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Running on empty? The peak oil debate

Policy Brief No.16
September 2010
ISSN 1836-9014

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TAI

Policy Brief

Peak oil glossary

ABARE	Australian Bureau of Agricultural and Resource Economics
ASPO	Australian Association for the Study of Peak Oil and Gas
Bbls	Barrels of oil
BITRE	Bureau of Infrastructure, Transport and Regional Economics
CAFE	Corporate average fuel economy
CERA	Cambridge Energy Research Associates
CNG	Compressed natural gas
CO_2	Carbon dioxide
CSIRO	Commonwealth Scientific and Industrial research organisation
EIA	Energy Information Administration (US)
Gb	Gigabarrels
GFC	Global Financial Crisis
IEA	International Energy Agency
ITPOES	UK Industry Taskforce on Peak Oil and Energy Security
LNG	Liquified natural gas
Mbls	Million barrels
OECD	Organisation for Economic Co-operation and Development
OPEC	Organisation of Petrol Exporting Countries
Tcm	Trillion cubic metres
UKERC	UK Energy Research Centre
URR	Ultimately recoverable reserves
USGS	US Geological Survey
US EIA	US Energy Information Administration
WEO	*World Energy Outlook* produced by the IEA

Acknowledgements

The authors wish to thank Hugh Saddler and Barry Naughten for helpful comments on the paper.

Summary

Like climate change, the possibility of peak oil poses an uncomfortable challenge to citizens and governments alike in the 21st century. 'Peak oil' is the term used to describe the point in time at which the worldwide production of crude oil extraction will be maximised. But while it is inevitable that production will peak at some point, it is uncertain when that point will be reached.

Peak oil concerns exploded during the rapid escalation of oil prices prior to the 2007 global financial crisis (GFC), and resurfaced recently when oil prices appeared to resume their upward trend. These concerns have been underscored by official bodies such as the International Energy Agency (IEA) warning of a possible 'supply crunch' brought about by a lack of new investment following the GFC.

World oil field discoveries (as distinct from the amount of oil extracted) peaked in the 1960s at around 55 Gigabarrels (Gb) a year, but fewer than 10 Gb a year have been discovered between 2002 and 2007. Current demand is 31 Gb a year. According to official estimates, around 40 to 75 years of supply remains at existing usage rates but much fewer if demand continues to grow. Although usage has more or less stabilised in developed western countries, the rapid economic growth of populous nations such as China and India is creating significant upward pressure on the demand for oil products.

There is not much disagreement about the concept of peak oil, but there is fierce debate about how near the world is to the peak and what, if anything, should be done about it. In fact, a substantial amount of oil remains in the earth and peak oil doomsayers have often been proved wrong in the past. But this is not a reason for complacency. Oil is a precious resource; there is a finite supply in the earth and there is no reason at all to use it wastefully. Moreover, as the IEA has argued, the world is currently embarked on a fossil-fuel future that is patently unsustainable from an environmental perspective, quite apart from the fact that rates of extraction will exhaust fossil-fuel resources far too quickly, thus ignoring the needs of future generations.

World economies are built on oil. The question is what will happen when it runs out, or merely becomes difficult and very expensive to procure. The probable answer is not an acceptable one. As occurred in response to the OPEC oil shock of the 1970s, skyrocketing oil prices are likely to result in severe disruption to economies, with central banks raising interest rates to slow runaway inflation, people out of work, famine, hunger and serious civil unrest. It is a scenario that governments and their constituents should be attempting to avoid at all costs but so far very little has been done to prepare for or contend with the eventuality.

Perhaps the first step is for governments to recognise that there is a looming potential problem and to begin to plan for it. Not only will this cushion the impact if it does occur, but many of the solutions to peak oil are also advantageous in the fight against climate change, thereby doubling the benefit of remedial measures. This paper outlines some of the policy options available to the Australian Government to assist in addressing the contingencies that are already confronting the country as a result of increasing oil prices and a rising population.

From an international perspective, the paper argues that the important immediate steps are for countries to stop subsidising liquid fuels, and for the US to cease its profligate consumption, a result of very low fuel taxes. But countries like Australia, while small in terms of their contribution to demand, also have a role to play, and fuel and road-pricing regimes need to be altered to

encourage fuel efficiency. Moreover the sustainability of the current low-density urban model, itself a reflection of the US situation, needs to be re-evaluated.

Finally, some of the alternatives to conventional oil are becoming economic at current prices, and might offer a way around the impending predicament occasioned by the finite supply of the resource. But it must be recognised that they involve extremely high and possibly unsustainable costs in terms of greenhouse gas emissions, for example the extraction of oil from tar sands or its processing from coal and natural gas. This poses a potential dilemma for policy, but the answer is actually quite simple—a price on carbon.

The paper suggests that a carbon tax rather than a trading system is the optimal method for pricing carbon, but ultimately the method is not as important as the existence of a price that is relatively uniform across countries and is sufficiently high to materially affect production and consumption decisions, particularly the decision as to whether or not to pursue the development of emission-intensive alternatives to oil. In the medium term, the circumstances created by a price on carbon will likely expand the use of natural gas, both for power generation and transport; in the long term, it is likely to expand the role of electric vehicles and non-fossil forms of power generation.

As with climate change, the most cost-effective response to the inevitable but uncertain timing of peak oil is to invest in early adaptation. It will be impossible to redesign cities, switch the vehicle fleet to new forms of fuel and transform the location decisions of producers in a timely manner after the oil supply has peaked. Early investment in adaptation measures will pay high dividends in the future, whether in response to peak oil, climate change or simply better city design and reduced congestion on roads.

The paper concludes by suggesting that the peak-oil issue is sufficiently important for regular official re-assessments of the situation to be designed and implemented. If mitigation actions are not planned in advance, the alternative may be for a future where periodic price spikes and shortages affect the nation's ability to manage the economic cycle by causing the re-emergence of 'stop-start' economic conditions such as those experienced in the 1970s.

Introduction: what is peak oil?

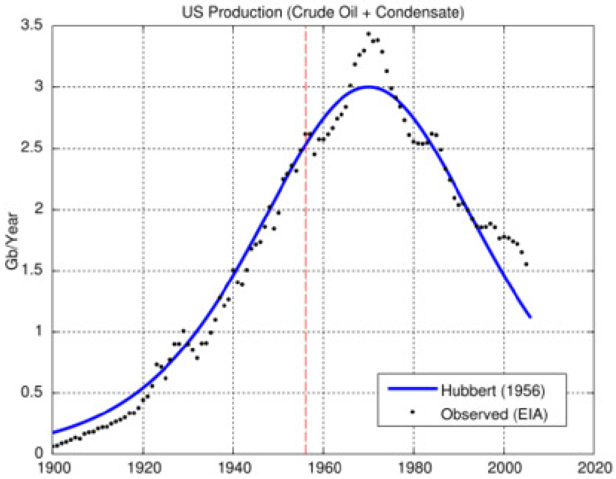
Peak oil is the proposition that there is a finite supply of oil in the earth and, at some point, it will no longer be possible to increase production in response to rising demand. Indeed, the supply of oil will plateau and begin to fall.

Peak-oil scares have come and gone as the price of oil has waxed and waned over the past three decades. Currently, fears are in abeyance as motorists have become accustomed to pump prices at around $1.30 a litre, although this is still considerably higher than was the case several years ago. But prices are on a long-term upward trend and seem likely to spike again when the world economy regains some strength following the GFC.

While demand for oil appears to have stabilised in the developed world, the rapid growth of countries like India and China will create a significant rising demand. This paper argues that the time for the world to worry about peak oil is now, while there is a window of opportunity to do something about it. It does not make economic or social sense to delay action until prices are already rising sharply.

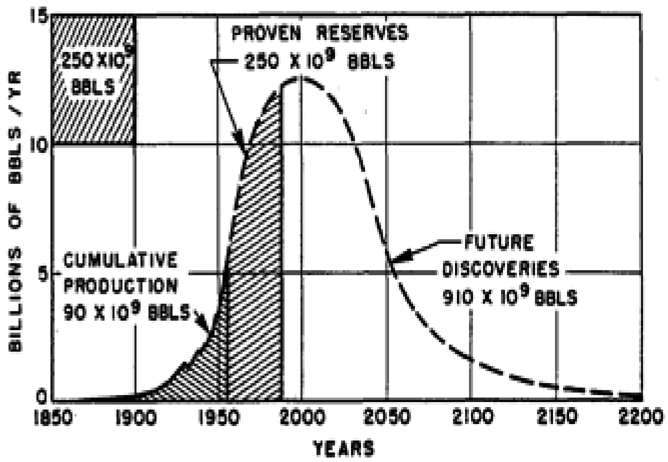
World oil production is the sum total of the production of individual countries, but the oil supply of many countries, including Australia, is now beginning to exhibit peaking qualities or is already assumed to be past its peak. The concept of peak oil is primarily associated with the US geologist M King Hubbert ('Hubbert's peak'), who in the 1950s predicted that US oil production would peak in about 1970, a prediction borne out by events. Hubbert's mathematical model and its variants have described with reasonable accuracy the peak and decline of production from oil wells, fields, regions and countries. However, his estimates for the world peak, 1995–2000,[1] were clearly early and well below actual production. Figure 1 shows Hubbert's projections for US oil production and Figure 2 his projections for world oil production, estimated at a maximum of 12.5 billion barrels of oil (gigabarrels (Gb)) a year. Actual production is now 31 Gb.

Figure 1: Predicted US peak oil (high scenario) and actual



Source: Med.Library.org.[2]

Figure 2: World peak oil, Hubbert projections



Source: M K Hubbert.[3]

Note: Bbls is a contraction for barrels; 10^9 means billions, also denoted by Gigabarrels (Gb). Current production is 31 billion barrels (Gb) annually as compared to the 12.5 Gb peak suggested in the graph.

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1 Hubbert devised various scenarios and there is no single-year estimate for the peak.

2 Med.Library.org, 'Hubbert peak', 2010. Available at: http://medlibrary.org/medwiki/Hubbert_peak.

3 M K Hubbert, 'Nuclear energy and the fossil fuels', presented before the Spring Meeting of the Southern District Division of Production American Petroleum Institute ,Plaza Hotel, San Antonio, Texas March 7–8–9, 1956, *Energy Bulletin*, 8 March 2006. Available at: http://www.energybulletin.net/node/13630.

The idea that oil is a finite resource and production will peak at some point is not disputed but predictions about the timing of the peak attract controversy. Some people believe that it is imminent, or indeed already here,[4] while others believe that new discoveries, higher prices and technological innovation will place the peak far in the future.[5] There is also a view held by some that the peak simply does not matter because alternatives to oil will gradually assume more significance as the price makes it economic to produce them.

The principal contention concerning peak oil is what, if anything, should be done about it. Laissez-faire economists take the view that rising oil prices will stimulate investments in new exploration, energy efficiency and the development of alternatives such as biofuels and these, over time, will automatically take care of the problem. In contrast, many experts consider that the transition to a post-oil economy will be incredibly disruptive if not handled well, with the possibility of rolling recessions when central banks react to price spikes by slowing economies.

While peak oil and climate change are clearly separate problems, there is a high degree of overlap in the potential solutions. In addition, climate change may limit the ways in which the world is able to adapt to peak oil by ruling out some, or even many, unconventional oil resources on the basis of the greenhouse gas emissions involved in their extraction. The climate-change issue is also relevant in that some peak-oil adaptations, for example energy conservation, will also help ameliorate climate change. Like climate change, peak oil requires a move away from the historic reliance on fossil fuels into a ‘post carbon’ economy.

This paper first discusses oil supply, then oil demand and how the two will interact in terms of price; it then considers possible responses to peak oil, the link to climate-change policies, and finally some policy options for Australia.

Oil supply

Trends in discovery/exploitation

World oilfield discoveries peaked in the 1960s at around 55 Gb a year, but since then the rate of discovery has fallen and between 2002 and 2007, fewer than 10 Gb a year have been discovered. To put that in perspective, current demand is 31 Gb a year. Oil is being used at a faster rate than new supplies are being found, although improvements in the conversion of resources into reserves,[6] due to a better understanding of resources and the use of better extraction technologies, is helping to offset this. Production first surpassed new discoveries around 1985 (Figure 3).

Figure 3: Oil production and discovery (proven plus probable)

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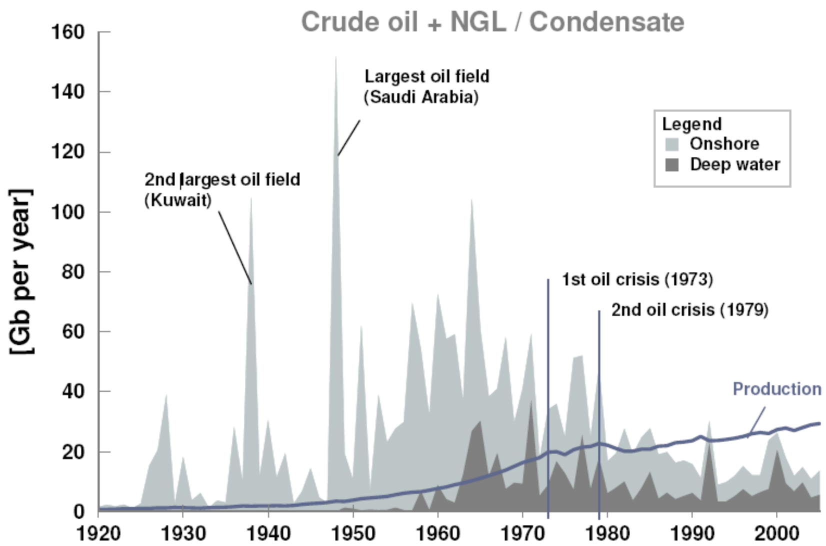
4 For example, see EWG (The Energy Watch Group), *Crude oil—the supply outlook*, Rev ed., Berlin, February 2008. Available at: http://www.energywatchgroup.org/fileadmin/global/pdf/2008-02_EWG_Oil_Report_updated.pdf.

5 See for example IHS CERA (IHS Cambridge Energy Research Associates, Inc), *The future of global oil supply: Understanding the building blocks*, special report by P M Jackson, Cambridge, Mass, 2009. Available at: http://www.cera.com/aspx/cda/client/report/report.aspx?KID=5&CID=10720.

6 Resources include the total quantity of oil in the reservoir, but typically only 35 to 40 per cent of this is recoverable. If prices are high, the economically recoverable fraction increases. Reserves include all crude oil that it is technically possible to extract from reservoirs at an assumed cost and are classified as proven, probable and possible; proven reserves are generally considered to have at least a 90 to 95 per cent certainty of containing the amount specified, probable reserves have a 50 per cent and possible reserves a five to 10 per cent probability.

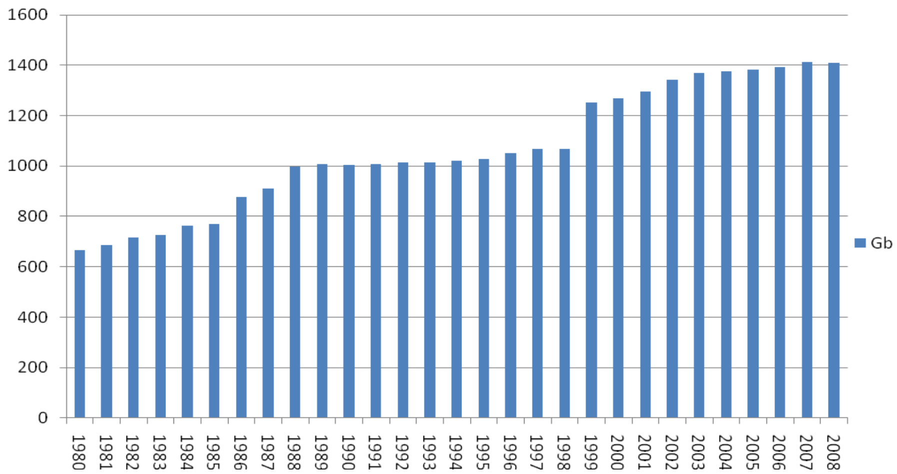


Source: EWG.[7]

Note: The gap between the production and the discovery lines shows the extent to which production is now outpacing discovery.

Economists tend to take the sanguine view that when the price is high enough, investment in both exploration and extraction will become more profitable, allowing more oil to be found and extracted. High prices also increase the economically recoverable fraction of existing reserves, as does improved technology. Thus, according to BP, annual additions to reserves through new discoveries and reserve growth have been greater than annual production,[8] at least up to 2008 (Figure 4).[9]

Figure 4: World oil reserves according to BP



7 EWG, *Crude oil—the supply outlook*, Figure 1.

8 BP plc, *Statistical Review of World Energy June 2006*, London, 2006. Cited in Senate Standing Committee on Rural and Regional Affairs and Transport, *Australia's future oil supply and alternative transport fuels*, Final report, Commonwealth of Australia, 7 February 2007, p. 10.

9 It is difficult to reconcile these two differing views; the explanation appears to lie in the conversion of resources into reserves, which alters as more information about existing fields becomes available and recovery techniques become increasingly efficient.

Source: BP plc.[10]

Note: From 1999, the figures include Canadian oil sands, 150 Gb of these in 2008.

The optimistic view that production will 'never run out' is based on experience gained with conventional metal resources like copper or gold, where progressively lower grades of the resource become economically exploitable as prices rise. There is no theoretical limit to this process. However, recent circumstances have determined that even an enormous increase in the oil-drilling effort may not lead to increased production in a mature oil-producing region like the US. In addition, the average recovery factor (the amount recovered as a percentage of the resource), currently around 35 to 40 per cent, has proved very difficult to increase, although in some fields, recovery factors can be as high as 70 per cent. A further fundamental limitation on the capacity to increase supply by relying on lower-quality sources is the deterioration in the energy balance—that is, the extraction of these lower-quality stocks ultimately uses more energy than the end product can deliver.

On current official estimates, the world has some 1,200[11] to 2,300[12] Gb of *ultimately recoverable reserves* (URR) compared to cumulative production through to 2007 of 1,128 Gb;[13,14,15] that is 40 to 75 years of supply at current usage rates but much fewer if usage continues to grow. However, these estimates are controversial. Some commentators suggest that even the lower figure of 1,200 Gb is inflated by 300 Gb due to the difficulties of extraction[16] and over-optimistic depletion and exploration assumptions.[17] There are also concerns that some OPEC members have inflated their reserves in order to gain higher production quotas from that organisation. There is no transparent process for verifying the oil reserves of many OPEC members; indeed, there is a history of step jumps in claimed reserves and no apparent depletion despite yearly production.

Uncertainty about the exact size of remaining world reserves is central to the debate about peak oil. According to Hubbert's modelling, the peak will be reached when about half the reserve has been exploited, suggesting that if the remaining reserve is 1,200 Gb and 1,100 Gb has been exploited, this point has virtually been reached. But IHS CERA points out that this simple arithmetic is based on 'proved plus probable reserves' alone and ignores the remaining

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10 BP plc, *Statistical Review of World Energy June 2009*, London, 2009.

11 The lower figure is from the International Energy Agency (IEA) as presented in its periodic editions of the *World Energy Outlook*, but it includes conventional oil only. The EWG reports total proven plus probable reserves of between 854 and 1,255 Gb. See EWG, *Crude oil—the supply outlook*.

12 The higher figures are from the USGS (US Geological Survey), 'USGS world petroleum assessment 2000: new estimates of undiscovered oil natural gas, and natural gas liquids, including reserve growth, outside the United States', USGS fact sheet 062-03, June 2003. The USGS publishes estimates of likely undiscovered oil, gas and natural gas liquids, and potential increases in reserves. Added to current figures, these result in substantially higher estimates of URR.

13 USGS (US Geological Survey), 'USGS world petroleum assessment 2000'. This publication gives figures at the top end of this range. Cited in UKERC (UK Energy Research Centre), *Global oil depletion: an assessment of the evidence for a near-term peak in global oil production*, report produced by the Technology and Policy Assessment function of the UK Energy Research Centre, London, October 2009.

14 Senate Standing Committee on Rural and Regional Affairs and Transport, *Australia's future oil supply and alternative transport fuels*, Final report, Commonwealth of Australia, 7 February 2007,p. 13.

15 Updated but similar estimates appearing in IEA (International Energy Agency), *World energy outlook 2005: Middle East and North Africa insights*, International Energy Agency, OECD, Paris, 2005, are based on USGS, 'USGS world petroleum assessment 2000'.

16 The 2004 scandal surrounding the writing-down of 20 per cent of Shell's reserves with a loss of 4.5 Gb illustrates this problem. See M Harrison, 'Shell auditors told of problems with overstated reserves two years ago', *The Independent: Business*, 16 July 2004.

17 ITPOES (UK Industry Taskforce on Peak Oil and Energy Security), *The oil crunch: securing the UK's energy future*, First report, London, October 2008.

categories of conventional and unconventional reserves and resources that could ultimately contribute as much again. Indeed, IHS CERA estimates that remaining global reserves could be around 3,700 Gb.[18] If the reserve is larger, the peak is correspondingly delayed.

Annual production declines from existing fields

Fatih Birol, chief economist of the IEA, has stated that both the public and many governments appear oblivious to the fact that the oil on which modern civilisation depends is running out faster and that global production is likely to peak at least a decade earlier than previously estimated.[19]

According to the IEA's *World energy outlook 2008*, the decline in production from existing oil fields is now running at 6.7 per cent a year compared to the 3.7 per cent decline it had estimated in 2007, and this rate is rising. The faster existing field production declines, the faster new fields must be discovered and developed merely to maintain current levels of supply. It is important to note that the figures indicating the faster-than-expected rate of decline include the impact of measures to offset this decline, suggesting that the *natural* rate of decline is even higher. As the IEA states:

> A major finding of past Outlooks is that the future rate of production decline from producing fields aggregated across all regions is the single most important determinant of the amount of new capacity that needs to be added and the need to invest in developing new fields … In other words, future supply is far more sensitive to decline rates than to the rate of growth of oil demand.[20]

Higher prices and new technologies will perhaps help to offset these accelerating rates of decline but that said, the overall picture is not promising. Dr Birol also highlights the problem of under-investment by oil-producing countries. Total investment has fallen by nearly 20 per cent since the GFC and Dr Birol suggests that this circumstance is likely to result in an 'oil crunch' within the next five years that may jeopardise world recovery. According to this view, a short-term supply crisis would not be caused by a fundamental shortage of oil but by entirely man-made factors; there is thus no contradiction with the IEA's forecast of long-term supply growth to 2030.

The UK Energy Research Centre (UKERC) maintains that:

> The timing of the global peak for conventional oil production is relatively insensitive to assumptions about the size of the global resource. For a wide range of assumptions about the global URR [ultimate recoverable resource] of conventional oil and the shape of the future production cycle, the date of peak production can be estimated to lie between 2009 and 2031. *Although this range appears wide in the light of forecasts of an imminent peak, it may be relatively narrow in terms of the lead time to develop substitute fuels.* … [F]orecasts that delay the peak of conventional oil production until after 2030 rest upon several assumptions that are at best optimistic and at worst implausible [emphasis added].[21]

Unconventional sources of oil supply

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18 IHS CERA (IHS Cambridge Energy Research Associates, Inc, *The Future of global oil supply: Understanding the building blocks*, special report by P M Jackson, Cambridge, Mass., 2009, p. 7.

19 R Parker, 'Fatih Birol of IEA: peak oil in 2020', *Future Pundit*, 4 August 2009.

20 Rates of decline are rising as the average field size decreases. See IEA, *World energy outlook 2008*, International Energy Agency, OECD, Paris, 2008, Chapter 10.

21 UKERC, Global oil depletion, p.ix–x.

The major unconventional sources of oil being considered for large-scale production are the Athabasca oil sands in Canada, the heavy oil in the Orinoco belt in Venezuela, and the Green River deposits of oil shale in the western US. Oil from these sources is more difficult and more expensive to extract than conventional oil and is often highly viscous with a thick, glutinous consistency that does not flow readily. Shale oils are a precursor to oil and need further treatment. All these sources involve high greenhouse gas emissions.

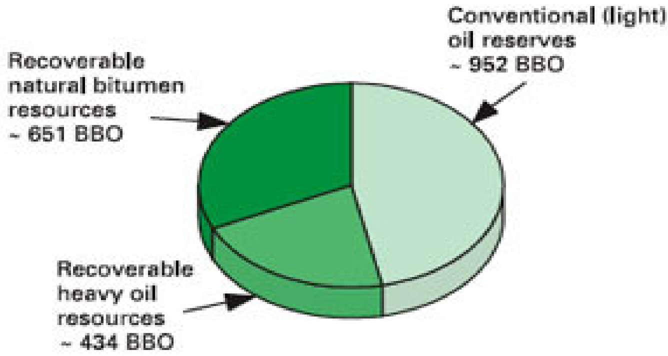
Unconventional sources are not included in the calculation of reserves until a facility is available for their extraction, but they possibly contain reserves that are ultimately several times as large as conventional oil sources. Exploiting them may become economically viable at prices not significantly higher than they are currently.[22] According to the US Geological Survey (USGS), the total of all these deposits is 2,040 Gb (Figure 5),[23] but this figure is subject to a great deal of uncertainty and will ultimately depend on both the oil price and the price placed on carbon pollution.[24]

[22] At the time of writing, the oil price was US$73 a barrel; it was as high as US$147 before the global financial crisis. It is notable that the estimated breakeven price for unconventional sources like oil shale always seems to lie at about $10 above the current price.

[23] R F Meyer and E D Attanasi, *Heavy oil and natural bitumen—strategic petroleum resources*, Fact sheet 70-03, USGS, August 2003.

[24] It is assumed that most countries will eventually impose a price on greenhouse gas pollution such as CO_2, whether through emissions trading or a carbon tax.

Figure 5: USGS estimate of resources



Source: USGS.[25]

Note: BBO equates to Gb. The total in the graph adds up to 2,037Gb.

The energy balance of unconventional sources is not advantageous; they require substantial energy inputs and, as a consequence, emit very considerable greenhouse gases during their production—up to three times as high as conventional oil. Production also tends to be quite polluting in other ways, for example the highly toxic tailings (waste products) that are left at the end of the tar sands process. If companies are forced to pay the full social costs of producing oil from unconventional resources, for example by incurring a carbon cost for greenhouse gas emissions, it is likely that the breakeven oil price that will make them economically viable will be high.

In addition to concerns about the sufficiency of reserves, there is also a problem with the timeliness of new supplies coming on stream. For example, the new Brazilian deep-water discoveries (2008–09) have generated some excitement, but it will be many years before these sources are brought online, and the expense will be vast. There is also an increasing awareness of pollution risk following the appalling consequences of the BP oil-rig disaster in the Gulf of Mexico.

Finally, it is possible to produce oil and oil substitutes synthetically from gas and coal and biofuels like ethanol and if oil prices rise sufficiently, these alternatives become profitable to explore. In some countries (for example South Africa), synthetic oils have been produced since the 1970s. The issue here involves the breakeven price (inclusive of a realistic carbon price), the rate at which such alternatives can be developed and the huge scale of investment likely to be necessary. There is also the concern that greater reliance on ethanol made from corn or sugar cane will put upward pressure on global food prices, although there is the potential for development of other feedstocks.

Socio-political constraints

There is a concern that some major exporting countries are reserving oil for domestic use in a manner similar to the way some Australian states are reserving part of their gas supplies, and are becoming increasingly reluctant, or unable, to export. For example, Mexico has been a large supplier of oil to the US, but output from its super-giant Cantarell Field is declining by 13 per cent per annum and Mexico may not be a net exporter in coming years. Indonesia is already a net importer of crude. In 2006, internal consumption grew by six per cent in the five biggest

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[25] USGS, ‘USGS world petroleum assessment 2000’.

exporting countries and their exports declined by three per cent. Some oil exporters impose a relatively low domestic price for oil and this tends to inhibit domestic demand responses to rising world prices.

Consumer subsidies for petrol and related products are common in many non-OECD countries, and artificially inflate demand. In 2007, energy-related consumption subsidies in 20 non-OECD countries, which account for over 80 per cent of non-OECD energy demand, amounted to $310 billion.[26] The IEA suggests that 'most of these countries have policies to reform subsidies, although often the intended timing is vague and the commitment is half-hearted'.[27] However, countries can be severely constrained by domestic politics—Indonesia experienced riots when kerosene subsidies were reduced, and Iran encountered similar difficulties in relation to petrol-price reforms.

Two-thirds of world reserves are in the hands of state-owned companies such as Saudi Aramco, the national oil company of Saudi Arabia, and political factors are also limiting the access of western oil companies to countries like Venezuela, Mexico, Iran, Iraq, Kuwait and Russia. As a result, western oil companies, which often possess the most advanced technology and the capital necessary to fully exploit resources, have access to a declining fraction of world reserves.

On the other hand, artificial constraining of supply by state-owned companies may actually aid the world in its transition to a less oil-dependent future by reducing both the height of the peak and the rate of decline after the peak is reached. This is also true of the manner in which the OPEC cartel deliberately restricts supply. Such restriction can make perfect sense in a context where leaving oil in the ground creates more value than immediate extraction, and may actually contribute to a better long-run balance between supply and demand. But these useful side effects will be less apparent if oil-producing countries continue to adopt two-tier pricing policies that artificially foster domestic oil demand.

What the optimists say

As noted above, some experts believe that oil will not so much peak as plateau, giving countries a long period of time to deal with the new reality of constrained supply and to make the investments necessary to reduce oil dependence. Several US agencies predict that oil supply will continue to grow for many more years, notably the US Energy Information Administration (EIA) and the USGS. There are even specialists who deny that oil will ever enter a depletion phase because unconventional sources will come on-stream, along with biofuels.

Rising oil prices will render unconventional resources and new extraction technologies viable, thus expanding total recoverable oil reserves, and will direct new monies into exploration in evermore challenging frontiers such as the deep seas and the Arctic. The Antarctic is off-limits by international treaty.

A prominent optimist, Michael Lynch, argues that peak oil advocates have consistently and, over time, wrongly suggested an imminent production decline. He states:

> In the end, perhaps the most misleading claim of the peak-oil advocates is that the earth was endowed with only 2 trillion barrels of "recoverable" oil. Actually, the consensus among geologists is that there are some 10 trillion barrels out there. A century ago, only 10 percent of it was considered recoverable, but improvements in technology should allow us to recover

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[26] IEA (International Energy Agency), 'World energy outlook 2009 fact sheet', International Energy Agency, OECD, Paris, 2009.

[27] IEA, 'World energy outlook 2009 fact sheet'.

> some 35 percent—another 2.5 trillion barrels—in an economically viable way. And this doesn't even include such potential sources as tar sands, which in time we may be able to efficiently tap.
>
> Oil remains abundant, and the price will likely come down closer to the historical level of $30 a barrel as new supplies come forward in the deep waters off West Africa and Latin America, in East Africa, and perhaps in the Bakken oil shale fields of Montana and North Dakota.[28]

Optimists like Lynch are referred to as 'cornucopians' in the peak-oil literature. As discussed later, the $30 a barrel prediction is completely at odds with official predictions by bodies such as the IEA.

When will oil peak?

Hubbert predicted in 1974 that world oil production would peak in 1995 'if current trends continue'.[29] Because of the oil shocks of the 1970s and 1980s, global oil consumption temporarily dropped, with a shift to more energy-efficient cars and to coal-fired electricity and natural gas for heating. However, since then oil production has climbed to more than double the rate Hubbert initially assumed.

In 2000, the US EIA estimated that a peak would be reached sometime between 2020 and 2050, depending on assumptions about demand growth and the size of the URR. In a similar exercise in 2004, the IEA estimated a peak of conventional oil production between 2013 and 2037.[30] But many commentators predict an earlier peak.

Agencies such as the IEA have been modifying their views on peak oil and how high production will rise. In its *World energy outlook 2005* for example,[31] the IEA saw demand rising to 120 million barrels a day (mbpd) by 2030 compared to the current output of 85 mbpd, and assumed that supply would rise to meet demand. The IEA's subsequent annual reviews have revised these projections downwards; in 2009, the 2030 demand was lowered to 105 mbpd, with the possibility of short-term supply-constraints beginning in 2010 and leading to rapidly increasing oil prices.[32]

In the IEA's view, these constraints arise because of man-made factors, particularly the 20 per cent decline in investment and the deferral of new projects that followed the GFC. Upstream developments necessary to offset decline in existing oilfields and to supply demand growth will require very significant investment. The IEA's most recent edition of its *World energy outlook* has stressed that there is no guarantee that this will be forthcoming.

The IEA's increasing pessimism has resulted in its chief economist, Fatih Birol, issuing a warning that the output of conventional oil will peak in 2020 if oil demand grows on a business-as-usual basis.[33] This is a new and striking claim. Until now, the IEA had not committed itself to a firm prediction as to when energy supplies might cease to grow. But, according to Dr Birol, the

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28 M Lynch, '"Peak Oil" Is a Waste of Energy', *The New York Times*, 24 August 2009. Available at: http://www.nytimes.com/2009/08/25/opinion/25lynch.html?_r=1.

29 Cited in N Grove, 'Oil, the dwindling treasure', *National Geographic*, June 1974.

30 Senate Standing Committee on Rural and Regional Affairs and Transport, *Australian's future oil supply and alternative transport fuels,* p. 2.

31 IEA, World energy outlook 2005.

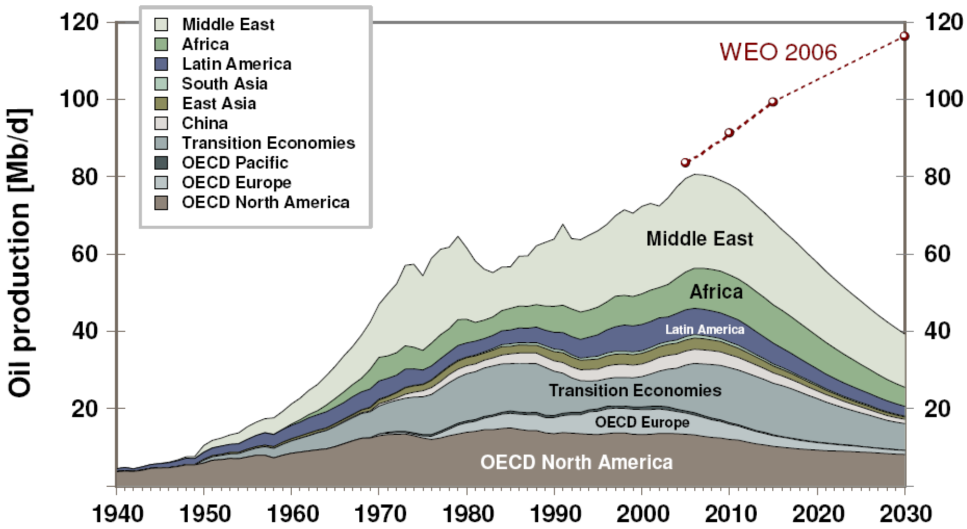
32 IEA (International Energy Agency), *World energy outlook 2009: executive summary*, International Energy Agency, OECD, Paris, 2009.

33 T MaCalister and G Monbiot, 'Global oil supply will peak in 2020, says energy agency', *The Guardian*, 15 December 2008.

declining rates of production from existing fields (described elsewhere) suggest that 'the world would need to find more than 40m barrels per day of gross new capacity—equal to four new Saudi Arabias—just to offset this decline'.[34]

IHS CERA, an energy research consultancy firm based in Boston, is regarded as an oil optimist. It projects a 2015 production level of over 100 mbpd with productive capacity growing to around 115 mbpd by 2030, and no evidence of a peak in supply. 'Post-2030 supply may well struggle to meet demand, but an undulating plateau rather than a dramatic peak will likely unfold'.[35] Others doubt that even the 100 mbpd level will ever now be achieved. A UK industry group reported that the peak was likely to occur by 2013,[36] but some fear that a catastrophic peak is almost here, or perhaps already past. Figure 6 below shows one such projection.

Figure 6: Oil production world summary



Source: EWG.[37]

Note: WEO refers to the *World energy outlook* produced by the IEA.

Has the oil supply peaked already?

Recently, a whistle-blower at the IEA is reported as suggesting that '[t]he [IEA's] 120 million figure always was nonsense but even today's [105 million] number is much higher than can be justified … Many inside the organisation believe that maintaining oil supplies at even 90 million or 95 million barrels a day would be impossible …'[38] The IEA's response to this suggestion was that peak-oil critics had often wrongly questioned its figures.

Most of the world's largest fields were found before 1985 and have already been in production for many years. Peak-oil advocates point out that of the 58 discovered 'super-giant' oil fields, all but four are already in production and many are in decline with an average depletion factor of half; that is, half the extractable resource is already used up. Of the largest 21 fields, at least nine are in decline. The world's largest oil field, the Ghawar Field in Saudi Arabia, which has

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34 'The IEA puts a date on peak oil production', *The Economist*, 10 December 2009.

35 IHS CERA, The future of global oil supply, p. 1.

36 ITPOES, The oil crunch.

37 EWG, *Crude oil—the supply outlook*.

38 T MaCalister, 'Panic warning as oil supplies run low', *Sydney Morning Herald*, 11 November 2009.

been responsible for half of Saudi production over the last 50 years, appears to have peaked. The second largest field, the Burgan Field in Kuwait, entered decline in 2005. This is important because out of 70,000 fields, the 20 largest, sometimes called super-giants, account for a quarter of total production while the hundred largest account for half.

In total, an estimated 79 per cent of the world's remaining conventional oil reserves are contained in fields that are already being exploited.[39] Oil production is in decline in 33 of the 49 largest oil producing countries,[40] and the geology of oil is such that it becomes increasingly likely that new discoveries will be progressively smaller and more difficult to exploit. On the other hand, IHS CERA has argued that 'assertions that giant oil fields are past their prime simply are not borne out in a recent detailed study … some 76 giant fields, representing 84 billion barrels, remain undeveloped. Fields in general and giant fields in particular still show considerable potential for reserve upgrades ...'[41]

The 2006–07 inquiry into peak oil by the Senate Standing Committee on Rural and Regional Affairs and Transport examined a broad range of world oil-production forecasts. These were loosely grouped into 'early peak' forecasts, envisaging the peak in the 2005–15 timeframe, and 'late peak' forecasts, placing the peak beyond 2020. The committee concluded: 'In view of the enormous changes that will be needed to move to a less oil dependent future, Australia should be planning for [peak oil] now'.[42]

Peak oil in Australia

Australia, in common with many other nations such as the US and the UK, has already passed the peak in oil and liquids production;[43,44] a plateau was reached over the period 2000–09 and production has been slowly falling since then. In the near term, an uplift in production is expected but this will fall away again in the absence of major new discoveries.[45] Australia's yearly oil-import bill was recently $12 billion and is projected to grow to $20 billion by 2015–20.[46,47] This has not been seen as a particular problem in this country, which has a net surplus of energy with exports of coal, uranium and natural gas rising rapidly and providing ample funds to cover imports of oil.[48] Australia also exports some crude and condensate and, as a result, the net oil-import bill is much less than the gross bill would be.

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39 IEA (International Energy Agency), *World energy outlook 2008*, International Energy Agency, OECD, Paris, Chapter 10. Available at: http://www.worldenergyoutlook.org/docs/weo2008/chapter10.pdf.

40 Senate Standing Committee on Rural and Regional Affairs and Transport, *Australia's future oil supply and alternative transport fuels,* p. 8.

41 IHS CERA, *The future of global oil supply*, p. 5.

42 Senate Standing Committee on Rural and Regional Affairs and Transport, *Australia's Future Oil Supply and Alternative Transport Fuels*, p. 55.

43 A Syed, R Wilson, S Sandu, C Cuevas-Cubria and A Clarke, *Australian Energy: National and State Projections to 2029–30,* ABARE Research Report 07.24, prepared for the Australian Government Department of Resources, Energy and Tourism, Canberra, December 2007.

44 Senate Standing Committee on Rural and Regional Affairs and Transport, *Australia's Future Oil Supply and Alternative Transport Fuels*, p. 16.

45 Department of Resources, Energy and Tourism, *National Energy Security Assessment 2009*, Canberra: Commonwealth of Australia.

46 B Foran, *Powerful choices: transition to a biofuel economy in Australia*, Land and Water Australia, Canberra, June 2009.

47 Senate Standing Committee on Rural and Regional Affairs and Transport, *Australia's Future Oil Supply and Alternative Transport Fuels*, par. 2.49 and p.18.

48 ABARE (Australian Bureau of Agricultural and Resource Economics), *Energy in Australia 2010*, produced and compiled by C Cuevas-Cubria, A Schultz, R Petchley, A Maliyasena and S Sandu for the Department of

Natural gas can be compressed into compressed natural gas (CNG), or liquefied by refrigeration into liquefied natural gas (LNG), and there is the potential for Australia to use more of its natural gas as a transport fuel if oil becomes too expensive.[49] One of the problems associated with this is the lack of retail infrastructure and the extra weight and cost of gas tanks. However, some companies are already rolling out CNG infrastructure. The *Powerful choices* study for Land and Water Australia suggests that natural gas presents significant possibilities both as an interim transport fuel and for the production of mid-carbon electricity, provided of course that it has not been sold overseas in the meantime.[50]

This raises the issue of the need to preserve some of Australia's gas for domestic uses. WA already has a 20 per cent and QLD is contemplating a 15 per cent domestic reservation policy. However, such policies seldom meet the approval of the gas industry even if they are popular with other industrial users. Some economists take the view that efficiency is promoted by maximising the price at which the gas can be sold, others that it is important to ensure that domestic consumers have access to a reasonably priced resource.

Previous sections in this paper discussed the oil supply. Price, of course, is determined by the interaction of supply and demand and we now turn to a consideration of the factors underpinning demand.

World demand for oil

World demand for oil grew at an average of 1.76 per cent a year from 1994 to 2006; despite some slowing due to the GFC, it still stands in aggregate at around 85 mbpd. The IEA forecasts that demand will increase by another 24 per cent over 2006 levels by 2030 due, in large part, to the transport sector where oil products are by far the most convenient power source. Worldwide transport accounts for 55 per cent of total oil demand; other major uses, which are diminishing in importance, include heating and power generation.

Industrialisation in China and India is dictating the surge in the demand for oil, with millions of new cars being added annually to the fleets in these two countries. Between 1995 and 2005, oil consumption in China increased from 3.4 mbpd to seven mbpd, an increase of over 100 per cent, while India's oil imports are predicted to triple by 2020, rising to five mbpd. As countries develop, industry, urbanisation, and higher living standards drive up energy use. In the developed world, by contrast, demand is stabilising as a result of better fuel efficiency and low population growth and, on current projections, is not expected to grow very much. IHS CERA believes that demand has peaked in the developed world and may never be as high again due to continuing energy efficiency, diminished population growth and encroachment by substitutes like ethanol and natural gas.[51] This is consistent with the projections of the IEA.

Population growth is also a driver of the demand for oil and although birth rates are declining and alleviating the situation, life expectancies are increasing. By 2007, the global population growth rate had fallen to 1.2 per cent per annum, down from 2.1 per cent in 1970, but continues to produce a burgeoning population and an associated demand for natural resources like oil. The combination of population growth and rising incomes in the less developed world is a powerful upward influence on the demand for oil.

Resources, Energy and Tourism, Canberra, Commonwealth of Australia, 2010. Available at: http://www.abare.gov.au/publications_html/energy/energy_10/energyAUS2010.pdf

49 The Howard Government committed to rolling out CNG and LNG in 2000, and set in place several schemes to promote this.

50 B Foran, *Powerful choices*.

51 A Brady, *Peak Oil Demand in the Developed World: It's Here*, [abstract], IHS CERA, 29 September 2009.

The oil price

The combination of a rising demand for oil and a flat supply outlook is likely to lead to escalating oil prices unless strong mitigation action is taken. Exacerbated by reports that production was at or near capacity, the price of oil peaked most recently in June 2008 at over US$145 a barrel; prior to that, the highest price in inflation adjusted terms was US$100 in 1980. Between these two peaks there was a long period of relatively subdued prices, followed by a rapid escalation commencing in around 2003, which was brought to an end by the GFC. Oil prices fell to as low as US$35 in its aftermath but have now resumed their upward trajectory and are back at over US$75 a barrel. This is relatively high in historical terms.

It is widely believed that prices will continue to trend upward as the world recovers from the GFC. Previously, government agencies such as the IEA and the US EIA had forecast that oil prices of around US$60 to US$70 would persist for the long term. These agencies are belatedly updating their estimates and the most recent IEA outlook sees prices reaching US$102 a barrel by 2015, US$131 by 2020 and US$190 by 2030. These are nominal figures; after adjusting for inflation these prices correspond in current dollars to US$87, US$100 and US$115 respectively.[52] But the price in 2010 has already touched the amount forecast for 2015, suggesting that these projections may be conservative.

The primary source of government advice on energy prices in Australia is the Australian Bureau of Agricultural and Resource Economics (ABARE). In 2006, it assumed a long-term oil price of US$40 a barrel on the grounds that prices would be held to that level by competition from substitutes such as oil from coal,[53] in its view viable at that price. But oil substitutes are very energy-intensive to produce and it is necessary to factor a carbon cost into the price. According to modelling undertaken for the Senate, a $40-a-tonne CO_2 price adds some $10 to $20 a barrel to production costs.[54] The IEA suggests that extracting oil from heavy oil and bitumen is viable at US$40 a barrel, and from shale oil at US$70 a barrel, even with the requirement to make these processes carbon neutral,[55] and extraction of oil from tar sands is already happening on a large scale in Canada. Obviously, these costings depend on assumptions about the carbon price.

In the view of those concerned about peak oil, these official price projections are wildly optimistic. The demand for oil is so insensitive to changes in price, particularly in the short term, that very large movements are often necessary to re-establish equilibrium between supply and demand. This occurred for example in 2008 and is graphed in Figure 8 below. The figure shows a huge spike in prices in 2008 followed by the crash brought on by the GFC, now partially unwound as growth has resumed in most economies.

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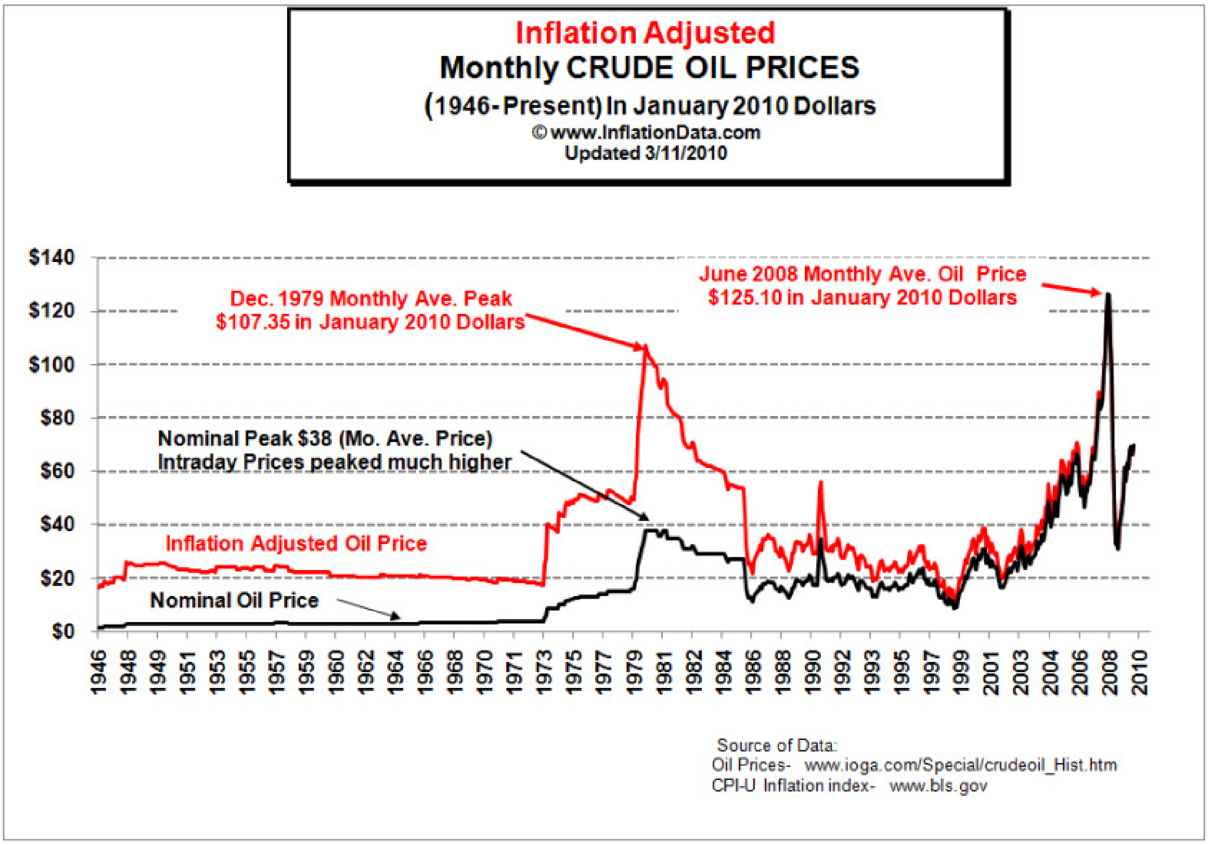
52 IEA, 'World Energy Outlook 2009 fact sheet'.

53 Oil is not extracted from coal but re-processed using a chemical procedure.

54 Senate Standing Committee on Rural and Regional Affairs and Transport, *Australia's Future Oil Supply and Alternative Transport Fuels*, p. 49.

55 Senate Standing Committee on Rural and Regional Affairs and Transport, *Australia's Future Oil Supply and Alternative Transport Fuels*, p. 51.

Figure 8: Historical oil price to 2010



Source: InflationData.com[56]

In the past, high oil prices have been one of the causal factors in economic recessions such as the 'stagflation' of the 1970s that followed the first oil shock. Because oil is such an important input of modern economies, spikes in its price generate flow-on effects throughout the price chain. Central banks believe they have little choice but to mitigate these effects by increasing interest rates in order to help control inflation and slow the economy.[57] In aggregate, economies do not respond well to oil-price shocks and the peaking of oil production will lead to more of these.

There have been developments that will help economies adjust to the higher price of oil, in particular the trend in modern western economies of being far less energy-intensive per unit of output than was the case in the past. But this may be of limited assistance to third-world countries struggling with high import bills, budget blow-outs (from the petrol and kerosene price subsidies they often provide) and balance-of-payments crises in the wake of oil-price shocks.

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[56] InflationData.com, 2010. Available at: http://www.inflationdata.com/inflation/images/charts/Oil/Inflation_Adj_Oil_Prices_Chart.htm.

[57] There is also a real-income effect on oil-importing countries from oil-price shocks as reflected in the balance of payments, and it takes time for 'sticky' real wages to reflect this.

Responding to peak oil

Concerns and attitudes

What should be done about peaking oil? If the peak is distant and occurs gradually, there will be sufficient time for markets to adjust to the new situation and only modest government intervention is likely to be needed. However, if the peak is imminent and abrupt, the market may not cope well with the resulting dislocation and the consequences could be very serious with skyrocketing oil prices leading to a cycle of economic downturns. In the more pessimistic scenarios, one of the consequences of peak oil is an abandonment of the suburbs in the developed world due to the perceived unsustainability of the current urban model.[58]

Because oil and gas are integral to modern agricultural methods, a fall in global oil supplies could cause spiking food prices and famine in poor third-world countries. Fertiliser production uses large amounts of natural gas and, although gas is more plentiful than oil, the two are partial substitutes (for example, vehicles can be modified to run on CNG) and oil-price hikes will undoubtedly spill over into the natural gas market.[59] The possibility of famine is heightened by issues associated with population growth. When oil peaks, it may prove difficult to maintain the intensive agriculture necessary to support a growing global population.

There are emerging indications that actions taken to address the peak could have damaging consequences. It is now widely recognised that the production of biofuels such as ethanol competes with the production of food and could have an extremely deleterious effect on the world's poorest people. There is also a concern that exploitation of unconventional oil sources, for example Canada's tar sands, will produce enormous quantities of greenhouse gases and other pollution and should not be seen as part of a rational solution to the peak-oil situation.

What should be the response to peak oil?

There are two broad alternatives to dealing with the potential peaking of the oil supply. The default option is for policymakers to ignore the problem and leave it to the market to resolve. Proponents of this approach assume that each new price spike will drive energy efficiency and also increased investment in new sources of supply, including alternative fuels. Critics of this approach suggest that it will drive a cycle of economic boom and bust as high oil prices feed inflation and force central banks to clamp down on economies, generating unemployment and social unrest.

The second alternative is for governments to plan pro-actively for the oil peak by driving investment in energy efficiency and alternative fuels. One argument for intervention is that alternative fuels face a 'chicken and egg predicament'; investment is not forthcoming because of lack of demand, and demand is not forthcoming because of lack of distribution infrastructure. This has arguably been the situation in Australia with regard to ethanol, an issue now partly resolved with the help of government regulation and subsidies on the distribution side. It may also be the situation with regard to the possible wider use of natural gas as a transport fuel.

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[58] J H Kunstler, *The Long Emergency: surviving the end of oil, climate change, and other converging catastrophes of the twenty-first century*, Grove Press, NY, 2006.

[59] As explained later, the natural gas supply situation is improving with new horizontal drilling techniques, fracturing, and shale gas.

The IEA has called for a 'global energy revolution' to prepare mitigation options by 2020.[60] Its chief economist, Fatih Birol, argues: '[W]e have to leave oil before it leaves us, and we have to prepare ourselves for that day. The earlier we start the better …'[61]

In 2005, the US Department of Energy published the Hirsch Report,[62] which emphasised the need to find alternatives at least 10 to 20 years before the peak and to use that time to phase out petroleum. In the view of its authors, the operation of market forces will not be an effective strategy because the approach of peak oil will cause huge price volatility.

> … [W]ithout timely mitigation, the economic, social and political costs will be unprecedented. Viable mitigation options exist on both the supply and demand sides, but to have substantial impact, they must be mitigated more than a decade in advance of peaking.[63]

The authors suggest that: 'Intervention by governments will be required, because the economic and social implications of oil peaking will otherwise be chaotic'.[64]

The Hirsch Report described three scenarios.

- Wait until production peaks and then take crash action; this approach is projected to leave the world with a significant liquid-fuels shortfall for more than two decades.
- Initiate a crash mitigation program 10 years before the peak; this will help considerably but will leave a liquid-fuels shortfall for a decade.
- Establish a mitigation program commencing 20 years before the peak; this approach will offer the possibility of avoiding a liquid-fuels shortfall. However, the report was published in 2005 and suggested that a peak was likely within 20 years; if correct, this leaves insufficient time to implement the preferred policy response.

The Hirsch Report saw peak oil causing a severe liquid-fuels problem for the transport sector rather than an 'energy crisis' in the usual sense, and predicted the likelihood of dramatically higher oil prices resulting in protracted economic hardship in the US and around the world. The production of large amounts of substitute liquid fuels will be required. This is feasible with existing technology (the report concentrated on technologies that were immediately available), but it will require a significant investment in the construction of facilities to process such fuels (indeed, a crash program), coupled with significant increases in transport fuel efficiency.

Some commentators, such as the author James Kunstler, suggest that since 90 per cent of transport in the US uses oil, the outlook for suburban living with its heavy reliance on the automobile is one of environmental unsustainability.[65] Radical options to address the peak-oil problems that flow from such analyses include redesigning cities to increase population densities and to ensure that public transport, cycling and walking are more viable alternatives than driving cars. On the other hand, increasingly fuel-efficient cars such as hybrids or even electric cars may allow the suburban lifestyle to continue although it will involve new challenges.

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60 IEA (International Energy Agency), *New energy realities: WEO calls for global energy revolution despite economic crisis*, media release, 12 November 2008.

61 S Connor, 'Warning: oil supplies are running out fast', *The Independent*, 3 August 2009.

62 R Hirsch, R Bezdek and R Wendling, *Peaking of world oil production: impacts, mitigation, & risk management*, US Department of Energy, February 2005.

63 Hirsch, Bezdek and Wendling, *Peaking of world oil production*, p. 4.

64 Hirsch, Bezdek and Wendling, *Peaking of world oil production*, p. 5.

65 Kunstler, *The Long Emergency*.

Many years and a huge financial cost will be necessary to change the vehicle fleet over to more fuel-efficient transport and it will not totally solve the problem. Electric cars impose their own costs in terms of the greenhouse gases emitted both in their manufacture and the generation of the electricity required to power them.

In 2009, the US Congress commissioned a report by a committee of the US National Research Council of the Academy of Sciences, which recorded several main findings.[66] First, more compact urban development would reduce vehicle miles travelled; in fact, doubling residential densities could reduce vehicle miles travelled by up to 25 per cent if coupled with increased employment density and improved public transport. Higher density, mixed-use developments would also reduce fuel use. However, a major obstacle to more compact development is political resistance from local zoning regulators and their electorates.

New-automobile fuel efficiency standards under CAFE[67] (the preferred instrument in the US) will ultimately involve the replacement of conventional gasoline-powered cars with hybrids and/or diesel-powered cars and, more recently, plug-in electric vehicles. Further approaches to mitigating the impact of peak oil include increased production of unconventional oils, coal liquefaction, enhanced oil recovery and 'gas to liquids'.[68] Governments will likely have a role in facilitating new investment into all these options.

Despite the warnings from the IEA and the US Department of Energy, the fact is that governments do not have a very good record when it comes to energy policies. For example, the US Government has long had a policy of subsidising ethanol production, which has resulted in the production of extremely expensive ethanol in the US, and has driven up the price of corn and in turn food prices generally. At the same time, the US has placed a heavy tariff on much cheaper Brazilian ethanol made from sugar cane. Clearly, domestic politics are an important determinant of such policies.

Whether it is massive investment in new fuels or massive investment in redesigning cities, it is likely that governments will need to take a role in preparing for peak oil if they wish to avoid major economic dislocations.

Natural gas as a bridging transport fuel?

One way of mitigating against peak oil is to rely temporarily on alternative fuels such as natural gas, which is predominantly methane and can be used as a transport fuel in both diesel and petrol engines in two possible forms:

- a compressed gaseous form known as *compressed natural gas* or CNG (this is different from the liquefied petroleum gas (LPG) comprised mainly of propane and/or butane used in taxis and some other vehicles in Australia)
- a refrigerated liquid form, cooled to -163C and stored in cryogenic tanks, known as *liquefied natural gas* or LNG.

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[66] Committee for the Study on the Relationships Among Development Patterns, Vehicle Miles Traveled, and Energy Consumption, *Driving and the Built Environment: The Effects of Compact Development on Motorized Travel, Energy Use, and CO_2 Emissions*, Transportation Research Board Special Report 298, National Academy of Sciences, Washington DC, 2009.

[67] CAFE (Corporate average fuel economy) mandates that new cars sold must meet an aggregate fuel-efficiency standard.

[68] Gas to liquids is a refinery process that converts natural gas and other gaseous hydrocarbons into longer-chain hydrocarbons such as gasoline or diesel fuel. Methane-rich gases are converted into liquid fuels either via direct conversion or via syngas as an intermediate.

The Hirsch Report was concerned with 'the developing shortages of US natural gas' and this (erroneous) perception may have been the reason behind the authors' neglect of the CNG and LNG options for transport fuel. The long-term global recoverable gas reserve base is estimated at more than 850 trillion cubic metres (tcm), although nearly of half this is made up of unconventional gas resources such as coalbed methane, 'tight' gas and shale gas.[69] At the end of 2008, proven global gas reserves totaled more than 180 tcm, equal to 60 years of production at current rates. To date, only 66 tcm of gas has been consumed, a part of which has been wastefully flared (burnt off) as a by-product of oil extraction.

Plentiful gas and cheaper gas prices in the US are causing flow-on effects for the rest of the world, with the possibility of a looming glut according to the IEA.

> The recent rapid development of unconventional gas resources in the United States and Canada, particularly in the last three years, has transformed the gas market outlook, both in North America and in other parts of the world. New technology, especially horizontal drilling combined with hydraulic fracturing, has increased productivity per well from unconventional sources—notably shale gas —and cut production costs. … [However,] [t]he extent to which the boom in unconventional gas production in North America can be replicated in other parts of the world endowed with such resources remains highly uncertain. [70]

In 2007, an Australian Senate Committee[71] considered the wider use of natural gas as a transport fuel but found that there were significant problems.

1) Natural gas requires either a refrigeration system or compression and a large gas tank for storage, which limits its range.

2) The process of compression or freezing is energy-intensive and therefore detracts from the net energy available for transport.

3) In the case of commercial vehicles, the extra weight and cost of a gas conversion makes the payback period quite lengthy and the economics are thus dependant on generous tax concessions in the excise regime.[72]

4) A nationwide lack of refuelling infrastructure appears to be another obstacle to wider use[73].

The Senate Committee's conclusion regarding the use of natural gas was thus ambivalent.

In the medium term, gas might substitute for oil as a transport fuel but its use would be only a bridge, not a long-term fix, and ultimately gas will run out as well.

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69 IEA, *World Energy Outlook 2009*. New technologies are making it possible to unlock reserves in these unconventional forms, such as coal seam methane on the east coast of Australia and shale gas in the US.

70 IEA, *World Energy Outlook 2009*.

71 Senate Standing Committee on Rural and Regional Affairs and Transport, *Australia's Future Oil Supply and Alternative Transport Fuels*.

72 An excise for gas in transport is being phased in but will only have reached half that of petrol by 2015.

73 However, there are evolving technologies which make small-scale production of CNG and LNG more feasible, even in home applications, and the private sector is beginning to provide infrastructure for commercial distribution points.

The future in Australia

In 2008, the CSIRO published *Fuel for thought. The future of transport fuels: challenges and opportunities,* which suggested that further substantial increases in the price of oil-based products such as petrol and diesel, are plausible although 'very uncertain in their timing and extent'.[74] The publication argues that if there is a near-term peak in international oil production, petrol prices could increase to between $2 and $8 a litre by 2018. The implication for a medium passenger vehicle is a rise in weekly fuel bills from $40 a week in 2007 to between $50 and $220 in real terms by 2018. Although freight costs will also be affected, the CSIRO modelling indicates that the adoption of new fuels and technologies will leave freight costs broadly unchanged in the long term.

If oil peaks, technology alone will not be sufficient to meet the fuel-supply gap; reduced freight and passenger transport will be necessary. The CSIRO considers several different scenarios for oil supply and prices. One of these, the slow decline scenario, sees a reduction in transport use of less than five per cent, but if the decline is rapid it could be up to 40 per cent with an associated three per cent decrease in GDP. However, a shift towards public transport and rail and sea freight could reduce kilometres travelled by 30 per cent and greenhouse gas emissions by 17 per cent.

According to the CSIRO, the introduction of emissions trading is unlikely to radically change the transport sector. A $100-a-tonne CO_2 permit price will increase the cost of fuel by only 25 cents a litre[75] and, because demand is inelastic to petrol and diesel prices, a 20 per cent rise in prices is likely to reduce kilometres travelled by only five per cent. Significantly, the Rudd Government's delayed CPRS imposes no actual increase in the price of fuel.

The CSIRO predicts that Australians will be using a more diversified mix of fuels, especially electricity, LPG and CNG, the latter for freight particularly. Beyond 2020, advanced biofuels that limit competition with food production and synthetic fuels derived from gas and coal (using carbon capture and storage) are also expected to come into production when the required infrastructure has had sufficient time to scale up. The modelling indicates that there will be a steady shift towards low-emission fuels and vehicles. In the view of the CSIRO report, governments may need to intervene given the high social impacts of the worst-case scenarios outlined, but there are risks in any industry development policy that requires governments to 'pick winners'.

The *Powerful Choices* study for Land and Water Australia[76] suggested that bio-methanol from wood feedstocks is capable of meeting Australia's transport-fuel needs, but 40 to 60 million hectares of wood production on currently cleared farmlands would be required by 2051. Bio-ethanol is also feasible but less attractive since it requires more arable land and delivers low-energy profits.[77] Both CNG and shale oil are seen as feasible routes to transport-energy security, but with a reduced possibility of greenhouse gas mitigation.

In 2009, the Department of Resources, Energy and Tourism issued an assessment of national energy security,[78] which concluded that Australia's liquid-fuels security is currently high and will remain so over five and 10 years, and moderate over 15 years. Threats include the possibility

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[74] CSIRO, *Fuel for thought. The future of transport fuels: challenges and opportunities*, Future Fuels Forum, Canberra, 2008.

[75] CSIRO, *Fuel for thought*.

[76] Foran, *Powerful choices*.

[77] There is a high-energy cost in making bio-ethanol compared to the energy produced when it is burned.

[78] Department of Resources, Energy and Tourism, *National Energy Security Assessment 2009*.

that Australia will not continue to have access to well-functioning global oil markets and that global investment in production capacity will fail to keep pace with demand growth and field declines.

The link between peak oil and climate change

The need to tackle greenhouse gas pollution reinforces the need to tackle peak oil (through energy conservation, for example), while adding further complications by making certain options technically feasible but climatically disastrous. This includes exploitation of unconventional oil, which is energy-intensive and produces significant CO_2 emissions, and coal to liquids and gas to liquids technologies, which may be viable only in conjunction with underground sequestration of the generated CO_2 emissions. Ultimately, these issues can only be addressed by the introduction of a comprehensive carbon-pricing mechanism that delivers an internationally consistent carbon price. This can be achieved either by international trade in carbon permits or, the best and simplest option, an internationally harmonised carbon tax.[79]

However, the peak-oil and climate-change challenges are different in one fundamental way. Oil markets have the capacity for self-correction if allowed to operate appropriately, for example by removing price subsidies which artificially foster demand. Climate change, on the other hand, is not a self-correcting problem and requires determined government intervention, although this can take the form of simply changing relative prices using carbon taxes or trading schemes.

The industrialisation of the developing world renders both the peak-oil and the climate-change problems more difficult. On the demand side, China and India are transforming global energy markets because of their sheer size and rate of economic growth. Between now and 2030, these two countries will account for 70 per cent of new, global oil demand and 80 per cent of new coal demand. For instance, car sales in China were expected to overtake those of the US in 2016; in fact they have already done so. China undertook to reduce the energy intensity of its GDP growth at the Copenhagen climate-change summit, but even so its energy and oil use is on a very fast growth trajectory.[80]

The IEA's reference scenario, 'business as usual', projects that oil will remain the single largest component of the primary fuel mix in 2030, although its share will drop from 34 to 30 per cent. Oil use is forecast to rise from 85 to 105 mbpd by 2030 and 97 per cent of the increase will be attributable to the transport sector. In the view of the IEA, the continuation of existing policies will see a fossil-fuel future that will not only be disastrous for the planet but will lead to a rapid depletion of oil. The IEA states that:

> Continuing on today's energy path, without any change in government policy, would mean rapidly increasing dependence on fossil fuels, with alarming consequences for climate change and energy security. … These trends would lead to a rapid increase in the concentration of greenhouse gases in the atmosphere.[81]

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79 A 'harmonised' carbon tax would have broadly similar rates and bases. The problem with the trade in permits is that producers of permits have an incentive to cheat, and lack of integrity in one country rapidly spreads to other countries via the permit price. This is one reason Kyoto has been a failure. A second disadvantage of trading is that the permit price fluctuates and such uncertainty makes it difficult to build a business case for required investments in energy alternatives.

80 China's energy efficiency is low: by 2030, China could save twice the annual output of the Three Gorges Dam through the use of more efficient refrigerators and air conditioning. See F Birol, 'Fatih Birol presents the IEA World Energy Outlook 2007', presentation in London at the Shell Centre, hosted by the British Institute of Energy Economics, notes by M Pepler, *The Oil Drum: Europe*, 7 December 2007. Subsequent editions of WEO have expanded on the IEA's preferred scenarios.

81 IEA, *World Energy Outlook 2009*, p. 6.

The IEA describes a second scenario that will achieve stabilisation of atmospheric CO_2 levels at 450 parts per million (ppm), the level some experts believe is capable of preventing global temperatures from rising by more than 2°C. Reductions are achieved by means of carbon pricing, changes in the fuel mix and a widespread improvement in energy efficiency, the largest contributor to CO_2 abatement. The average emissions intensity of new cars, for example, is reduced by more than half as a consequence of improved fuel economy (hybrids and plug-in electric vehicles) and the expansion of biofuels.

This stabilisation scenario, the IEA's '450 scenario', implies a huge global investment of US$10.5 trillion more than the reference scenario, annually between a half and one per cent of GDP. This is a modest cost to insure against a possibly catastrophic outcome for the planet. As the IEA states, '[t]he cost of the additional investments needed to put the world onto a 450-ppm path is at least partly offset by economic, health and energy-security benefits'.[82]

The main policy options for Australia

Possible policy responses to peak oil are discussed in the Senate Standing Committee's Final Report of 2007[83] and ASPO Australia's submission to Infrastructure Australia,[84] and predominantly involve alternative fuels and energy efficiency. Additional responses are canvassed in recent reports from The Australia Institute. Some of the principal possibilities include:

1) More investment in public transport systems in cities and in intercity rail, possibly financed by congestion charges (see Point 7 below); rail freight uses a third the fuel of road freight per tonne carried.[85]
2) Urban consolidation and better planning to reduce urban commuting distances and make public transport more viable.
3) Increased usage of ethanol and bio-diesel, possibly by mandating minimum proportions; there is an existing government biofuels target of 350 million litres by 2010, which could be extended.[86]
4) Promotion of CNG and LNG as alternative fuels by facilitating the roll-out of distribution infrastructure; the current lack of distribution points is inhibiting the market but natural gas is plentiful in Australia and could be a useful bridging fuel.

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[82] IEA, *World Energy Outlook 2009*, p. 9.

[83] Senate Standing Committee on Rural and Regional Affairs and Transport, *Australia's future oil supply and alternative transport fuels.*

[84] ASPO Australia, *Peak oil and Australia's national infrastructure*, Submission to Infrastructure Australia, October 2008.

[85] Senate Standing Committee on Rural and Regional Affairs and Transport, *Australia's future oil supply and alternative transport fuels,* p. 158.

[86] R Webb, 'Government assistance to alternative transport fuels', research note no. 9 2006–07, Parliamentary Library, 2006. Government assistance to alternative fuels takes the following forms:

- consumption subsidies in the form of excise exemptions for LPG, LNG and CNG, which will phase out over 2011–2015
- from 1 July 2015, a 50 per cent 'discount' for excise on all alternative fuels
- production subsidies
- capital grants to biofuel producers to:
  - increase production capacity
  - encourage petrol stations to sell fuel ethanol, and
  - encourage users to convert to alternative fuels, and
  - provide assistance under the government's response to the Biofuels Taskforce: see http://www.aph.gov.au/library/pubs/rn/2006-07/07rn09.htm.

5) Preserving a portion of Australia's natural gas for domestic use with a national policy that could supersede or complement state schemes in WA and QLD.
6) Provide or subsidise infrastructure for electric cars, including the installation of charging points and battery exchange stations, a space in which the private sector is already active.
7) Impose congestion charges on road users in the larger capital cities and use some of the revenue to improve public transport, as advocated for example by Ingles.[87] The Bureau of Infrastructure, Transport and Regional Economics (BITRE) suggests that optimal congestion charges have the potential to reduce peak-hour travel in cities by 20 per cent, overall travel time by 40 per cent and total traffic fuel consumption by 30 per cent.[88] The Henry Tax Review also advocated congestion pricing, as well as heavier road-use charges on trucks, which would in turn promote rail usage.
8) Increase and index the existing fuel excise frozen at 38 cents a litre in 2001, possibly using some of the revenue to reduce motoring fixed costs like registration charges so that for low-income motorists driving is still affordable.
9) Gradually remove excise concessions on natural gas and LPG as transport fuels; these charges are essentially for congestion and pollution externalities, and road use.
10) Move to reduce motoring fixed costs (stamp duties, registration and insurance) and raise variable costs (costs per km), as suggested by Ingles.[89]
11) Review the existing voluntary fuel-efficiency targets and consider the imposition of tighter and mandatory targets; the current code calls on members of the Federal Chamber of Automotive Industries to improve average fuel consumption of new passenger cars from 8.28 litres per 100 kms to 6.8 litres per 100km by 2010, but some types of vehicles are not covered by this standard.[90]
12) Reform the way car fringe benefits are taxed (the estimated subsidy is $1.8 billion a year), as recommended in the Henry Tax Review. The concessional treatment of FBT on cars encourages car use and contributes to urban congestion. It is suggested that in Sydney, 50 per cent of cars on the road in peak hours enjoy FBT concessions.[91,92]
13) Work four-day weeks and reduce commutes by 20 per cent.

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87 D Ingles, *Road congestion charges—an idea whose time has come*, Technical Brief No. 5, The Australia Institute, Canberra, 2009.

88 BITRE (Bureau of Infrastructure, Transport and Regional Economics), *Greenhouse policy options for transport*, BITRE report no. 105, Bureau of Transport & Regional Economics, Canberra, 2002, p. xv.

89 D Ingles, *Greening Motoring Costs*, Technical Brief No. 6, The Australia Institute, Canberra, 2009.

90 BITRE, *Greenhouse policy options for transport*,

91 Senate Standing Committee on Rural and Regional Affairs and Transport, *Australian's future oil supply and alternative transport fuels*, p. 162.

92 This year, the concessional taxation of fringe benefits is expected to cost $3.5 billion in forgone revenue relative to the Treasury tax expenditures benchmark. Concessions for cars are a large part of this total, some $1.8 billion, described as 'application of statutory formula to value car benefits'. See Treasury, *Tax Expenditures Statement 2008*, Commonwealth of Australia, 2009, p. 12.

Conclusion

Peak oil will arrive; the question is simply one of timing. It will probably be sooner than most people expect and definitely sooner than many would prefer. In an ideal world, governments would anticipate this development and plan for it; the alternative is a laissez-faire scenario likely to impose extremely high economic costs in terms of stagflation and lost output. The IEA and the US Department of Energy have stated publicly that they think the peak is sufficiently close that governments should begin to invest in the transition.

Unfortunately, the reality is that government interventions may turn out to be costly, misguided and perhaps ineffective. The current LPG conversion subsidy is a case in point. Australia is running out of LPG at least as quickly as it is running out of crude[93] and the subsidy may not have a net economic benefit. In the US, the subsidies to the ethanol industry have been basically a boondoggle for the farm sector and have driven up the price of food.

There is also the issue that individual countries possess limited power to affect the worldwide crude-oil demand. Ideal first steps would include the abolition of price subsidies worldwide and the imposition of a higher fuel excise in the US, which currently has wastefully low petrol and diesel taxes.[94] There also needs to be internationally harmonised carbon pricing. These are not, however, steps within the control of an Australian Government.

Nonetheless, there appear to be a number of steps that can usefully be taken domestically. The list above provides a guide. The government needs to commission a review along the lines of the Hirsch Report in the US both to grapple with the mounting evidence of the likelihood of early peak oil and to arrive at policies to deal with it. However, the failure of the Hirsch Report to canvass important options (like gas and electric cars), and the pace of change since it was handed down, indicates that there will be an important role for flexibility in handling the oil peak and there are grave dangers in 'picking winners'.

Peak oil and climate change need to be tackled together, and the mechanisms for solving both problems may be the same. For example, energy conservation is a common component of the response, and bio-fuels will involve less carbon pollution than oil. As the IEA points out, the world is on an unsustainable path of fossil-fuel use and the time has come to address this urgently.

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93 Senate Standing Committee on Rural and Regional Affairs and Transport (2007). *Australia's future oil supply and alternative transport fuels,* p. 87. Recall that LPG is different from LNG, which is not in danger of running out.

94 The excise rate is low compared with numerous academic studies on the external (social) costs of motoring.

Appendix 1

‘The statutory formula method for valuing car fringe benefits applies a declining taxable value the further the car is driven in a year. The original purpose of this policy was to apply tax to the private use of the vehicle, not its use for work purposes, and distance travelled was used as a proxy for the proportion of business travel. The value of the car for FBT purposes is its cost multiplied by a 'statutory fraction' which depends on how far the car is driven in the relevant tax year. The statutory fraction, and hence the taxable value of the car benefit, reduces as the number of kilometres driven increases’.

Table 1: Distance thresholds for the FBT statutory fraction

Number of kilometres driven	Statutory fraction
< 15,000	0.26
15,000 to 24,999	0.20
25,000 to 40,000	0.11
> 40,000	0.07

Source: Treasury[95]

‘This valuation formula has two main impacts on incentives. It reduces the overall cost of car ownership and provides employees with an incentive to drive additional kilometres to reduce the amount of FBT payable. These incentives indirectly encourage increased greenhouse gas emissions, pollution and congestion through increased car use’.[96]

The bottom line is that either the statutory fractions are too low and need to be increased or, alternately, the scheme needs to be re-structured entirely.

95 Treasury, *Australia’s future tax system*, Table 13.1.

96 Treasury, *Australia’s future tax system: consultation paper*, Commonwealth of Australia, Canberra, December 2008, p. 251.

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