http://energy.cr.usgs.gov/WEcont/chaps/ES.pdf>
- iv Reserve growth is calculated as a product of known petroleum volume and a 30-year growth multiplier, estimated by the USGS assuming that petroleum reserves everywhere in the world will be developed with the same level of technology, economic incentives and efficacy as in the U.S.
- v *Proved* means quantities that with reasonable certainty can be recovered from known reservoirs under existing economic and operation conditions. A standard interpretation of *proved* is a 90 per cent chance of producing the estimated reserves (P90).
- vi EIA 2004 [http://www.eia.doe.gov/oiaf/ieo/pdf/0484\(2004\).pdf](http://www.eia.doe.gov/oiaf/ieo/pdf/0484(2004).pdf)
- vii <http://www.ncpa.org/abo/inthenews/Petroleum.html>.
- viii By the year 2000, the estimate had grown to 3,000 billion barrels (Deming, D. 2003)
- ix The Economist Feb 2001 [http://www.economist.com/displayStory.cfm?Story\\_id=497454](http://www.economist.com/displayStory.cfm?Story_id=497454)
- x <http://sepwww.stanford.edu/sep/jon/world-oil.dir/lynch/worldoil.html>
- xi Laherrère (2003) also criticised the ‘negative camp’ for using political (published) data rather than the technical (confidential) data utilised by the affirmative camp. While potentially important, is beyond the scope of this paper.
- xii Campbell <http://www.isv.uu.se/UHDSG/articles/OilpeakMineralsEnergy.doc>
- xiii Campbell (2002) <http://greatchange.org/ov-campbell,outlook.html>
- xiv See Oil and Gas Journal  
[http://ogi.pennnet.com/forum/display\\_messages.cfm?CategoryID=1&TopicID=685&SiteIDs=OGJ](http://ogi.pennnet.com/forum/display_messages.cfm?CategoryID=1&TopicID=685&SiteIDs=OGJ)
- xv Campbell 2002 <http://greatchange.org/ov-campbell,outlook.html>
- xvi For more detail see  
[http://www.bp.com/liveassets/bp\\_internet/globalbp/STAGING/global\\_assets/downloads/T/Table\\_of\\_proved\\_oil\\_reserves\\_at\\_end\\_2002.pdf](http://www.bp.com/liveassets/bp_internet/globalbp/STAGING/global_assets/downloads/T/Table_of_proved_oil_reserves_at_end_2002.pdf)
- xvii <http://www.oilcrisis.com/laherrere/supply.htm>
- xviii Source
- xix Greenspan, A. 2004, remarks before the Center for Strategic & International Studies, Washington, D.C. April 27, <http://www.federalreserve.gov/boarddocs/speeches/2004/20040427/default.htm>
- xx [http://library.iea.org/textbase/weo/pubs/weo2002/WEO2002\\_1sum.pdf](http://library.iea.org/textbase/weo/pubs/weo2002/WEO2002_1sum.pdf) p. 29
- xxi Note that these projections have been ‘smoothed out’ and do not reflect the inevitable short-term fluctuations around the average. Mishaps, natural disasters, acts of terrorism and peak demands (due to simple things like climate extremes) will all prompt short term increases in price.
- xxii World energy, technology and climate policy outlook (WETO 2030) 2003

- 
- xxiii President and Chief Executive Officer, Saudi Aramco, May 26 2004  
[http://www.saudiaramco.com/bvsm/JSP/content/articleDetail.jsp?BV\\_SessionID=@@@2037427485.1086154008@@@@&BV\\_EngineID=ccckadclimklkicefeceefdfnkdfih.0&datetime=06%2F02%2F04+08%3A26%3A48&SA.channelID=-11748&SA.programID=19469&SA.contentOID=1073763419](http://www.saudiaramco.com/bvsm/JSP/content/articleDetail.jsp?BV_SessionID=@@@2037427485.1086154008@@@@&BV_EngineID=ccckadclimklkicefeceefdfnkdfih.0&datetime=06%2F02%2F04+08%3A26%3A48&SA.channelID=-11748&SA.programID=19469&SA.contentOID=1073763419)
- xxiv See <http://news.bbc.co.uk/1/hi/business/3768971.stm>
- xxv As articulated by the USGS <http://energy.cr.usgs.gov/WEcont/chaps/AR.pdf> AR-2
- xxvi See <http://www.bp.com/genericarticle.do?categoryId=108&contentId=2004232>
- xxvii Brent oil for delivery in 2005 jumped above \$40 a barrel for the first time, in what some observers say is a crucial shift in long-market expectations (Times Online August 23 2004).
- xxviii It should be noted that those who have the evidence that the market has overestimated oil reserves have the opportunity to ‘buy long’, with the anticipation of significant profits when the market becomes better informed and the price of oil jumps.
- xxix See <http://www.cato.org/testimony/ct4-16-5.html> for full testimony.
- xxx Robinson (2004) discusses the pitfalls of governments targeting favoured energy activities.