



National Assembly for **Wales**
Cynulliad Cenedlaethol **Cymru**

Peak Oil

This research paper examines the theory of peak oil, and considers the implications for oil users of the impending peak.

Gorffennaf/July 2008

Members' Research Service / Gwasanaeth Ymchwil yr Aelodau

Peak Oil

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July 2008

Paper number: 08/042

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Executive Summary

At some point, global oil production will reach a peak.

Peak oil does not mean the end of oil, but that about half of the total amount available has been used up. The oil that remains will be more difficult and costly to extract.

Some analysts contend that the peak has occurred already, and that production will decrease slowly over time. Others expect the peak to occur within the next ten years. Most government and industry sources contend that global production will increase for the next few decades, and decrease thereafter. One such source estimates that peak oil will occur in 2037. The UK Government believes that the world's oil and gas resources are sufficient to sustain economic growth for the foreseeable future.

The UK's oil production peaked in 1999, and the UK became a net importer of oil in 2006. Imports will form an increasing proportion of oil consumption in the UK.

Authorities in the south Wales valleys tend to have a relatively low per capita use of fuel for personal road transport; rural authorities tend to have higher per capita use.

One of the manifestations of peak oil will be a rapid escalation in oil price. Oil prices are currently the highest they have ever been, even accounting for inflation. In July 2008, the Deputy First Minister wrote to HM Treasury to raise concern over the impact of increasing fuel costs on businesses and consumers in Wales.

There is broad agreement that peak oil will have profound economic impacts, and that these will in turn have social repercussions. There is also a consensus that those countries that do plan and prepare for peak oil will have an advantage over those that make no preparation. Sweden is the only country that has an explicit government commitment to breaking its dependence on oil.

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Peak Oil

1 History of Peak Oil

"That's it. I can now refer to the world oil peak in the past tense. My career as a prophet is over. I'm now an historian".

Kenneth S Deffeyes, Professor Emeritus of Geology, Princeton University, February 2006¹

Peak oil is a term that is used to describe the point in time when the maximum rate of global petroleum production is reached, after which the rate of production enters into terminal decline². There is very little disagreement about the notion that oil production will peak; the main focus of dispute is now around the timing of that peak.

In the event that demand is higher than anticipated, the peak will come sooner than predicted, to be followed by a steeper decline³. Similarly, reducing the demand for oil will delay the occurrence of peak oil. The Chief Executive of Total estimates that if oil demand growth were halved, the global oil peak would be delayed by a decade⁴.

Hubbert

Marion King Hubbert was a geophysicist (1903-1989) who suggested that the fossil fuel era would be "but a pip" in human history, with the consumption of energy from fossil fuels:

"rising sharply from zero to a maximum, and almost as sharply declining, and thus representing but a moment in the total of human history"⁵.

He developed a theory, now called Hubbert peak theory, to accurately predict in 1956 that oil production in the United States of America would peak between 1965 and 1970⁶ (the peak occurred in 1970⁷). His model has since been used to predict the peak petroleum production of many other countries. According to the model, the production rate of a limited resource follows a roughly symmetrical bell-shaped curve based on the limits of exploitability and market pressures. The shape of the curve has since been shown to vary considerably⁸, sometimes with several peaks, depending on economic, technical and political factors⁹. The concept of peak oil states that global production will follow a similar bell-shaped curve, with total production falling as oil field production peaks.

¹ Deffeyes KS (2006), [Join us as we watch the crisis unfolding](#), 11 February 2006 [accessed 17 June 2008]

² Deffeyes KS (2005), *Beyond oil: The view from Hubbert's peak*, p. xiii, Princeton: Princeton University Press

³ Campbell CJ (2002), [Forecasting global oil supply 2000-2050](#), Hubbert Center Newsletter No. 2002/3

⁴ Anon (2006), *Total sees 2020 oil output peak, urges less demand*, Reuters, 7 June 2006.

⁵ Hubbert MK (1949), [Energy from fossil fuels](#), *Science*, 109 (2823), 4 February 1949, pp. 103-109

⁶ Hubbert MK (1956), [Nuclear energy and the fossil fuels](#). API Conference, San Antonio, TX (March 7-9, 1956), later published as Publication no. 95, Shell Development Company (June 1956), p. 26

⁷ Deffeyes K (2001), *Hubbert's peak: The impending world oil shortage*, Princeton: Princeton University Press

⁸ Strahan D (2007), *The last oil shock*, London: John Murray, p. 44

⁹ Laherrere J (2002), [Comments on the book: Hubbert's peak: The impending world oil shortage](#), 6 January 2002 [accessed 17 June 2008]

2 The Theory

The theory behind the exploitation of any finite, non-renewable resource is relatively simple. Hubbert's theory¹⁰ states that:

- Production starts at zero
- Production rises to a peak
- Once the peak has been passed, production declines until the resource is depleted.

The point of maximum production tends to coincide with the midpoint of depletion of the resource, which means that when the Hubbert peak is reached, approximately half of the recoverable oil available on earth will have been used¹¹.

The best approximation of total maximum global oil production (estimated ultimate recovery) can be calculated by summation of¹²:

- The amount produced to date (cumulative production)
- Estimates of how much remains to be produced from known fields (reserves)
- Estimates of how much will be produced from undiscovered fields (yet-to-find).

Several attempts have been made to calculate the estimated ultimate recovery (Table 1). Most attempts also extrapolate a date for peak oil.

Table 1 Estimated ultimate recovery and date of peak oil

Author	Estimated ultimate recovery (barrels)	Date of peak conventional oil ¹³
Bartlett ¹⁴	2,000 billion	2004
Campbell ¹⁵	1,925 billion	2010
Deffeyes ¹⁶	2,013 billion	16 December 2005
Robelius ¹⁷	-	2018
Skrebowski ¹⁸	-	2011
USGS ¹⁹ /EIA ²⁰	3,021 billion	2037

Source: Compiled by Members' Research Service

¹⁰ Hubbert MK (1980), *Techniques of prediction as applied to the production of oil and gas*; Oil & Gas Supply Modeling, Ed. S.I. Gass; Proceedings of a symposium held at the U.S. Department of Commerce, National Bureau of Standards, Washington, D.C., June 18-20, 1980; Report N.B.S. Special Publication #631, May, 1982, p. 16-141

¹¹ Hubbert Peak of Oil Production (undated), [Theory](#) [accessed 17 June 2008]

¹² Campbell CJ (2002), [Forecasting global oil supply 2000-2050](#), Hubbert Center Newsletter No. 2002/3

¹³ Conventional oil excludes oil from coal and shale, heavy oil, deep-water oil (>500m), and polar oil

¹⁴ Bartlett AA (2000), [An analysis of US and world oil production patterns using Hubbert-style curves](#), *Mathematical Geology*, 32 (1), pp. 1-17

¹⁵ Campbell CJ (2002), [Forecasting global oil supply 2000-2050](#), Hubbert Center Newsletter No. 2002/3

¹⁶ Deffeyes KS (2006), [Join us as we watch the crisis unfolding: Estimate of uncertainty](#), 14 June 2006 [accessed 17 June 2008]

¹⁷ Robelius F (2007), [Giant oil fields – the highway to oil. Giant oil fields and their importance for future oil production](#), *Uppsala dissertations from the Faculty of Science and Technology* 69. 156pp

¹⁸ Skrebowski C (2006). Quoted in Strahan D (2007), *The last oil shock*, London: John Murray, p. 203.

¹⁹ US Geological Survey (2000), [World energy assessment](#) [accessed 17 June 2008]

²⁰ Energy Information Administration (2004), [Long-term world oil supply scenarios: The future is neither as bleak nor as rosy as some assert](#), 18 August 2004 [accessed 17 June 2008]

The Energy Information Administration in the USA estimates that world production will peak at 146 million barrels per day in 2037²¹. The National Petroleum Council notes that oil companies' average projection of global petroleum production is 96 million barrels per day in 2015 and 107 million barrels per day in 2030²². During 2005 (the year of historical maximum production), an average of 74 million barrels per day was produced²³.

The alternative to attempting to calculate when peak oil will occur is to assume that it has already happened²⁴. In this case, information from the Energy Information Administration indicates that peak oil passed in February 2008²⁵, with 74.6 million barrels per day. 2005 was the year with the highest production (an average of 73.8 million barrels was produced per day²⁶) (Figure 1).

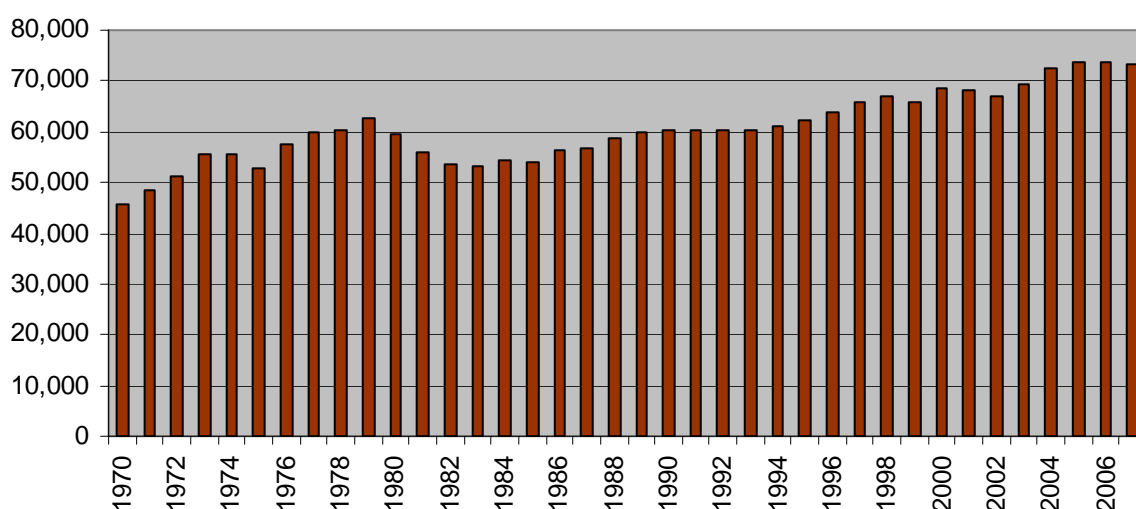


Figure 1 Average world crude oil production (thousand barrels per day). Source: Energy Information Administration

The principal problem with this approach is that the peak will only be known after the event, so it is not a useful predictive mechanism. Also, although production in 2007 was 0.7 per cent below the 2005 record, results from the first three months of 2008 indicate that production for the year may exceed the 2005 level.

The National Petroleum Council disagrees with the contentions of peak oil theorists. Its main argument is that new discoveries of oil, and new technology for enhancing recovery from existing reservoirs and unconventional sources, will delay the onset of peak oil until the 2030s²⁷. One Emeritus Professor of Economics suggests that supplies of minerals, including oil, are limitless:

²¹ *ibid*

²² National Petroleum Council (2007), [Hard truths: Facing the hard truths about energy](#), July 2007, p. 115

²³ Energy Information Administration, [Table 1.1d World crude oil production \(including lease condensate\), 1997-present](#), 9 June 2008 [accessed 17 June 2008]

²⁴ Deffeyes KS (2008), [Join us as we watch the crisis unfolding: The second Great Depression](#), 6 February 2008 [accessed 17 June 2008]

²⁵ Energy Information Administration, [Table 1.1d World crude oil production \(including lease condensate\), 1997-present](#), 9 June 2008 [accessed 17 June 2008]

²⁶ Energy Information Administration, [Table 4.1d World crude oil production \(including lease condensate\), 1970-2007](#), 9 June 2008 [accessed 17 June 2008]

²⁷ National Petroleum Council (2007), [Hard truths: Facing the hard truths about energy](#), July 2007, p. 18

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"Minerals are inexhaustible and will never be depleted. A stream of investment creates additions to proved reserves, a very large in-ground inventory, constantly renewed as it is extracted... How much was in the ground at the start and how much will be left at the end are unknown and irrelevant"²⁸.

²⁸ Adelman MA (1993), *The Economics of Petroleum Supply*. Boston: Massachusetts Institute of Technology, p. xi

3 The Political Background

"Our present national and international leadership is reluctant even to acknowledge that there is a problem... the crisis will occur, and it will be painful. The best we can realistically hope for is that when it happens, it will serve as a wakeup call, and will not so badly undermine our strength that we are unable to take the giant steps that are needed".

David Goodstein, Professor of Physics and Applied Physics, California Institute of Technology²⁹

3.1 The US Geological Survey

The US Geological Survey (USGS) produced a report in 2000 that suggested the global estimated ultimate recovery to be 3,021 billion barrels³⁰. However, this was based on assessments of new discoveries that have been challenged by many commentators³¹. In particular, the report forecasted that a mean of 674 billion barrels would be found between 1995 and 2025, an average of 23 billion barrels per year³². Between 1995 and 2002, the average of new discoveries was 10 billion barrels per year³³. Historically, the largest oil fields tend to be discovered first; in mature oil provinces, progressively smaller fields are discovered³⁴. The fact that actual discoveries have departed so far from the USGS modelling suggests an overestimate of the likely ultimate recovery.

The USGS report is used as a reference text by many government analyses.

3.2 The International Energy Agency

The International Energy Agency (IEA) acts as energy policy adviser to 27 member countries, including all 15 pre-enlargement EU Member States. It aims to assist its members' efforts to "ensure reliable, affordable and clean energy for their citizens"³⁵.

The IEA was founded during the oil crisis of 1973-74 as a result of an agreement on an International Energy Programme. Its initial role was to co-ordinate mitigation measures in times of oil supply emergencies. The objectives of the Agreement are³⁶:

- To maintain and improve systems for coping with oil supply disruptions.
- To promote rational energy policies in a global context through co-operative relations with non-member countries, industry and international organisations.
- To operate a permanent information system on the international oil market.
- To improve the world's energy supply and demand structure by developing alternative energy sources and increasing the efficiency of energy use.
- To promote international collaboration on energy technology.

²⁹ Goodstein D, quoted in Semple RB (2006), *NY Times: The end of oil*, 28 February 2006, [accessed 11 June 2008]

³⁰ US Geological Survey (2000), *World energy assessment*

³¹ For example, Campbell CJ (2002), *Forecasting global oil supply 2000-2050*, Hubbert Center Newsletter No. 2002/3; Deffeyes KS (2005), *What happens once the oil runs out?*, *New York Times*, 25 March 2005

³² US Geological Survey (2000), *World energy assessment*

³³ Campbell CJ (2002), *Forecasting global oil supply 2000-2050*, Hubbert Center Newsletter No. 2002/3

³⁴ *ibid*

³⁵ International Energy Agency (undated), *About the IEA* [accessed 17 June 2008]

³⁶ International Energy Agency (2007), *IEA response system for oil supply emergencies*, 2007, p. 1

- To assist in the integration of environmental and energy policies.

The Agreement requires IEA member countries to hold oil stocks equivalent of at least 90 days of net oil imports and, in the event of a major oil supply disruption, to release stocks, restrain demand, switch to other fuels, increase domestic production, or share available oil, if necessary. Such measures would not be taken in response to price increases, but rather an actual physical shortage³⁷. Public stocks of oil, held exclusively by member countries for emergency purposes, were 1.5 billion barrels in mid 2007³⁸. At a drawdown rate of 4 million barrels per day, these stocks would last one year. The most recent supply disruption of this scale occurred during the Iraq invasion of Kuwait (production of 4.3 million barrels per day was lost from August 1990 to January 1991)³⁹. This was one of only two events during which the IEA has acted to bring additional oil onto the markets (the other was in response to the hurricanes in the Gulf of Mexico in 2005, which caused production losses of 1.5 million barrels per day)⁴⁰.

The IEA considers world resources to be sufficiently abundant "to sustain likely growth in the global energy system for the foreseeable future"⁴¹. However, it tempers this assessment with uncertainty as to whether sufficient investment will be committed to new output up to 2030 in order to compensate for falling output in existing fields, and to keep pace with the projected increase in demand⁴².

3.3 The oil industry

Much of the oil industry contests the notion that oil production will peak in the near future. For example, the National Petroleum Council in the USA suggests that:

"the world is not running out of energy resources, but there are accumulating risks to continuing expansion of oil and natural gas production from the conventional sources relied upon historically"⁴³.

ExxonMobil placed a one-page advert in the New York Times on 2 March 2006 (in response to a peak oil article⁴⁴) stating that:

"Oil is a finite resource, but because it is so incredibly large, a peak will not occur this year, next year, or for decades to come... conservative estimates of heavy oil and shale oil push the total resource well over four trillion barrels"⁴⁵.

ExxonMobil's oil production fell almost 10 per cent in the first three months of 2008⁴⁶.

The oil industry forecasts for global oil production are higher than the lowest estimates (usually those provided by peak oil theorists), but lower than the EIA and IEA reference case scenarios⁴⁷.

³⁷ *ibid*, p. 3

³⁸ *ibid*, p. 7

³⁹ *ibid*, p. 11

⁴⁰ *ibid*

⁴¹ International Energy Agency (2005), [Resources to reserves: Oil and gas technologies for the energy markets of the future](#). Paris: International Energy Agency, p. 13

⁴² International Energy Agency (2007), [World Energy Outlook 2007: Fact Sheet – Oil](#)

⁴³ National Petroleum Council (2007), [Hard truths: Facing the hard truths about energy](#), July 2007, p. 5

⁴⁴ Semple RB (2006), [NY Times: The end of oil](#), 28 February 2006, [accessed 11 June 2008]

⁴⁵ ExxonMobil (2006), [Peak oil? Contrary to the theory, oil production shows no sign of a peak](#) [accessed 18 June 2008]

Oil companies are required to list their reserves with the US financial market regulator Securities and Exchange Commission (SEC) in the USA. The SEC regulates share trading to ensure that investors are not defrauded. An oil company's value is based largely on its reserves, and this is reflected in its share price⁴⁸. On 9 January 2004, Royal Dutch/Shell announced that 20 per cent of its 'proved' reserves⁴⁹ should be recategorised (downgraded)⁵⁰. Following the admission, £3 billion was lost on the share value⁵¹, and the company paid more than £200 million in fines and compensation⁵².

Shell recognises the inevitability of peak oil. In an internal email to staff, the Chief Executive noted that:

"Shell estimates that after 2015 supplies of easy-to-access oil and gas will no longer keep up with demand"⁵³.

The President of Shell has also commented that the recent high price of oil is related to a lack of supply: "The fundamental laws of supply and demand are at work"⁵⁴.

In May 2008, the Chairman and President of BP America Inc stated:

"We cannot change the world market... Today's high prices are linked to the failure both here and abroad to increase supplies, renewables and conservation"⁵⁵.

3.4 Industry commentators

Yergin notes that:

"This is not the first time that the world has 'run out of oil'. It's more like the fifth. Cycles of shortage and surplus characterize the entire history of the oil industry"⁵⁶.

The article was, however, written when oil was at \$60 per barrel, in 2005. The commentator's record on predicting oil prices has itself been criticised by others⁵⁷.

Riva cautions that:

"The power of the quest for profits is sometimes underappreciated by geologists in their projections of future oil availability... An oil supply crisis in the next few years appears somewhat premature, but the

⁴⁶ McNulty S, [Exxon oil production struggles for growth](#), *Financial Times*, 2 May 2008

⁴⁷ National Petroleum Council (2007), [Hard truths: Facing the hard truths about energy](#), July 2007, p. 91

⁴⁸ BBC (2004), [Oil giant Shell's investors shocked](#), 15 July 2004 [accessed 17 June 2008]

⁴⁹ The SEC permits oil companies to disclose only proved reserves that a company has demonstrated by actual production or conclusive formation tests to be economically and legally producible under existing economic and operating conditions

⁵⁰ Shell (2004), [Proved reserves recategorisation following internal review: No material effect on financial statements](#), 9 January 2004 [accessed 12 May 2008]

⁵¹ BBC (2004), [Oil giant Shell's investors shocked](#), 15 July 2004 [accessed 17 June 2008]

⁵² Webb T (2008), [Shell to write off half of last year's reserves](#), *The Observer*, 16 March 2008

⁵³ van der Veer J, quoted in Mortishead C (2008), [Shell chief fears oil shortage in seven years](#), *The Times*, 25 January 2008

⁵⁴ Hofmeister J, quoted in Hargreaves S (2008), [Don't blame us for prices – oil execs](#), CNNMoney.com, 20 May 2008

⁵⁵ Malone R, quoted in Hargreaves S (2008), [Don't blame us for prices – oil execs](#), CNNMoney.com, 20 May 2008

⁵⁶ Yergin D (2005), [It's not the end of the oil age](#), *Washington Post*, 31 July 2005

⁵⁷ Morton G (2008), [Holding Daniel Yergin and CERA accountable](#), 10 January 2008 [accessed 17 June 2008]

scales seem to be tipping in favor of geology. In the context of the 21st century, a world oil supply crisis, while not imminent, appears more likely sooner than later"⁵⁸.

In 1999, at historically low oil prices, Udall and Andrews noted:

"Although it's hard to imagine sharply higher oil prices during an oil glut, what seems unlikely is inevitable. The crunch may arrive suddenly. Or in slow motion. As former Energy Secretary Don Hodel says, "We're sleepwalking to disaster." When it happens, journalists will shout, "We're running out of oil." That's not true. Rather, we are running out of *cheap* oil. After production peaks oil will be readily available at a higher price, though in declining amounts, for at least 50 years. What we face is not a short-term crisis but a chronic shortfall... the transition to more expensive oil could be bumpy"⁵⁹.

Other commentators are convinced that peak oil will manifest itself shortly, or that it has already occurred. Deffeyes notes:

"The profits of major oil companies are piling up by the tens of billions of dollars per quarter. They are hoarding cash, buying back stock, and declaring dividends. They are not investing heavily in new facilities. If oil production has ceased growing and is about to decline, nobody needs new refineries, new pipelines, or new tanker ships. Most telling of all, the majors are not increasing their investment in exploration drilling"⁶⁰.

The lack of investment is affirmed by Alan Greenspan, former US Federal Reserve Chairman, who claimed that companies have invested too little in production and infrastructure to keep supply growing in line with higher demand⁶¹. Gordon Brown, the UK Prime Minister expressed the hope that some of BP and Shell's record £7 billion first-quarter earnings in 2008 would be invested in "getting more oil out of the North Sea"⁶².

In May 2008, the US Energy Secretary commented that:

"The high-priced energy environment is being driven by the fact that demand has outstripped supply"⁶³,

while the European Commission noted in June 2008 that:

"The current surge in oil prices is largely the result of a major structural shift in oil supply and demand in the global economy. Oil supply is struggling to keep pace with rising global demand"⁶⁴.

Simmons refers to the importance of 'giant' oilfields (those producing more than 100,000 barrels a day) in global oil supply. Approximately 3 per cent of the world's 4,000 active oilfields produce 47

⁵⁸ Riva JP (1999). [Is the world's oil barrel half full or half empty? It depends upon whether you're an economist or a geologist!](#), Hubbert Center Newsletter No. 99/2

⁵⁹ Udall R and Andrews S (1999). [When will the joy ride end? A petroleum primer](#), Hubbert Center Newsletter No. 99/1

⁶⁰ Deffeyes KS (2005), [Join us as we watch the crisis unfolding](#), 28 November 2005,

⁶¹ Tweed D (2008), [Greenspan says oil to keep rising on capacity limits](#), *Bloomberg*, 14 May 2008 [accessed 17 June 2008]

⁶² Macalister T (2008), [Brown wants profits poured into North Sea](#), *The Guardian*, 30 April 2008

⁶³ Bodman S (2008), [Testimony to the House Select Committee on Energy Independence and Global Warming](#), US Department of Energy, 22 May 2008

⁶⁴ European Commission press release IP/08/916 (2008), [Commission calls for swift adoption of energy and climate policies as best coordinated response to rising oil prices](#), 11 June 2008

per cent of the world's supply⁶⁵. The 14 largest oil fields produce 20 per cent of the world's supply. The average age of these fields is 44 years⁶⁶. None of the new fields discovered recently is projected to provide daily production in excess of 250,000 barrels (0.34 per cent of global production)⁶⁷.

3.5 The Energy Information Administration

The Energy Information Administration (EIA) is the US Government provider of energy statistics. In May 2007 it published its *International Energy Outlook 2007* (IEO2007)⁶⁸. The IEO2007 is based around a number of scenarios, shown in Table 2.

Table 2 Oil prices under different EIA scenarios, and actual price

Scenario (all prices for 2008)	Price per barrel (US\$)	Difference between projected EIA oil prices and actual oil price (per cent)
EIA low world oil price ⁶⁹	59.14	91
EIA reference world oil price ⁷⁰	63.25	79
EIA high world oil price ⁷¹	70.85	60
Actual world oil price ⁷²	113.18	-

Source: EIA IEO2007, EIA, and Members' Research Service calculations.

Under the reference scenario of IEO2007, world consumption of petroleum⁷³ increases from 83 million barrels per day in 2004 to 97 million in 2015 and 118 million in 2030⁷⁴. Such a projection does not recognise the possibility either that peak oil has already occurred (at a maximum of 74 million barrels per day in 2005), or that it will occur in the near future.

The series of International Energy Outlook documents produced since 2001 has consistently underestimated the likely future price of oil (Figure 2).

⁶⁵ Simmons MR (2002), [The world's giant oilfields](#), 9 January 2002 [accessed 17 June 2008]

⁶⁶ *ibid*

⁶⁷ *ibid*

⁶⁸ Energy Information Administration (2007), [International energy outlook 2007](#), May 2007

⁶⁹ *ibid*, p. 12

⁷⁰ *ibid*, p. 30

⁷¹ *ibid*, pp. 14 and 30

⁷² Actual world oil price is 2008 average, up to and including 14 July 2008

⁷³ Petroleum refers to all conventional crude oil and energy liquid substitutes

⁷⁴ Energy Information Administration (2007), [International energy outlook 2007](#), May 2007, p. 29

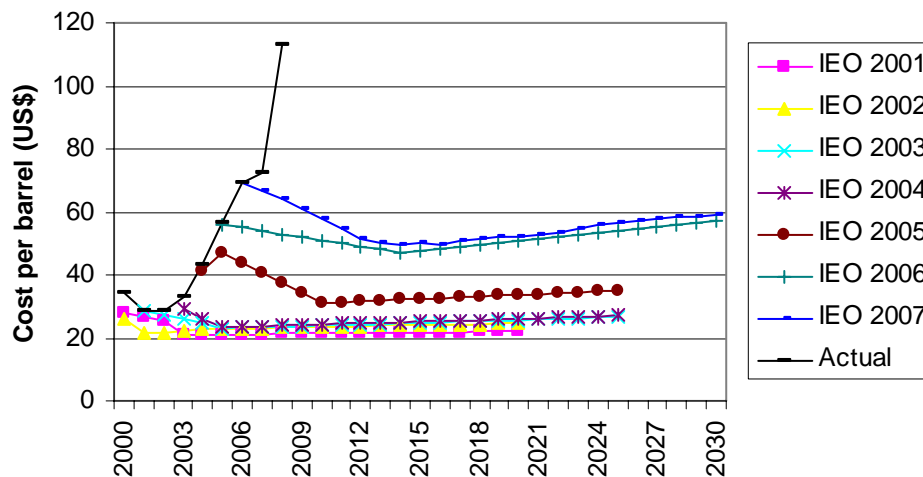


Figure 2 EIA International Energy Outlook forecasts of oil price, and actual oil price. Source: EIA. 2008 price is the average up to and including 14 July

The EIA information uses industry standard journals and sources, and is regarded as being one of the main repositories of information on the subject. According to the EIA, proved reserves⁷⁵ of global oil are approximately 1.2 trillion barrels⁷⁶. However, these proved reserves include the official reports from the member countries of the Organisation of the Petroleum Exporting Countries (OPEC). Many commentators outside the oil establishment regard the reserve reporting from some of the OPEC countries as dubious⁷⁷. One example of mistrust in official figures derives from the Iraqi troops' firing of Kuwaiti oilfields, which destroyed 2 billion barrels of oil, but which was not reflected in official Kuwaiti reserve figures⁷⁸. In January 2006, *Petroleum Intelligence Weekly* uncovered official data that suggested Kuwait's reserves to be less than half the official value⁷⁹.

More significantly, during the 1980s, there was discussion that the size of OPEC countries' reserves should be a factor in the calculation of a country's export quota. Since a larger export quota meant greater oil export revenue for the country concerned, there is suspicion that the increases in OPEC quotas between 1986 and 1991 (amounting to more than 300 billion barrels of oil) were little more than a political exercise⁸⁰. Growth in reserves over the period is believed to have contributed no more than 100 billion barrels to OPEC inventories⁸¹. Furthermore, between 1990 and 1999, there were no significant changes in the annually claimed oil reserves of seven of

⁷⁵ Proved reserves are estimated quantities that analysis of geologic and engineering data demonstrates with reasonable certainty (80-90 per cent) are recoverable under existing economic and operating conditions.

⁷⁶ Energy Information Administration (2007), [World proved reserves of oil and natural gas, most recent estimates](#), 9 January 2007 [accessed 17 June 2008]

⁷⁷ For example, Robelius F (2007), [Giant oil fields – the highway to oil. Giant oil fields and their importance for future oil production](#), Uppsala dissertations from the Faculty of Science and Technology 69. 156pp.

Riva JP (1999). [Is the world's oil barrel half full or half empty? It depends upon whether you're an economist or a geologist!](#), Hubbert Center Newsletter No. 99/2, and

Ivanhoe LF (2000), [Oil reserve revisions: Major OPEC and communist countries 1979 to 1999](#), Hubbert Center Newsletter No. 2000/2-2, and

Laherrere J (2007), [Uncertainty of data and forecasts for fossil fuels](#) [accessed 17 June 2008]

⁷⁸ Riva JP (1999). [Is the world's oil barrel half full or half empty? It depends upon whether you're an economist or a geologist!](#), Hubbert Center Newsletter No. 99/2

⁷⁹ Anon (2006). [Oil reserves accounting: The case of Kuwait](#), *Petroleum Intelligence Weekly*, 30 January 2006

⁸⁰ Ivanhoe LF (2000), [Oil reserve revisions: Major OPEC and communist countries 1979 to 1999](#), Hubbert Center Newsletter No. 2000/2-2, p. 6

⁸¹ *ibid*

the largest oil producers in the world⁸², even though they produced 105 billion barrels of oil between them (this amount was not deducted from their 'proven reserves')⁸³. There is no way to audit sovereign governments' claims⁸⁴.

3.6 The UK Government

The UK Government has argued that oil (and gas) resources will not peak for at least a few decades. In 2006, it was the UK Government's view that although global oil and gas production will one day peak:

"We believe that such a peak is not imminent and will not be reached until some time after 2030, provided the necessary investments in expanding and replacing production capacity are made"⁸⁵.

In October 2007, the UK Government's assessment was that:

"the world's oil and gas resources are sufficient to sustain economic growth for the foreseeable future"⁸⁶.

Then, in May 2008, the UK's Prime Minister stated that:

"The cause of rising prices is clear: growing demand and too little supply to meet it both now and - perhaps of even greater significance - in the future... Our strategic interests... all now point in the same direction: decreasing dependency on oil"⁸⁷.

The UK Government's analysis of the oil supplies within its jurisdiction has proven erroneous. In the 2003 Energy White Paper, the UK Government predicted that "by around 2006 we will also be a net importer of gas and by around 2010 of oil"⁸⁸. The UK became a net importer of gas in 2004⁸⁹, and of oil in 2006⁹⁰.

⁸² Saudi Arabia, Kuwait, Iraq, Iran, United Arab Emirates, Russia and China

⁸³ Ivanhoe LF (2000), [Oil reserve revisions: Major OPEC and communist countries 1979 to 1999](#), Hubbert Center Newsletter No. 2000/2-2

⁸⁴ *ibid*

⁸⁵ Wicks M (2006). [Peak oil letter from UK Energy Minister](#), Energy Bulletin, 9 May 2006

⁸⁶ 10 Downing Street (2007), [Peak oil – petition reply](#) [accessed 17 June 2008]

⁸⁷ Brown G (2008), [Gordon Brown: We must all act together](#), *The Guardian*, 28 May 2008

⁸⁸ DTI (2003), [Energy White Paper: Our energy future – creating a low carbon economy](#), London: DTI, p. 9

⁸⁹ Tran M (2005), [Q&A: Gas Prices](#), *The Guardian*, 23 November 2005

⁹⁰ DBERR (2008), [Table 3.1.1: Crude oil and petroleum products: Production, imports and exports 1970 to 2006](#) [accessed 26 June 2008]

4 Oil Prices and Production

"There is a different and more fundamental cost that is independent of the monetary price. That is the energy cost of exploration and production. So long as oil is used as a source of energy, when the energy cost of recovering a barrel of oil becomes greater than the energy content of the oil, production will cease no matter what the monetary price may be".

Dr M King Hubbert (1903-1989), Former Senior Research Geophysicist at the US Geological Survey⁹¹

4.1 Oil prices

Oil prices have been of particular interest recently, largely as a result of substantial increases (Figure 3).

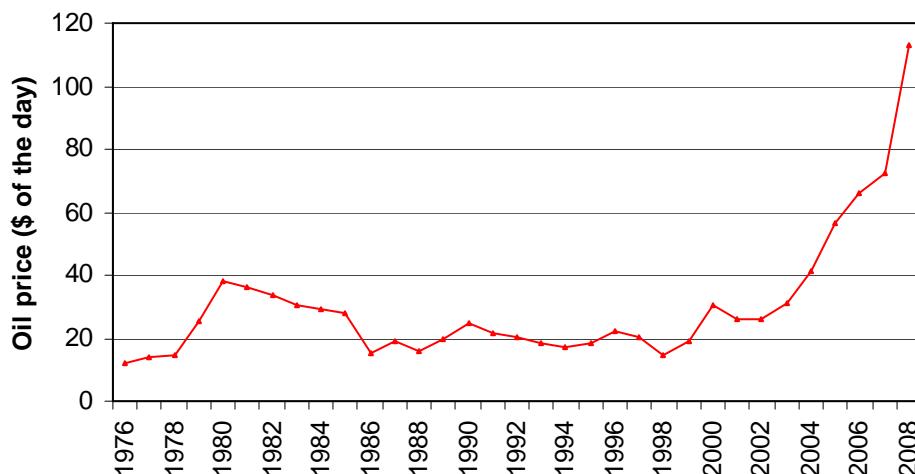


Figure 3 Average oil price per barrel (actual prices) (data up to 14 July 2008 inclusive). Source: BP⁹² and EIA⁹³

There have been rapid increases in oil prices before. There were seven post-war oil crises up to 2003; in none of these cases was a peak oil scenario reached⁹⁴. All crises involved the Middle East, and all involved the deliberate stoppage of exports by oil-producing countries. The main difference between the high oil prices of 2008 and earlier spikes in oil price is that many commentators believe that global production is largely maximised⁹⁵.

This theory bears consideration when examining oil prices and production volumes from Saudi Arabia. Saudi Arabia has long been the world's largest oil producer, and is known as a 'swing' producer because it has been able to produce more oil in order to keep supplies going when

⁹¹ Hubbert MK (undated), *Handwritten note on Ivanhoe's copy of NBS special publication 631*, 1982, pp. 140-141

⁹² BP (2007), *Oil: Spot crude prices* [accessed 18 June 2008]

⁹³ Energy Information Administration (2008), *Crude1* [accessed 18 June 2008]

⁹⁴ Robelius F (2007), *Giant oil fields – the highway to oil. Giant oil fields and their importance for future oil production*. Uppsala dissertations from the Faculty of Science and Technology 69. 156pp

⁹⁵ *ibid*

production has been disrupted elsewhere. In 2004, the Saudi Minister for Petroleum announced that in light of oil prices exceeding \$50:

"Saudi Arabia will... increase the Kingdom's production capacity to 11 million barrels per day by intensifying drilling in production fields"⁹⁶.

In 2005, he stated that production capacity would be expanded from the current level of 11 million barrels per day to 12.5 million barrels per day by 2009 to meet spare demand and maintain spare capacity of at least 1.5 million barrels per day⁹⁷.

However, Saudi Arabia's highest average daily output since 1981 was 9.6 million barrels from April to September 2005⁹⁸, when oil was an average of \$58.12 per barrel. Its output from January to April 2008, when oil was an average of \$101.74 per barrel, was 9.2 million barrels per day. In October 2007, the former head of exploration and production at the state-owned Saudi oil company Saudi Aramco commented that production was unlikely to increase further:

"The evidence is that in spite of the increases - very large increases - in oil prices over the last four years, we haven't been able to match that with increasing capacity. So, essentially, we are on a plateau"⁹⁹.

The Chief Economist at the International Energy Agency indicated that:

"According to normal economic theory, and the history of oil, rising prices have two major effects... they reduce demand and they induce oil supplies. Not this time"¹⁰⁰.

Libya's acting Oil Minister Chukri Ghanem recently indicated that OPEC countries cannot increase their production of crude oil, saying "I believe that we don't have much more to produce"¹⁰¹.

One economist considers that demand from fast-developing countries with high levels of foreign exchange reserves means that oil prices are unlikely to reduce as they did after previous oil shocks¹⁰². The analyst who correctly predicted oil prices breaching \$80 and \$100 recently predicted that oil will reach an average of \$150 per barrel by 2010, and more than \$200 per barrel by 2012¹⁰³, in a report that "stands to drive North American bicycle sales through the roof"¹⁰⁴. In May 2008, Goldman Sachs published a document that suggested:

"The possibility of \$150-\$200 per barrel seems increasingly likely over the next 6-24 months"¹⁰⁵.

⁹⁶ Saudi Arabia Market Information Resource and Directory (2004), [Saudi Arabia to raise oil production to 11 million barrels per day](#), 28 September 2004 [accessed 17 June 2008]

⁹⁷ Royal Embassy of Saudi Arabia (2005), [Oil Minister address to the 18th World Petroleum Congress](#), 10 March 2005 [accessed 17 June 2008]

⁹⁸ Energy Information Administration, [Table 1.2: OPEC crude oil production \(excluding lease condensate\)](#), 1997-present, 10 July 2008 [accessed 16 July 2008]

⁹⁹ al-Huseini S (2007), [Former head of Saudi Aramco: Oil has peaked](#) [accessed 17 June 2008]

¹⁰⁰ Birol F, quoted in Mouawad J (2008), [Oil price rise fails to open tap](#), *New York Times*, 29 April 2008

¹⁰¹ Staff correspondents (2008), [Oil prices dive](#), *The Australian*, 3 May 2008

¹⁰² McRae H (2008), [We will never have cheap oil again](#), *The Independent*, 30 April 2008,

¹⁰³ Rubin J and Buchanan P (2008), [How much higher will oil prices go?](#), CIBC World Markets, 24 April 2008,

¹⁰⁴ Harding J (2008), [Crude forecast to reach \\$225US](#), *The Calgary Herald*, 25 April 2008

¹⁰⁵ Goldman Sachs (2008), [Global: Energy: Oil](#) [accessed 17 June 2008]

4.2 Inflation-adjusted oil prices

Inflation means that the real price of oil historically cannot be compared on a like-for-like basis with the price today. One way of achieving this comparison is to account for inflation (Figure 4).

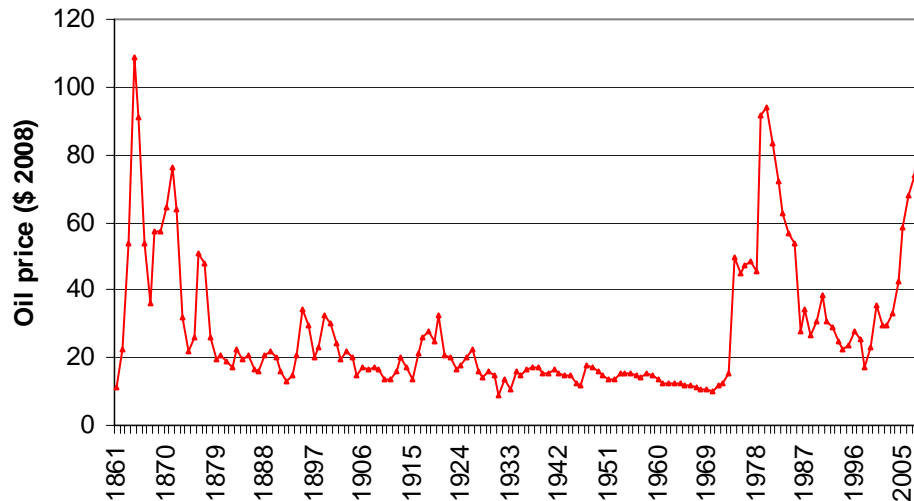


Figure 4 Average oil price per barrel (\$US 2008) (data up to 14 July 2008 inclusive). Source: BP¹⁰⁶, EIA¹⁰⁷, Government Printing Office¹⁰⁸ and Members' Research Service calculation

Oil prices in 2008¹⁰⁹ are now higher in real terms than at any time in history. However, Deffeyes notes that correcting oil prices to take account of inflation is a "highly circular exercise" because energy prices are a major cause of inflation¹¹⁰.

¹⁰⁶ BP (2007), [Oil: Spot crude prices](#) [accessed 18 June 2008]

¹⁰⁷ Energy Information Administration (2008), [Crude1](#) [accessed 18 June 2008]

¹⁰⁸ Government Printing Office (2006), [Gross Domestic Product and deflators used in the historical tables: 1940-2009](#) [accessed 18 June 2008]

¹⁰⁹ Up to and including 18 June 2008

¹¹⁰ Deffeyes KS (2008), [Join us as we watch the crisis unfolding: The New York Times](#), 6 March 2008 [accessed 17 June 2008]

4.3 Oil demand

Table 3 shows the 15 countries in the world that have the most oil reserves, and the 15 that use the most oil.

Table 3 Countries with biggest oil reserves and highest oil use

Oil reserves (as at end of 2005)			Oil consumption ¹¹¹ (2006 data)		
Country	Reserves (billion barrels) ¹¹²	Proportion of world reserves (%)	Country	Amount (million barrels per day) ¹¹³	Proportion of world consumption (%)
Saudi Arabia	262.3	19.9	United States of America	20.6	24.6
Canada*	179.2	13.6	China	7.7	9.2
Iran	136.3	10.4	Japan	5.2	6.2
Iraq	115.0	8.7	Russia	2.7	3.2
Kuwait	101.5	7.7	Germany	2.6	3.1
United Arab Emirates	97.8	7.4	India	2.6	3.1
Venezuela	80.0	6.1	South Korea	2.3	2.7
Russia	60.0	4.6	Canada	2.2	2.6
Libya	41.5	3.1	Brazil	2.1	2.5
Nigeria	36.2	2.7	Saudi Arabia	2.0	2.4
Kazakhstan	30.0	2.3	Mexico	2.0	2.4
United States of America	21.8	1.7	France	2.0	2.4
China	16.0	1.2	Italy	1.8	2.2
Qatar	15.2	1.2	UK	1.8	2.2
Mexico	12.4	0.9	Iran	1.7	2.0
Total top 15	1205.2	91.5	Total top 15	59.0	70.5

* Canadian reserves include 174 billion barrels of oil sands reserves

Source: EIA, BP, and Members' Research Service calculation

Several points of interest arise from these figures:

- More than half (52.6 per cent) of the world's oil reserves (including Canadian oil sands) lie within four countries (Saudi Arabia, Canada, Iran and Iraq).
- Excluding Canadian oil sands, the five countries with the largest oil reserves in the world, accounting for approximately 54 per cent of reserves, are Saudi Arabia, Iran, Iraq, Kuwait and the United Arab Emirates. All are members of OPEC.

¹¹¹ Oil consumption includes inland demand plus international aviation, marine bunkers, and oil products consumed in the refining process

¹¹² Energy Information Administration (2007), [World proved reserves of oil and natural gas, most recent estimates](#), 9 January 2007 [accessed 17 June 2008]

¹¹³ BP (undated), [World oil consumption](#) [accessed 17 June 2008]

- The USA consumes one quarter of global oil.
- Just under half (49.4 per cent) of global oil consumption is accounted for by the six largest consumers (USA, China, Japan, Russia, Germany and India).

The IEA considers that oil demand in 2008 will be 87 million barrels per day on average¹¹⁴, which is a substantial reduction on its previous forecasts.

4.4 Oil production, import and export

The age of oil fields has an important bearing on oil production rates. For example, future oil production from Angola will probably be 14 billion barrels¹¹⁵ and future contributions from the North Sea will be similar¹¹⁶, but production rates are expected to grow rapidly in Angola, while North Sea production is projected to decline¹¹⁷. Therefore, the size of oil reserves is not sufficient to know whether or not future production will decline or grow; maturity of fields and addition of new fields must also be considered¹¹⁸.

Of the top 40 oil-producing countries worldwide¹¹⁹ (accounting for 97.6 per cent of world production), oil production is declining in 14. Oil production has either reached a plateau or there is no clear trend in a further seven of the top 40 oil-producing countries, and production is increasing in 19.

The vice-president of Lukoil, Russia's largest independent oil company, announced in April 2008 that "the period of intense oil production [growth] is over", and that last year's Russian oil production of 10 million barrels per day was the highest he would see "in his lifetime"¹²⁰.

The UK's oil production history is shown in Figure 5. The production peak was 2.68 million barrels per day, in 1999¹²¹; at this level, the UK was responsible for 4.1 per cent of world production. UK production in 2007 (1.50 million barrels per day) was 44 per cent less than the peak level, and accounted for 2.0 per cent of global production.

¹¹⁴ IEA (2008), [Oil market report](#), 10 June 2008

¹¹⁵ Sandra I and Barkindo M (2007), West Africa-1: Undiscovered oil potential still large off West Africa. *Oil & Gas Journal* 105 (2), 8 January 2007

¹¹⁶ Radler M (2006), Special report: Oil production, reserves increase slightly in 2006. *Oil & Gas Journal* 104 (47), 18 December 2006

¹¹⁷ Robelius F (2007), [Giant oil fields – the highway to oil. Giant oil fields and their importance for future oil production](#). *Uppsala dissertations from the Faculty of Science and Technology* 69. 156pp

¹¹⁸ *ibid*

¹¹⁹ Information from BP, [Production](#) [accessed 18 June 2008]

Declining countries are the United States of America, Mexico, Argentina, Colombia, Denmark, Norway, UK, Oman, Syria, Yemen, Egypt, Gabon, Australia and Indonesia. These countries account for 25.3 per cent of production.

Countries increasing production are Canada, Brazil, Ecuador, Azerbaijan, Kazakhstan, Russia, Iran, Iraq, Kuwait, Qatar, United Arab Emirates, Angola, Republic of Congo, Libya, Sudan, Brunei, China, Thailand and Vietnam. These countries account for 47.7 per cent of production.

Countries on a production plateau or where there is no clear trend are Venezuela, Saudi Arabia, Algeria, Equatorial Guinea, Nigeria, India and Malaysia. These countries account for 24.6 per cent of production.

¹²⁰ Hoyos C and Blas J (2008), [Fears emerge over Russia's oil output](#), *Financial Times*, 14 April 2008,

¹²¹ Energy Information Administration (2008), [Table 4.1c World crude oil production \(including lease condensate\), 1970-2007](#), 9 June 2008

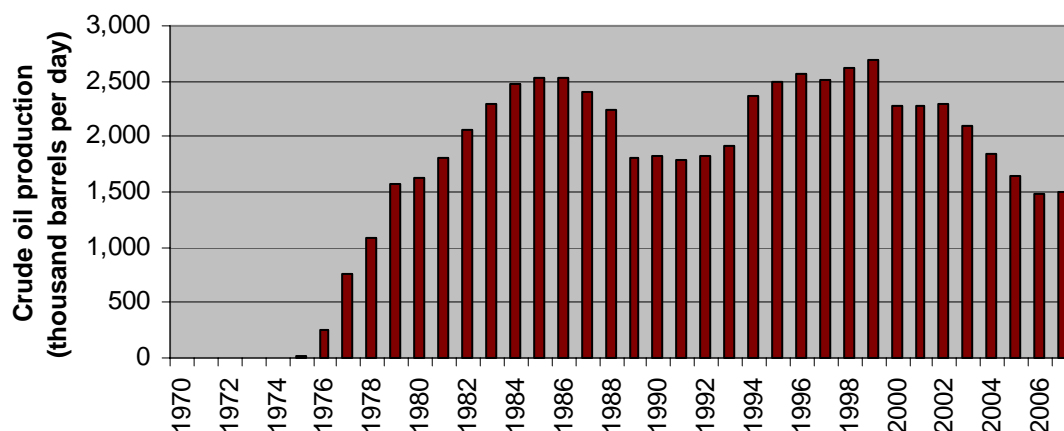


Figure 5 Average UK oil production. Source: EIA¹²².

The unusual 'double hump' configuration of production is attributed to the Piper Alpha disaster on 6 July 1988, which had the effect of depressing the UK's oil production for a number of years¹²³. The Piper field regained full capacity in 1994¹²⁴.

The former Secretary of State for Trade and Industry, Alastair Darling, confirmed:

"The UK's reserves of oil and gas are declining. While significant amounts still remain in the North Sea, production has hit its peak and is now falling. We will make the most of the reserves we have, but as our economy grows, we will become increasingly dependent on imports in a world where supplies are concentrated in less stable regions"¹²⁵.

The UK has been importing oil since 2006. Those 42 global oil exporters that remain are shown in Figure 6 (for original data see [Annex A](#)). Exports are calculated as oil production minus oil consumption (although this balance may not hold precisely because of stock draw-down and accumulation, and because some countries import crude oil to refine and export¹²⁶). Average exports in the years covered (usually 2006) were 40.4 million barrels per day. Exports from OPEC countries, Russia and Mexico (81.4 per cent of all exports) are anticipated to decline by 2.5 million barrels per day by 2012¹²⁷.

¹²² Energy Information Administration (2007), [Table 4.1c: World crude oil production \(including lease condensate\), 1970-2007](#), 9 June 2008 [accessed 1 July 2008]

¹²³ Ivanhoe LF (2000), [Petroleum positions of the United Kingdom and Norway Western Europe](#), Hubbert Center Newsletter No. 2000/2-

¹²⁴ *ibid*

¹²⁵ DTI (2007), [Meeting the energy challenge: A White Paper on energy](#). London: DTI, p. 4

¹²⁶ Ivanhoe LF (2002), [Canada's future oil production: Projected 2000-2020](#), Hubbert Center Newsletter No. 2002/2

¹²⁷ Rubin J and Buchanan P (2008), [How much higher will oil prices go?](#), CIBC World Markets, 24 April 2008

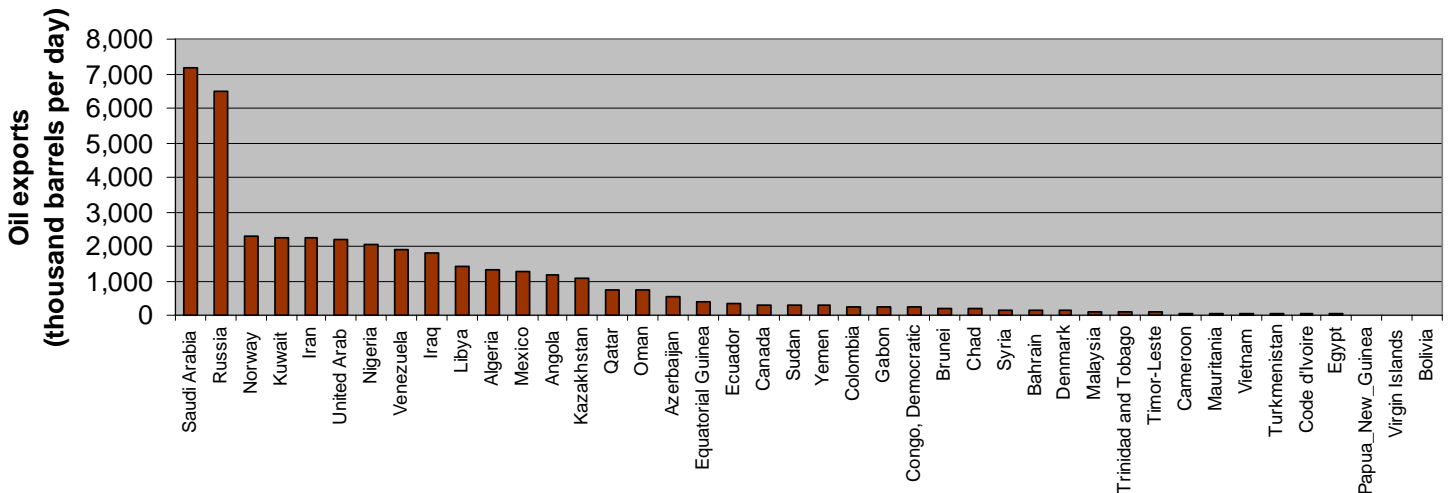


Figure 6 Oil exporting countries of the world

12 of the top 20 oil-exporting countries in the world are members of OPEC (Indonesia is the only member that is a net importer of oil, and it has stated its intention to leave the cartel¹²⁸). Their daily exports are 24.5 million barrels¹²⁹. The total exports of non-OPEC countries are 15.9 million barrels¹³⁰.

Some of the largest oil exporters have reported very large increases in oil consumption. Over the past five years, oil demand in Kuwait and Saudi Arabia has increased by 5 per cent per year; in Iran, the increase has been 7 per cent per year, and over the period 2004-07, Venezuela has reported an annual increase in oil demand of 10 per cent¹³¹. The increase in OECD demand was less than 1 per cent per year over the last five years¹³². The growth in domestic demand from countries with substantial oil exports is considered likely to "cannibalize" export capacity, reducing the availability of oil for importing countries¹³³.

This increasing demand is at least in part a result of the subsidies that many oil-producing countries apply to domestic pricing. Petrol costs in the order of 7 cents per litre in Venezuela, and between 13 and 16 cents per litre in Saudi Arabia, Kuwait and Iran¹³⁴. Since higher oil prices more than compensate for higher domestic subsidies, reduced demand in these countries is 'unlikely'¹³⁵.

India, Indonesia, Malaysia, Sri Lanka and Taiwan have all revised their administered prices of fuel¹³⁶, as a result of reassessing the 'budgetary reality' of maintaining subsidies on domestic fuel prices¹³⁷. Such subsidies can lead to outbound smuggling to non-subsidised countries¹³⁸. China's subsidy of its domestic oil market is calculated as being about \$87 billion per year: more than 2 per

¹²⁸ BBC, [Indonesia to withdraw from OPEC](#), 28 May 2008 [accessed 18 June 2008]

¹²⁹ Members' Research Service calculation, based on Annex A

¹³⁰ *ibid*

¹³¹ Rubin J and Buchanan P (2008), [How much higher will oil prices go?](#), CIBC World Markets, 24 April 2008

¹³² *ibid*

¹³³ *ibid*

¹³⁴ Rubin J (2008), [The age of scarcity](#), CIBC World Markets Inc.

¹³⁵ IEA (2008), [Oil market report](#), 13 May 2008

¹³⁶ Anon (2008), [IEA trims world oil demand, cuts supply forecast](#), Reuters, 10 June 2008

¹³⁷ IEA (2008), [Oil market report](#), 13 May 2008, p. 3

¹³⁸ *ibid*, p. 16



cent of GDP, and roughly 10 per cent of the government's fiscal revenues¹³⁹. India's subsidy is regarded by the IEA as "financing a massive transfer of wealth to the growing black market"¹⁴⁰. In June 2008, Malaysia announced it was raising petrol prices by 40 per cent¹⁴¹. Prior to the move, the government's fuel subsidies accounted for one third of total spending, and were equivalent to 7 per cent of GDP.

Not all oil production is available on the free market. Importing countries enter into agreements with exporting countries in order to gain preferential access to oil¹⁴². China's policy of acquiring international petroleum reserves (between June 2005 and June 2006, China invested equity in 0.3 per cent of global proven reserves¹⁴³) is described as a "mercantilist view of global energy resources", which "does not promote international cooperation in addressing limited supplies of petroleum"¹⁴⁴.

Rising food prices have put biofuel policy under scrutiny¹⁴⁵. The IEA describes as 'sobering' the scenario of replacing the biofuel component of US and European fuels with mineral oil, at around 1 million barrels per day¹⁴⁶. The European Parliament Environment Committee has confirmed its opposition to an EU biofuels consumption target for road transport¹⁴⁷, and there is speculation that the target will be adjusted downwards or removed completely¹⁴⁸. A Royal Society report published in January 2008 also highlighted the risk that biofuels could fail to deliver significant reductions in transport emissions, while creating harmful environmental and social impacts¹⁴⁹. Also in January 2008, the Environmental Audit Committee of the House of Commons requested a moratorium on biofuel targets¹⁵⁰.

4.5 Welsh road transport fuel use

Globally, 95 per cent of transport fuel is oil-derived¹⁵¹. In Wales, the only significant substitute for oil-based fuel is biofuels, which since April 2008 have been introduced in the form of a 2.5 per cent blend at UK refineries¹⁵².

Data relating to the road transport use of energy (total of petroleum products and biofuels) are available at a local authority level from 2002 onwards¹⁵³. Figure 7 shows the all-Wales trend in road transport fuel use. The drop between 2004 and 2005 is attributed to the experimental data.

¹³⁹ *ibid*, p. 14

¹⁴⁰ *ibid*, p. 15

¹⁴¹ Burton J, Malaysia petrol prices rise 40%, *Financial Times*, 5 June 2008

¹⁴² See, for example, The Associated Press, [Venezuela to sell oil to Portugal in exchange for food, technology, Chavez says](#), *International Herald Tribune*, 14 May 2008

¹⁴³ US-China Economic and Security Review Commission, [2006 report to Congress](#), November 2006, p. 102

¹⁴⁴ *ibid*, p. 107

¹⁴⁵ *ibid*

¹⁴⁶ IEA (2008), [Oil market report](#), 13 May 2008

¹⁴⁷ EU Business (2008), [European Parliament calls for biofuel targets to be cut](#), 8 July 2008 [accessed 9 July 2008]

¹⁴⁸ Traynor I (2008), [EU set to scrap biofuels target amid fears of food crisis](#), *The Guardian*, 19 April 2008

¹⁴⁹ The Royal Society (2008), [Sustainable biofuels: Prospects and challenges](#), Policy Document 01/08, London: The Royal Society

¹⁵⁰ Environmental Audit Committee (2008), [First report: Are biofuels sustainable?](#), 15 January 2008

¹⁵¹ International Transport Forum Press Release (2008), [Secretary General of the International Transport Forum calls for low-carbon transport system](#), 30 May 2008

¹⁵² UK Petroleum Industry Association (2008), [Briefing: Renewable Transport Fuels Obligation \(RTFO\)](#), April 2008

¹⁵³ Data sets from 2002 to 2004 inclusive are regarded as 'experimental'; subsequent datasets have been approved by National Statistics

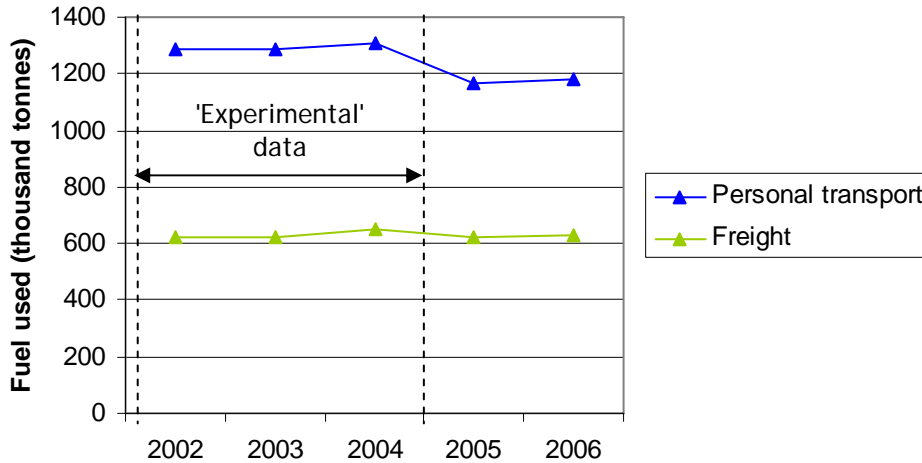


Figure 7 Road transport fuel use in Wales. Source: DBERR¹⁵⁴

Figure 8 shows the consumption of fuel for personal road transport purposes¹⁵⁵ for each local authority in Wales in 2006 (the year for which most recent statistics are available).

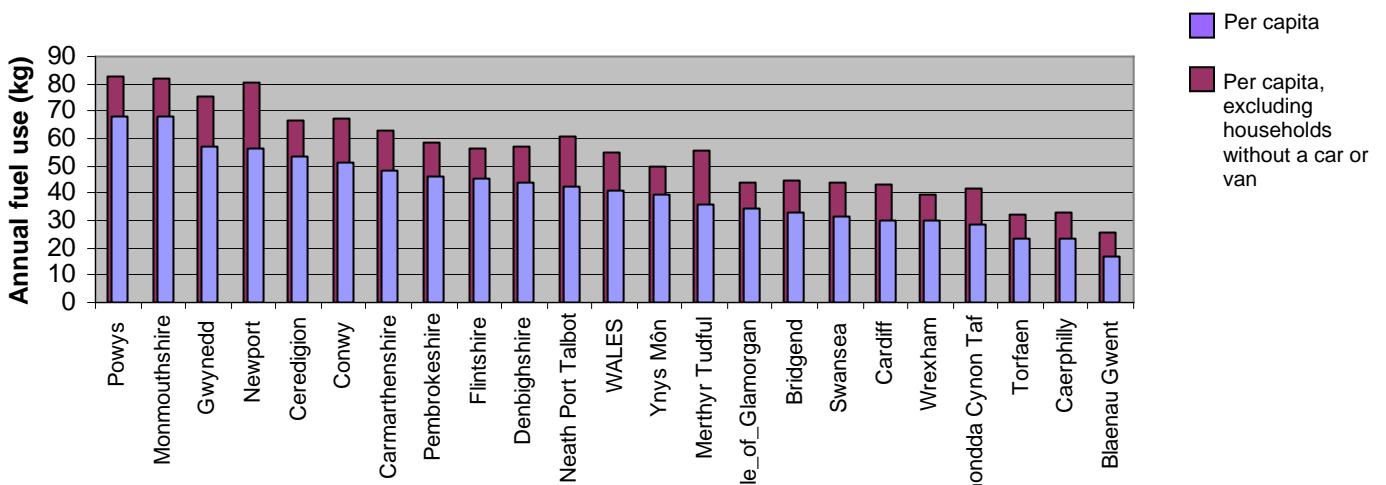


Figure 8 Consumption of fuel for personal road transport purposes in 2006. Source: DBERR¹⁵⁶ and StatsWales¹⁵⁷

Authorities in the south Wales valleys tend to have a lower per capita use of fuel for personal road transport, while rural authorities tend to have a higher per capita use. Excluding those households without a car or van, the trend is broadly similar, although Newport moves up to third place in the ranking. The way of life of people who have a high per capita use of fuel for road transport will be more disrupted by peak oil than those who have a low per capita consumption.

¹⁵⁴ DBERR (2008), [Regional and local authority road transport consumption statistics 2005, 2006](#) [accessed 26 June 2008], and DBERR (2008), [Experimental regional and local authority road transport consumption statistics 2002 to 2004](#) [accessed 26 June 2008]

¹⁵⁵ Bus, private car, and motorbike transport (of which 93.4 per cent of Welsh consumption is accounted for by private car transport)

¹⁵⁶ DBERR (2008), [Regional and local authority road transport consumption statistics 2005, 2006](#) [accessed 26 June 2008]

¹⁵⁷ StatsWales (2008), [\[003122\] Mid-year population estimates \(2001 onwards\), by local authority](#), and [\[001959\] Tenure and number of cars or vans by ethnic group](#) [accessed 26 June 2008]

5 Consequences of Peak Oil

"The Swedish Government has set a new policy target: the creation of the conditions necessary to break Sweden's dependence on oil by 2020. And there is, indeed, an increased sense of urgency. If we prepare now, the transition to a sustainable energy system can be smooth and cost-efficient. If we wait until we are forced by circumstances, the transition may be costly and disruptive. No country can escape from this transition; to act sooner or act later are the only options... It is already a major competitive advantage for Sweden's industry and the economy that, by international standards, Sweden is not so dependent on oil".

Mona Sahlin, Swedish Minister for Sustainable Development, 9 May 2006¹⁵⁸

To an extent, the consequences of peak oil depend on the preparation that countries make to buffer the impacts. For example, early mechanisms to decrease oil consumption and encourage substitution would provide better preparation than simply waiting for the oil price to suppress demand. Hirsch considers "aggressive risk management" to be essential to address the challenges arising from peak oil¹⁵⁹.

Sweden is the only country that has a government commitment to breaking its dependence on oil. The Commission on Oil Independence is tasked with ensuring that Sweden is "free of dependence on fossil fuels for transport and heating by 2020"¹⁶⁰.

Swenson has examined some scenarios for energy demand that could be followed as a consequence of peak oil. They are described in the Swenson curve (Figure 9).

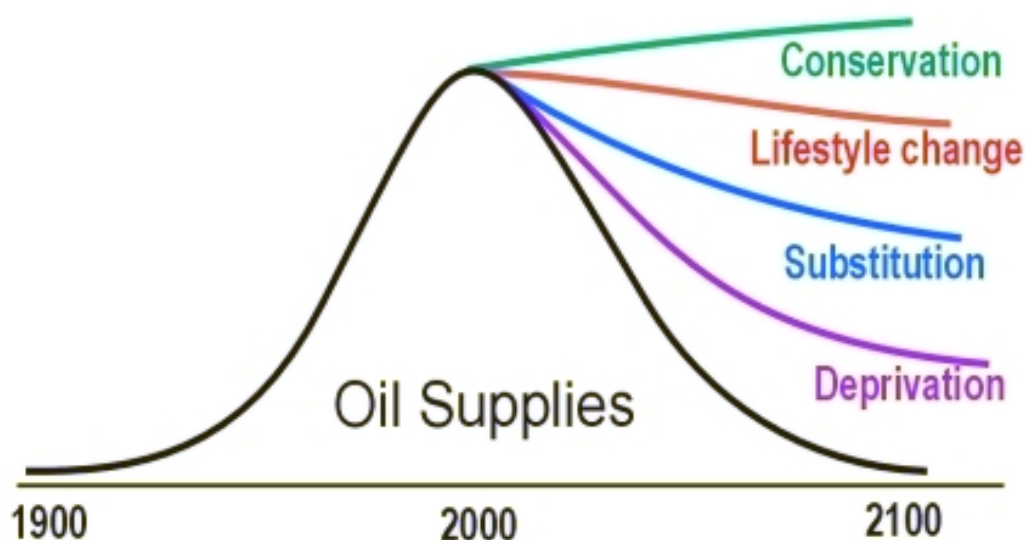


Figure 9 The Swenson curve depicting possible alternative energy demand scenarios as oil goes into decline (the timescale is based on a peak in 2000). Source: Hubbertpeak.com

¹⁵⁸ Socialdemokraterna, [Sveriges mål att bli oljeoberoende](#), 9 May 2006 [accessed 17 June 2008]

¹⁵⁹ Hirsch RL et al. (2005), [Peaking of world oil production: Impacts, mitigation and risk management](#), February 2005, p. 7 [accessed 17 June 2008]

¹⁶⁰ Regeringskansliet [Swedish Government], 2005. [Strategic challenges: A further elaboration of the Swedish strategy for sustainable development](#) [accessed 17 June 2008]

Each section of the post-peak curve describes the adaptation mechanisms that could be used to reduce the impact of reduced oil supply¹⁶¹:

- Conservation is described as enjoying a similar lifestyle, but accomplished with more energy-efficient artifacts, such as more energy-efficient appliances (although conservation is described elsewhere as the painful rationing that high prices will force on ordinary people¹⁶²).
- Examples of lifestyle change include people telecommuting instead of commuting, living a more community-based lifestyle, or living closer to work.
- Substitution is effected by using other energy sources to accomplish the same objectives (solar power, walking or cycling instead of driving).
- Deprivation means doing without. It includes scenarios such as mass hunger and starvation, and war over resources.

The implication is that since deprivation is more unpleasant than the alternative adaptation measures, action should be taken to encourage the three other measures before the peak is reached¹⁶³, particularly since 95 per cent of the energy used in the transport sector comes from oil¹⁶⁴. Campbell notes that those countries that do plan and prepare for peak oil "will clearly have great advantage over those that simply react to the crisis when it hits them"¹⁶⁵. The former US Energy Secretary noted that a major economic shock – and political unrest – would be the result of failing to prepare for the peak of conventional oil production¹⁶⁶.

Ayres comments that:

"The economy is utterly dependent on petroleum... and I think it is highly likely that when oil production peaks, so will the world economy. When petroleum gets more expensive everything that depends on it gets more expensive, and I cannot see how growth could really continue with much more expensive energy"¹⁶⁷.

The first manifestation of peak oil is likely to be an increase in oil price, as demand exceeds supply, and competition for resources takes place¹⁶⁸. A "supply-side crunch in the period to 2015" is regarded by the IEA as a possibility, which would involve "an abrupt escalation of oil prices"¹⁶⁹. At a certain level, increasing prices would force demand reductions¹⁷⁰, which would act to stabilise, and possibly temporarily reduce, prices¹⁷¹. However, rising energy prices increase business costs, so a rise in the real price of oil "has to be accommodated by a fall in the real wage"¹⁷². Professor

¹⁶¹ Hubbert Peak of Oil Production (undated), [Swenson's law](#) [accessed 17 June 2008]

¹⁶² Deffeyes KS (2005), *Beyond oil*, p. 181. New York: Hill and Wang, 202pp

¹⁶³ Energy Alternatives (undated), [Swenson's law](#) [accessed 17 June 2008]

¹⁶⁴ International Transport Forum Press Release (2008), [Secretary General of the International Transport Forum calls for low-carbon transport system](#), 30 May 2008

¹⁶⁵ Campbell CJ (2002), [Forecasting global oil supply 2000-2050](#), Hubbert Center Newsletter No. 2002/3

¹⁶⁶ Schlesinger J (2005), [Statement of James Schlesinger before the Committee on Foreign Relations, United States Senate, 16 November 2005](#) [accessed 17 June 2008]

¹⁶⁷ Strahan D (2007), *The last oil shock*, London: John Murray, p. 123.

¹⁶⁸ Oil Depletion Analysis Centre (undated), [Preparing for peak oil](#), p. 2

¹⁶⁹ *ibid*

¹⁷⁰ Fortson D (2008), [An ominous warning that the rapid rise in oil prices has only just begun](#), *The Independent*, 11 June 2008

¹⁷¹ Warner J (2008), *The oil price will eventually return to earth, but collateral damage is likely to be serious*, *The Independent*, 23 May 2008

¹⁷² Oswald A (2000), [Oil and the real economy: An interview with Andrew Oswald](#), Warwick University interview, 17 March 2000 [accessed 17 June 2008]

Oswald suggests that oil price rises take about 18 months to feed through noticeably to the real economy¹⁷³. One report suggests that the decade following the peak will feature dramatic increases in inflation, long-term recession, high unemployment and declining living standards¹⁷⁴.

A report commissioned by the United States Government noted that mitigation of peak oil would require a decade of "intense, expensive effort", and that intervention by governments will be required, because the economic and social implications of peak oil would otherwise be "chaotic"¹⁷⁵. The report goes on to note that prudent risk management requires the implementation of mitigation "well before peaking"¹⁷⁶. The problems of peak oil will be "especially serious" for developed countries, while problems in developing countries have the potential to be "much worse"¹⁷⁷.

In May 2008, the Ernst and Young Item Club warned that if oil prices remain at their current levels, it would have to cut its economic growth forecast for the UK for next year to 1.3 per cent; inflation would also be higher than 3 per cent for the next three years¹⁷⁸.

In April 2008, the Executive Director of the International Energy Agency claimed that an oil price of \$118 per barrel would raise concerns about the global economy's ability to avoid entering a recession¹⁷⁹.

A document written by the former Chief Economist at the US President's Council of Economic Advisers suggests the following likely responses to an oil price of \$120 per barrel¹⁸⁰:

- Disruptions to normal economic activity, including factory shutdowns, reduced long-distance travel, and layoffs in key industries which spread to the rest of the economy.
- Increased taxation will be necessary to cover the increased costs faced at all levels of government.
- Household energy bills (including automobile transport costs) will roughly double to 10-15 per cent of family budgets.
- A sharp reduction in revenues for travel, tourism, and automobile businesses.
- Inflation will rise from 2-3 per cent to 6-8 per cent, requiring decisions to be made over interest rates that may make economic growth rates 'tumble'.
- A 25 per cent decline in global stock market valuations.
- A cut in world GDP by up to 3.6 percentage points.
- Probably the onset of global recession.

The situation up to and beyond peak oil is described by Campbell as likely to be:

¹⁷³ *ibid*

¹⁷⁴ Hirsch RL et al. (2005), [Peaking of world oil production: Impacts, mitigation and risk management](#), February 2005, p. 7 [accessed 17 June 2008]

¹⁷⁵ Hirsch RL et al. (2005), [Peaking of world oil production: Impacts, mitigation and risk management](#), February 2005, p. 7 [accessed 17 June 2008]

¹⁷⁶ *ibid*, p. 6

¹⁷⁷ Hirsch RL et al. (2005), [Peaking of world oil production: Impacts, mitigation and risk management](#), February 2005, p. 7 [accessed 17 June 2008]

¹⁷⁸ Conway E (2008), [Growth forecast for UK economy will be hit by rising oil price](#), *The Daily Telegraph*, 10 May 2008

¹⁷⁹ Tanaka N, quoted in TradeArabia (2008), [Oil price can trigger recession: IEA](#), 22 April 2008 [accessed 17 June 2008]

¹⁸⁰ Westcott RF (2006), [What would \\$120 oil mean for the global economy?](#), *Securing America's Future Energy*, April 2006

"a period of recurring price surges, recessions, international tensions, and growing conflicts for access to critical oil supplies, as the indigenous energy supply situation in the United States and Europe deteriorates"¹⁸¹,

and peak oil supply constraints will curb demand by higher prices, so that "the historical pattern of economic growth has to end"¹⁸². Increasing oil prices will feed through into increasing food prices¹⁸³. Rising prices of food and energy hit poor people hardest¹⁸⁴.

An analyst at the Ernst and Young Item Club suggested that if oil reached \$200 a barrel permanently, the Governor of the Bank of England would suffer from "writer's cramp" with the number of letters he would have to write to the Chancellor explaining why the UK economy had breached the 2 per cent inflation target¹⁸⁵.

In the most optimistic scenario, the modelling used for the Energy Information Administration's report *International Energy Outlook 2007* suggests that long-term projections for economic growth will not be affected "substantially" by oil price, because by 2030 the global economy will have adjusted to different oil prices¹⁸⁶. However, in the shorter term, following the 'high world oil price' scenario:

"As higher oil prices feed through the economy and reduce purchasing power, real aggregate expenditures on goods and services decline... unemployment increases, energy-intensive capital stock begins to become obsolete, and real GDP is lower. In oil-importing countries that also have major oil producing sectors, like the United [Kingdom], higher oil prices increase the flow of economic resources into oil production activities. At the same time, national expenditures on petroleum imports increase, with negative repercussions for real GDP. Countries wholly dependent on oil imports, like Japan, are forced to spend more for their energy purchases... In the medium term, increases in unemployment lead to downward adjustments in wages and prices. In developed countries, central banks react by lowering key policy rates, thus boosting interest-sensitive aggregate demand. After 2015, the rebound effects of lower employment costs, lower prices, and lower interest rates outweigh the contractionary effects of higher oil prices, leading to stronger real GDP growth and lower inflation"¹⁸⁷.

The more immediate problem, however, is described by Deffeyes:

"Our transportation system is almost totally driven by products from oil. As we learned in the late 1970s, an oil shortage can ripple through the economy, lowering our standard of living. My concern is not about our long-term adaptation to a world beyond oil. Through our inattention, we have wasted the years that we might have used to prepare for lessened oil supplies. The next ten years are critical. It's going to be on-the-job training. Learn while doing: not always the most orderly way of adapting"¹⁸⁸.

¹⁸¹ Campbell CJ (2002), [Forecasting global oil supply 2000-2050](#), Hubbert Center Newsletter No. 2002/3

¹⁸² *ibid*

¹⁸³ Rees-Mogg W (2008), [King oil will turf out Gordon Brown](#), *The Times*, 12 May 2008

¹⁸⁴ Kaletsky A (2008), [Could oil mania be coming to an end?](#), *The Times*, 1 May 2008

¹⁸⁵ Conway E (2008), [Oil's surge to \\$120 poses new threat to UK economy](#), *The Daily Telegraph*, 10 May 2008

¹⁸⁶ Energy Information Administration (2007), [International energy outlook 2007](#), May 2007, p. 13

¹⁸⁷ *ibid*, pp. 14-15

¹⁸⁸ Deffeyes KS (2005), *Beyond oil*, p. 12. New York: Hill and Wang, 202pp



Annex A Oil exporting countries

Country	Amount exported (thousand barrels per day)	Year of data	OPEC
Saudi Arabia	7,147	2006	✓
Russia	6,512	2006	
Norway	2,274	2006	
Kuwait	2,260	2006	✓
Iran ^a	2,230	2006	✓
United Arab Emirates ^a	2,177	2006	✓
Nigeria ^a	2,026	2006	✓
Venezuela ^a	1,926	2006	✓
Iraq ^a	1,790	2007	✓
Libya ^a	1,391	2005	✓
Algeria ^a	1,331	2006	✓
Mexico	1,284	2006	
Angola ^a	1,190	2005	✓
Kazakhstan	1,092	2006	
Qatar ^a	722	2005	✓
Oman	708	2005	
Azerbaijan	544	2006	
Equatorial Guinea	382	2005	
Ecuador	356	2006	✓
Canada	303	2006	
Sudan	298	2006	
Yemen	272	2005	
Colombia	267	2005	
Gabon	253	2005	
Congo, Democratic Republic	225	2005	
Brunei	204	2006	
Chad	175	2005	
Syria	164	2007	
Bahrain	153	2005 & 2007	
Denmark	141	2006	
Malaysia	114	2006	
Trinidad and Tobago	95	2007	
Timor-Leste ^b	94	2005	
Cameroon	59	2005	
Mauritania	55	2005 & 2006	
Vietnam	43	2007	
Turkmenistan	40	2007	
Code d'Ivoire	31	2005	
Egypt	27	2006	
Papua New Guinea	24	2005	
Virgin Islands ^b	18	2005	
Bolivia	10	2007	

^a Two different values are given for these countries in the EIA data; the figures listed in the table are the mean values

^b Does not include any consumption value; data not available



Sources: BP oil consumption statistics

http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2007/STAGING/local_assets/downloads/pdf/table_of_world_oil_consumption_2007.pdf

EIA statistics

<http://www.eia.doe.gov/emeu/ipsr/t11a.xls>

<http://www.eia.doe.gov/emeu/ipsr/t11b.xls>

<http://www.eia.doe.gov/emeu/ipsr/t11c.xls>

<http://www.eia.doe.gov/emeu/ipsr/t11d.xls>

<http://www.eia.doe.gov/emeu/ipsr/t12.xls>

CIA World Factbook statistics

<https://www.cia.gov/library/publications/the-world-factbook/rankorder/2174rank.html>

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