global witness

HEADS *in the* SAND

Governments ignore the oil supply crunch and threaten the climate

A Report by Global Witness
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Recommendations

The priority recommendation is the need for international recognition of the underlying fundamental problems that equate to an imminent oil supply crunch. It is hard to see how effective solutions can be developed until there is widespread recognition of the problem.

- Governments and appropriate multilateral agencies should publicly recognise the imminence of an oil supply crunch.
- Governments must act urgently to fast-track the development and the building of a sustainable set of safe energy provision systems and implement energy conservation measures.
- To that end, and as a matter of national security, global leaders should commit to dialogue about energy both within and between countries at the highest level.
- Transparency is required for global petroleum reserves and exploration data, on a field-by-field basis. This transparency should be extended to other key primary energy sources, such as gas, uranium and coal.
- Promising technologies must receive sufficient investment as a matter of priority; reliance only on market solutions is insufficient. These should then be rolled out to achieve economy-of-scale price reductions.
- The Copenhagen targets need to reflect a precautionary approach based on up-to-date scientific evidence and findings.

Section 1 of this report (Why the oil supply matters) briefly outlines the potential social and geopolitical consequences of a global oil supply crunch.

Section 2 (The rise and fall of *Homo petroliensis*) looks at problems of depletion in aging oilfields, declining discoveries and the large increase in projected demand.

Section 3 (Time for governments to reconsider) outlines how the IEA has finally sounded the alarm about oil supply, but argues that its projections for future oil supply are unlikely to be successful in bridging the gap.

Section 4 (The IEA's history of overconfidence leaves a legacy of missed opportunity) briefly considers how the IEA's misleading use of data has led to an unfounded and dangerously misplaced confidence within most governments about future oil supply. This has been a major factor in the loss of a decade's progress in creating an alternative sustainable energy system, in turn severely delaying the action necessary to address the climate crisis. In addition, this has significantly increased the risk of instability, corruption, conflict and human suffering on a mass scale.

The Appendix at the end of the report looks in more detail at the way in which the IEA presented its assurances about a future of oil production abundance.

Contents

An overview of the climate and energy crises

The world is facing a twin emergency brought about by the confluence of the climate and energy crises, a situation that is exacerbated by the recent global economic collapse. Advances in scientific understanding clearly demonstrate that current mitigation efforts are unlikely to prevent dangerous climate change. Meanwhile, as this report shows, the world is facing an imminent oil supply "crunch", where increasing the volume of oil on to the international market to supply the trend of growing demand is likely to become impossible. This issue is not about futurology and trying to estimate when a crunch might happen, but it is about focusing on four underlying fundamental problems with securing sufficient oil supply. These are: oil field depletion, declining discovery rates, insufficient new projects and increasing demand. These factors have been obvious for a long time, although they have not been acknowledged or acted upon by governments, apart from a few notable examples. The dip in global demand due to the recession has not changed these fundamental problems. Given the key role played by oil across the global economy, the potential geopolitical consequences of an imminent oil crunch cannot be overstated. These include potentially severe negative impacts on international cooperation and agreements, threats to global food security, and threats to international stability. It is hard to imagine effective international cooperation and leadership to address the climate crisis under these circumstances.

Governments, multi-lateral agencies, and international fora have failed to recognise the imminence and scale of a global oil crunch, and the majority of governments remain completely unprepared for its consequences. To date, it has not even been possible to raise the issue without being derided as a peak oil alarmist. As a result, there has been very little international discussion about the nature and scale of this problem. Instead the majority of the world's governments have planned for increased availability of oil, along with the other key fossil fuels, coal and gas, as illustrated in the International Energy Agency (IEA) reference case scenario to 2030.* An earlier recognition of this problem could have led to a dramatically improved response to the climate crisis, if governments had risen to the challenge of seeking alternatives to energy from oil. Instead, the current international climate negotiations are focused on agreeing "pragmatic" targets, which the science increasingly shows are not safe, with government action heavily reliant on offsets, rather than redesigning the energy supply system. The presumption continues to be that climate solutions can be achieved through a "business-as-usual" approach, with incremental reductions to fossil fuel dependence. The data and the analysis to follow challenge governments to recognise the imminence of an oil supply crunch, and the need to ensure the urgent development and deployment of safe alternative energy systems.

Rioting for food in Haiti
Being priced out of the market may be a future for many

This report uses data from the IEA, the leading international organisation on which governments rely for authoritative energy analysis, together with other sources, to show that global oil supply is not as assured as has been generally presumed. Until recently, the IEA held an overconfident view that future oil supply will meet growing demand, but it has now substantially changed its position to one warning of an imminent oil supply crunch, bringing it broadly into line with those of many other analysts. Unfortunately, the IEA continues to hold an overconfident view about the potential for future oil production. It suggests that with massive investment, of up to US$450bn annually (which comes to over US$1.2bn per day, every day, for the next 22 years), future growth in oil demand can continue to be met. Global Witness analysis shows that – regardless of the level of investment – such an outcome is unlikely. It is no longer possible for the world to spend its way to an oil supply solution, or as the IEA's chief economist, Fatih Birol put it in 2008: "*We should not cling to crude down to the last drop – we should leave oil before it leaves us*."[1]

* IEA's Figure 2.1, page 80, *World Energy Outlook 2008* report, projects an increase in global oil demand of 26.8% between 2006 and 2030, with the sharpest increases between 2006 and 2015, at 12.3%. Coal demand is estimated to rise by 60.8% between 2006 and 2030, with gas demand increasing by 52.5% during the same period.

Rising demand and falling supply means a growing gap: ten things you ought to know about oil supply

Many of these facts have been staring us in the face for some time. In some cases, they have been obvious for decades, and yet depressingly, they seem not to have been acted upon. When taken together, the sheer scale of the imminent oil supply crunch, and the extent of missed opportunity and failed leadership become apparent.

1 1965 was the year in which the largest volume of oil was discovered. Since then, the trend in the number and average size of discoveries has been in decline.[2]

2 In 1984 global conventional crude oil production exceeded the volume discovered, and the gap has continued to increase since then.[3]

3 In 2007, just over half the world's crude oil production came from 110 oil fields, with approximately one quarter from just 13 fields.[4] There are 70,000 smaller oil fields which account for just under half of the world's conventional crude oil production.[5]

4 By 2007, out of the world's 20 largest producing oil fields, 17 were over 40 years old. The volume of oil production from 16 of this group of 20 largest fields was below their historical maximum.[6]

5 The rate of decline in oilfields can be rapid. By 2007 the average post-peak production rate of decline was 6.7% per year.[7]

6 Between 2005 and 2008 conventional oil production ceased to grow, despite massive investment, increasing demand and prices. This failure to increase conventional oil production, despite all the right incentives, is unprecedented in the history of the oil industry.

7 By 2015, the IEA projected a potential 7m bpd gap between supply and demand.[8] A gap of this size represents 7.7% of projected world demand of 91m bpd (barrels per day) in 2015.[9] It is also the equivalent to over 60% of China's projected demand, and 39% of that of the USA.[10]

8 Between 2008 and 2020, the IEA projects conventional crude oil production from existing fields to drop by almost 50%.[11]

9 To provide for its forecast demand for oil in 2030, the IEA stated that the world would require "*Some 64 mb/d* [million barrels per day] *of additional gross capacity – the equivalent of almost six times that of Saudi Arabia today – needs to be brought on stream between 2007 and 2030.*"[12]

10 As if replacement of lost volumes of oil was not a big enough problem, the ratio of units of energy input required to produce each unit of energy output (EROI) from oil is also decreasing. In the USA for example, EROI has shrunk from approximately 100:1 in the 1930s to 14:1 today. Estimates for the EROI of tar sands production vary between 10:1 (a very optimistic figure) and 2:1.[13,14] This means that, in energy content terms, each new barrel of oil is worth less than its predecessors.

Mind the gap!

The IEA's projection for a possible 7m bpd gap between supply and demand by 2015, in its November 2008 *World Energy Outlook (WEO)* report, represents the Agency's view at the time of publishing. Although projections are subject to change because of changes in the global economic situation, implying that the specific size of a gap in supply will vary, it is important not to lose sight of the underlying fundamental problems with supply that are the reason for a likely gap. In the table below, 7m bpd is presented as a percentage of the *WEO-2008* total world oil demand projection for 2015, for the various named countries and regions. When taken from a national perspective, a 7m bpd shortfall implies a massive economic consequence for the industrialised countries of the world. However, if those who can pay do in fact pay, the implication for the world's poorest is that they will receive little or nothing.

Table showing the IEA's *WEO-2008* projection of a possible supply-demand gap of 7m bpd by 2015. This volume is shown as a shortfall in terms of a percentage of projected national or regional demand (as of November 2008).[15] *

Country or region	Oil demand in 2015 (m bpd) (projected by IEA – November 2008)	IEA's 7m bpd world supply/demand gap shown as a % of projected national/regional demand
USA	18	39
OECD-Europe	13.5	52
China	11.1	63
Middle East	8	87.5
Japan	4.2	167
India	4.1	171
Africa	3	230

* These percentages were calculated by Global Witness from data in the IEA's *WEO-2008* report.

Will this soon become the norm?

The recession does not change the underlying fundamentals

There are divergent views about the length and scale of the global recession and the timing and pace of the subsequent economic recovery. These in turn lead to varying projections of global oil demand growth. The IEA's June 2009 mid-year report[16] is interesting because it has two scenarios: one which represents little change from its projections in its *WEO-2008* report, and which is based on the IMF's April 2009 "*World Economic Outlook*"; and a second, slower and lower economic recovery projection which, not surprisingly, leads to lower oil demand. It is worth noting that in May 2009, the US Government's Energy Information Administration (EIA), in its 2009 *International Energy Outlook* report,[17] provides a global projection for world oil demand of 90.6m bpd by 2015; just 0.4% down from the IEA's November 2008 projections.* In addition, in July 2009, whilst commenting on the status of the world economy, the IMF said that it had revised its projections for world economic recovery up by half a percent from its April 2009 assessment[18] – in other words, by July 2009, the IMF viewed global economic recovery in more favourable terms than it did in April. For these reasons, even though the exact path of economic recovery remains to be seen, the underlying fundamental problems of declining output from existing fields and shrinking new discoveries have not changed. If project delays and cancellations are taken into account, the post-recession recovery pathway alters the scale and imminence of the oil crunch by very little.

Derisory international leadership has been a disaster for the world's climate

There is a striking parallel between the failed leadership effort to date to properly address the climate crisis, and the widespread lack of preparation for an imminent oil-supply crunch. Failure over the climate provides a dangerous foretaste of how badly governments, on current form, are likely to perform on the energy crisis. If the world does not substantially shift its energy provision systems to those based on safe and sustainable alternatives, then it will be faced with the unmitigated impacts of the climate crisis, not to mention the geopolitical consequences of declining energy supplies from oil.

International efforts to prevent "*dangerous anthropogenic interference with the climate system*"[19] have resulted in a derisory 2.8% greenhouse gas (GHG) emissions reduction among the Kyoto Annex 1 countries between 1990 and 2005.[20] At this rate, it would take more than five centuries to achieve a 100% reduction. In contrast, the IPCC noted in 2007 that "*The recent rate of change is unprecedented; increases in CO_2 never exceeded 30 ppm in 1 kr* [one thousand years] *– yet now CO_2 has risen by 30 ppm in just the last 17 years.*"[21] Scientific evidence points to a maximum target of 350 ppm (the current level is well above this, at 387 ppm), and the need for steep and immediate declines to achieve this target. Despite the evidence indicating that the widely supported 2°C threshold is not safe, and which without imminent and stringent mitigation action is likely to be surpassed, many of the parties to the United Nations Framework Convention on Climate Change (UNFCCC) continue to base negotiations on it, instead of applying the precautionary principle. Thus, as things stand, it seems unlikely that the Copenhagen negotiations will achieve the necessary emissions reductions to avoid dangerous climate change.[22] †

"If humanity wishes to preserve a planet similar to that on which civilization developed and to which life on Earth is adapted, paleoclimate evidence and ongoing climate change suggest that CO_2 will need to be reduced from its current 385 ppm to at most 350 ppm, but likely less than that." [23] James Hansen, et al.

* It is also worth noting that the IEA projects world oil demand growth at 1.4% annually after 2009 in its higher IMF growth scenario. The addition of 1.4% growth to the IEA's 2014 projection of 89m bpd, suggests a total world demand in 2015 of 90.25m bpd – only 0.8% down from its November 2008 projections. In other words, the IEA's higher growth scenario from its mid-year report is, in terms of the underlying fundamental problems, virtually indistinguishable from its 2008 warning of an imminent oil crunch.

† Please see reference 22 for a sample of scientific papers and reports, demonstrating the scale of action required to avoid dangerous climate change.

The Greenland Ice Sheet is riddled with holes – not unlike the Copenhagen climate negotiating text.

Oil infrastructure is increasingly expensive – would the world's financial resources be better spent building a safe and sustainable energy system instead?

Number crunching‡

What we collectively choose to spend our money on will make all the difference. The following gives a rough "at-a-glance" tally of the financial consequences of the choices before us.

Which would you choose? (Annual total in US$)	
601 billion[24]	The annual amount suggested by the G77 (1% of world GDP) that should be spent on mitigation of and adaptation to the climate crisis.
2.5 – 3.37 trillion	The theoretical annual loss to world GDP with a 0.6-0.8% decline in world GDP for each 1% loss of global oil supply (see discussion in Section 1), on the basis of a 7m bpd gap between supply and demand by 2015[§]
450 billion	Annual total which the IEA identifies as needed for oil exploration and production – as discussed in this report, this amount seems unlikely, beyond the immediate future, to sustain sufficient supplies of oil to meet the world's liquid fuel energy requirements.

‡ With thanks to *Private Eye*.

§ This spread of world GDP decline rates was estimated by Robert Hirsch (see Section 1). The spread of potential cost to world GDP was calculated by Global Witness on the basis of the impact of a 7m bpd gap in supply, using World Bank figures for world GDP in 2008, which stood at US$60.1 trillion. The precise timing and the actual size of a gap will vary with the world economy, but the underlying fundamentals mean a likely imminent gap. The consequences of falling into such a gap are likely to be far more expensive than taking action to create an alternative, safe and sustainable set of energy systems.

The nub of the political challenge

The data presented in this document shows that governments and the IEA, the key international agency responsible for energy analysis, have all been asleep at the wheel. Whilst the latter appears to have belatedly woken to the immensity of the looming energy crisis, initially centred on oil, governments (with few exceptions) seem prepared to slumber on. Meanwhile the world is faced with the consequences of inadequate action to address the climate crisis; a situation that portends perhaps the ultimate Darwinian experiment on Earth's inhabitants. Humanity (and the rest of the planet's inhabitants) simply cannot afford a continuation of failure to decisively address the climate crisis. Unfortunately, although the hour is late, the status of the current international effort does not inspire confidence.

Despite this depressing situation, continued failed leadership around climate where the response is based on incrementally tinkering with our existing "business-as-usual" energy systems, does not have to be the prevailing outcome. This is because, regardless of vested interests and money, this report shows that "business-as-usual" is not an option. This means that the looming oil supply crunch is, like it or not, a game changer with profound consequences for the climate crisis: If governments now rise to the challenge, and in the public interest, seek to scale up and deploy a set of new, safe, and sustainable energy supply systems, there remains the possibility of addressing the climate crisis. If on the other hand, governments remain committed to keeping their heads in the sand and their populations ignorant, then the world appears headed, in the not too distant future, for a disaster.


1

Why the oil supply gap matters
The potential social and geopolitical consequences of a global oil crunch

"Welcome to the age of energy insecurity. Worldwide production will peak. The result will be skyrocketing prices, with a huge, sustained economic shock. Jobs will be lost. Key sectors of the economy, from agriculture to homebuilding, will be hit hard. Without action, the crisis will certainly bring energy rivalries, if not energy wars. Vast wealth will be shifted, probably away from the US."[30] Prescient comments by PFC Energy Chairman, J. Robinson West, from 2005 US Senate Commerce Committee testimony. J. Robinson West was formerly US Assistant Secretary of the Interior (1981-83), and Deputy Assistant Secretary of Defense for International Economic Affairs (1976-77).

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Oil—an essential component of food production, pharmaceuticals and petrochemicals

A WORLD IN WHICH THERE IS NOT ENOUGH OIL TO MEET demand is unlikely to be a peaceful place. Oil provides one third of the world's primary energy[25] and is the most geopolitically significant natural resource because it is relied upon across almost all sectors of the global economy:[26]

- 95% of all global transportation relies on oil.[27]
- About 95% of all products in shops are delivered using oil.
- It is essential for the production of pharmaceuticals and agro-chemicals.
- About 99% of food production uses oil or gas at some stage in its production.

The possible ramifications of a global oil shortage are likely to affect almost every aspect of life in current global society.[28,29]* These include threats to food security, increased geopolitical tension, increased corruption and threats to the nascent global governance reform agenda, and the potential for major international conflict over resources.

It has been well documented that the impacts of climate change are already being suffered by millions of people, predominantly the poor.[31,32] Yet they are often the most vulnerable and least resourced to cope with the price rises and instability likely to result from a restricted oil supply. An indicator of what impact this might have can be seen from the food crisis of 2007 and 2008 in which steep oil price rises, amongst other factors, played a role. According to the World Bank, by early 2008, global food prices had risen by

* The best recent example of the impact of a drastic reduction in oil availability to a modern industrialised "just-in-time" economy was provided in 2000 in the UK. In this case, a temporary oil refinery blockade resulted in severe national fuel, food and other essential commodity shortages within days. These were the consequences of a limited, short-term reduction in fuel supplies – rather than a year-on-year reduction of a few percentage points of available fuel.

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Newly "respectable" President dos Santos of Angola (front centre) travels to meet G8 leaders in Italy, July 2009

"We underline the possible security implications of the adverse impacts of climate change and the potential for increased conflict over scarcer resources."[40] From G-8 Communiqué, July 2009.

© AP/Press Association

83% and wheat by 181%.[33] The situation was described by the World Food Programme as "…a silent tsunami threatening to plunge more than 100 million people on every continent into hunger."[34] The UN Secretary General, Ban Ki-moon, warned that "If not handled properly, this crisis could result in a cascade of others…and become a multi-dimensional problem affecting economic growth, social progress and even political security around the world."[35] The comparatively wealthy complained about fuel prices, whilst in many developing countries people couldn't afford to buy food. There were more than 30 riots and protests around the world.[36,37]

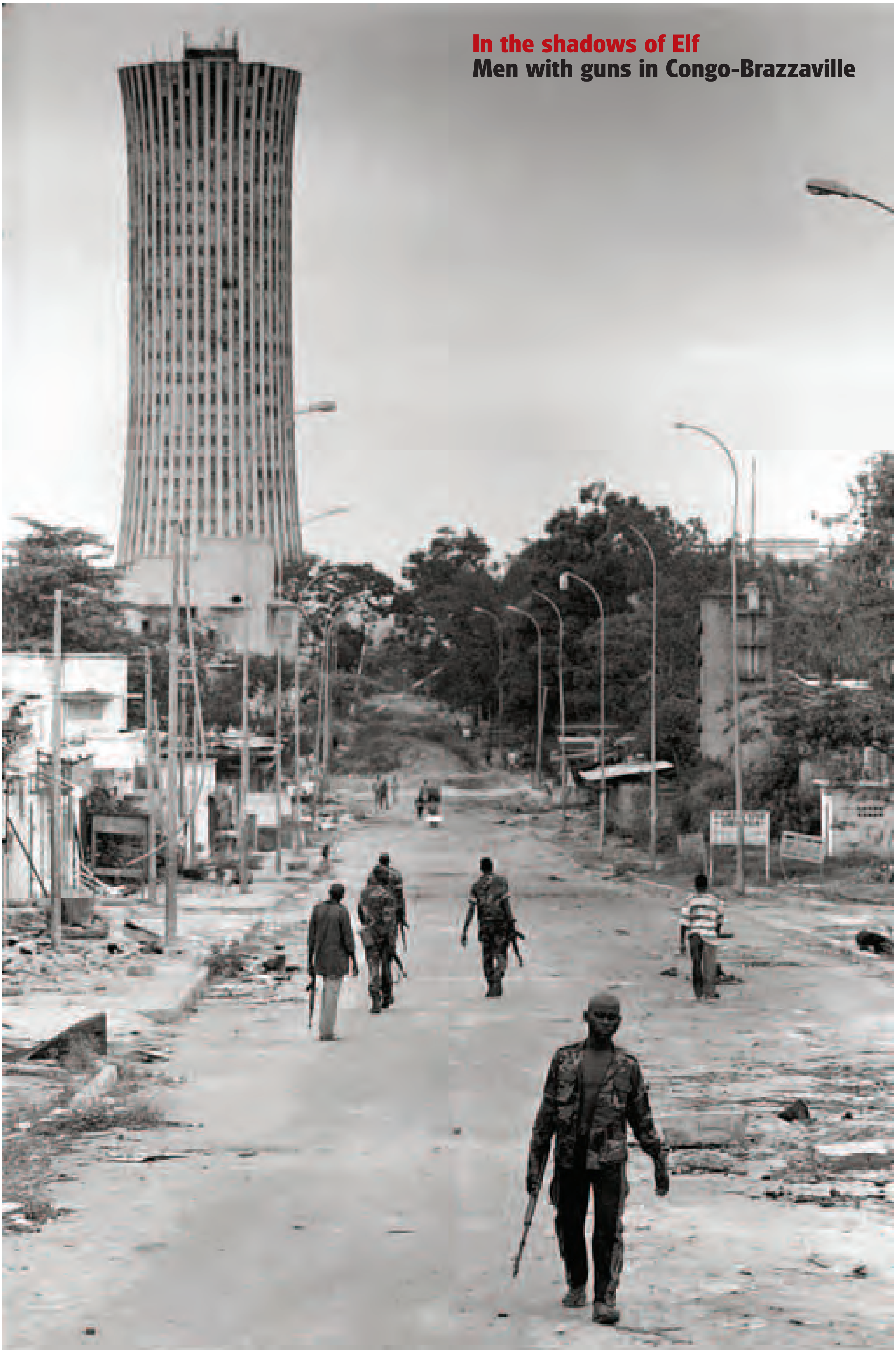
The geopolitical consequences of increasing competition for a shrinking oil resource are impossible to predict. However, it is clear that there is a seriously increased risk of tension building between states, as a consequence of competition over insufficient resources to go around. Whether, where and how these circumstances could degenerate into serious conflict between countries remains to be seen. There are those that have suggested that access to Iraq's oil resources was a factor in the 2003 US-UK invasion of Iraq. Whatever the truth about the war, the successful development of oil resources in this country represents the best opportunity anywhere in the world to add significant quantities of new conventional oil supplies onto the international market.

To date, the pursuit of national energy security has frequently resulted in turning a blind eye to serious human rights abuses perpetrated by kleptocratic and unaccountable elites in control of resource rich, but frequently desperately poor countries. This phenomenon has often undermined national and regional stability. What is seen as a national necessity for key consuming countries has resulted in death, destruction and state looting in others. This situation is often referred to as the "resource curse." In some cases, fierce competition for access to concessions has resulted in opaque deals and state looting by these kleptocratic elites. Some of the most egregious (although by no

"One of the disturbing facts of history is that so many civilisations collapse. Few people, however, least of all our politicians, realise that a primary cause of the collapse of those societies has been the destruction of the environmental resources on which they depended. Fewer still appreciate that many of those civilisations share a sharp curve of decline. Indeed, a society's demise may begin only a decade or two after it reaches its peak population, wealth, and power."[38] Jared Diamond, Professor of Geography at UCLA.

War in Iraq: "I am saddened that it is politically inconvenient to acknowledge what everyone knows: The Iraq war is largely about oil."[39] **Alan Greenspan, former US Federal Reserve Chairman.**

In the shadows of Elf
Men with guns in Congo-Brazzaville



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Former US Secretary of State Condoleezza Rice greeting President Obiang of Equatorial Guinea: "You are a good friend and we welcome you!" [43] – With "friends" like this…

…who looks after the interests of the people of Equatorial Guinea?

© Robert Grossman/Africaphotos.com

means the sole) examples of this phenomenon can be found in Nigeria, Angola, Congo-Brazzaville, Equatorial Guinea, Sudan, Kazakhstan and Turkmenistan.[41] An early casualty of an oil supply deficit could be the destruction and reversal of the nascent global governance reform agenda. The effectiveness of initiatives such as the Extractive Industries Transparency Initiative (EITI),[42]* could be seriously eroded, threatening the survival of such programmes. Frequently, oil development projects have also resulted in massive environmental destruction. All this has taken place in a world which has had the capacity to increase production, and in which there has been enough oil to go around. What might happen in a world where oil production is declining?

The economic impacts of an oil supply crunch are likely to be far-reaching. The role of the American financial crisis in the global economic downturn is an indicator of how financial instability, lack of trust and the lack of credit can cascade through the global financial system. A significant and ongoing reduction in the available volume of oil is also likely to have impacts that will flow within and between economies. The relationship between oil supply and economic growth is complex. One energy expert, Robert Hirsch, has analysed the relationship between GDP and oil use on a global basis. Emphasising the difficulty of precision, he has taken into account the impact of past oil shocks to provide an estimate of the potential impact of declining oil

* "3.5 billion people live in countries rich in oil, gas and minerals. With good governance the exploitation of these resources can generate large revenues to foster growth and reduce poverty. However, when governance is weak, it may result in poverty, corruption, and conflict. The Extractive Industries Transparency Initiative (EITI) aims to strengthen governance by improving transparency and accountability in the extractives sector. The EITI supports improved governance in resource-rich countries through the verification and full publication of company payments and government revenues from oil, gas and mining. It is a coalition of governments, companies, civil society groups and international organizations." www.eitransparency.org

supplies on the global economy.[44] Hirsch's analysis finds that the global GDP to oil use ratio stands at approximately 0.6-0.8 to 1, which implies that for every 1% loss of available oil supply, global GDP could fall by 0.6-0.8%.[45] Thus, with the global economy configured to oil dependence, as the gap between demand and supply increases, the world's economy is likely to decline.

The rise in 2008 of the price of oil to US$147 per barrel, and its subsequent collapse, is an indicator of likely future price volatility in a world of shrinking supply. The steep climb in the oil price, from 2002 through to the mid-2008 high, at 500% was more than double that of the first and second oil shocks of the 1970s.[46] The result was a vast deployment of national wealth by consuming economies, expenditure that would have been better used in the creation of an alternative and sustainable energy system.

An oil-soaked environment: Chevron faces a lawsuit for damages because of past contamination in Ecuador by Texaco.* Chevron denies responsibility.

* According to the claimants past oil extraction activities by Texaco (since taken over by Chevron) caused massive environmental damage.

Simply not cricket!

"The annual US oil import bill has risen by a staggering US$200bn since 2005. That's bigger than Congress' recent fiscal stimulus package, [a reference to the Bush Administration's 2008 tax cuts, prior to the financial meltdown bailouts] and both the Japanese and Euroland economies are far more vulnerable to oil price spikes than the American economy."[47] Jeff Rubin and Peter Buchanan of CIBC World Markets, commenting on the impact of increased oil prices on discretionary spending in the United States.†

† Rubin and Buchanan argued that the increased price of oil significantly removed the discretionary spending ability of many millions of indebted people, helping to push them faster into default over their debts. Thus in turn, they argued, the oil price increase played a role in precipitating the global economic meltdown during 2007 and 2008.

2

“Fill her up!”

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The rise and fall of *Homo petroliensis*

This section discusses the international energy supply crisis, focusing on the increasing likelihood that global oil production will soon be unable to meet growing world demand. It looks at problems of depletion in aging oil fields, declining discoveries, and the increase in projected demand. To date, governments appear to have based their economic planning on the presumption that global oil production can be expanded to meet projected growth in demand for the next few decades. This vision is not only totally inconsistent with urgent climate mitigation needs, but is based on an analysis of the oil sector that has ignored geophysical limitations and key trends in oil production and demand. This has resulted in a false sense of security, with governments unprepared for the consequences of an imminent decline in available energy from oil.

"We are heading for a crucial moment as the nations of the world face a time, the first time since we had major economic development, of an inability to increase the supply of oil."[48] James R. Schlesinger, former US Energy Secretary, September 2007.

To understand the scale and the urgency of the energy crisis, policymakers need to take into account a range of factors which have contributed to this. Notably, the combined effects of geophysical limitations and the current net global depletion rate for existing oilfields; the impact of inadequate investment; oilfield equipment cost inflation; delays to projects; an ageing industry workforce; and more recently, significant delays and even cancellations of new projects due to the low oil price and the world economic crisis.

2.1 Declining production from older oilfields

The international oil industry today moves vast quantities of oil around the globe.

So far, almost two-thirds of the world's oil-producing countries have moved into decline.[49] By 2007, just over half the world's crude oil production came from 110 oil fields (out of roughly 70,000 worldwide), with approximately one quarter from just 13 fields.[50] Many of the 110 fields have been in production for decades, and around half of them have passed their peak of production and have entered a phase of output decline.[51] In 2007, 17 out of the world's 20 largest producing oil fields were over 40 years old. The volume of oil production from 16 of this group of 20 largest fields was below their historical maximum.[52] Countries in decline include major oil producers such as the United Kingdom, Norway, the "lower 48" states of the United States, and Mexico (see *Countries past the peak*, later in this Section). The assumption by most energy policymakers, that increased demand for oil will drive an increased supply through financing additional investment, cannot be relied upon if geophysical limits are reached.

The rate of decline is often extremely rapid. By 2008, the average post-peak oilfield decline rate worldwide stood at

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"The world declines, and how fast the world declines is very significant. If it declines of the order of 7 or 8%, we've got big trouble soon."[55] James Buckee, then CEO of Canadian oil company Talisman Energy, September 2007.

Ghawar – Too big to fail. This field, seen from space, accounts for roughly half of Saudi Arabia's oil production, and has produced oil since 1951.

© Google Earth

6.7%. A decline of this rate means that in five years, a field would lose almost 30% of its output. The IEA project this rate to increase to 8.6% by 2030.[53]* In some cases the decline can be even more rapid, in Mexico for example, The Abaktun field has an annual decline rate of 16%; in the UK the Forties field in the North Sea has an annual decline rate of 8%.[54]

Understanding oil output decline rates is further complicated by the continual changes to overall production. For example, in June 2008, total global crude oil and liquids output was approximately 86.6m bpd, lifted that month by incremental output from OPEC.[56] Just one month earlier, there was a reported decline of approximately 400,000 bpd, due to output losses from depletion in the North Sea, the former Soviet Union (FSU) and OPEC countries.[57]

* The IEA's 6.7% figure is the 2008 average decline rate for oil fields worldwide that have passed their peak of production. The changing demographics of global oil production show that the global average post-peak decline rate is set to increase over time. This is because of increased dependence on smaller oil fields which have a faster decline rate and indicates how the task of sustaining global oil production is going to get harder over time.

The changing face of the international oil industry

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The international oil industry has changed profoundly during the last 30-40 years, as control over key resources has increasingly been ceded from the international oil companies (IOCs), such as Shell, BP, Chevron, Exxon and Total, to state-run national oil companies (NOCs) such as Saudi Aramco. Although the IOCs used to control the bulk of the world's petroleum reserves, today nine of the top ten reserve holders, which together control approximately 80% of the officially acknowledged reserves, are NOCs, or are under state control.[58] Throughout this dramatic shift in control over reserves, the global industry managed to increase production in line with global demand. Global production data from the EIA show the scale of this change. By 2005, total global crude oil and liquids production had increased by 73% since 1970: it rose from 48.9m bpd to 84.6m bpd by 2005.[59,60]

Between 2005 and 2008, however, the industry failed to sustain this record of production growth.[61] Despite a massive increase in expenditure on exploration and production, precipitated by the relentless oil price rise, much of this investment was eroded by inflation. For example, drilling rig costs increased by 300% between 2002 and 2008. Following the global financial meltdown, the 70% collapse in the price of oil resulted in significant delays to and cancellations of new projects, as demand and then prices fell.[62] However, it was not just inflation that held back development. Following a decline in investment in the mid- to late 1990s, the industry suffered a dearth of essential equipment and a lack of experienced field engineers coming up through the ranks, as its workforce has become increasingly skewed towards those nearing retirement age.[63] These underlying problems remain, and will likely impact upon the timely realisation of future oil development projects.

The difference between resources and reserves

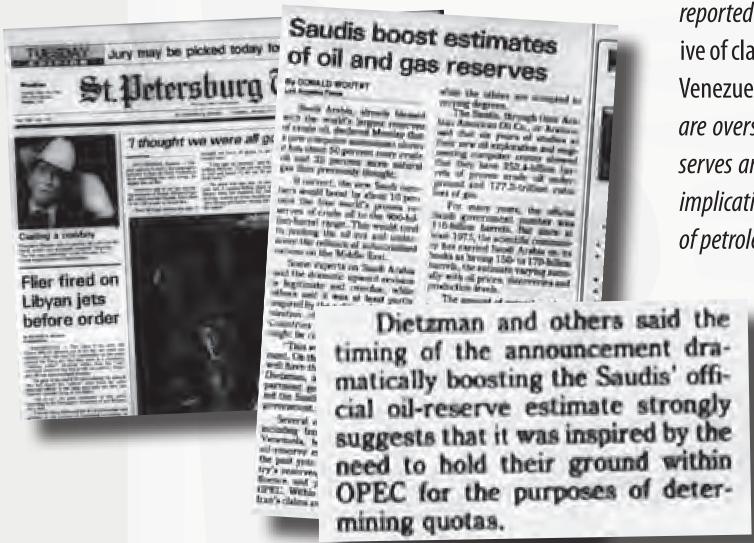
In examining oil production data, it can be hard to differentiate reality from mere assertion. To understand global oil production potential, it is necessary to distinguish between "resources" and "reserves". The term "resource" describes the amount of oil in the ground, while "reserve" describes the volume of oil expected to be extracted. The first is a product of nature. Although the second is a product of human economics, many people have forgotten that its size, and hence the availability of oil for production, is ultimately limited by the laws of nature. It is important to emphasise that the finding of large reserves does not in itself imply that it is possible to obtain a sufficient flow rate to satisfy increasing demand. The ultimate limit to the volume of available oil and its possible rate of extraction, set by the level of resources, cannot be exceeded regardless of the extent of increased demand. A good example is provided by the frequent confusion over the quantity of Canada's tar sands. The enormous size of the tar sands deposit, which is a resource, has led to significant over-interpretation by some, of the rate at which the available reserves can be put into production – see also *Non-conventional Oil Production* in Section 3.

In summary, increased demand coupled with increased oil prices, will precipitate additional investment in extraction, leading to an increase in the size of reserves, as previously uneconomic parts of the resource base become viable for extraction. Ultimately, however, after a certain point, the physical, chemical and geological attributes of a field become the limiting factors and the resource reaches its peak of production, after which the extraction process enters a phase in which, regardless of additional expenditure and effort, output volumes decline.

OPEC's phantom barrels – an overstatement of reserves?

The picture of decline is complicated by the debate over the 1980s' massive restatement of reserves by six OPEC countries: Saudi Arabia, Kuwait, Abu Dhabi, Dubai, Iraq and Iran.

Together these countries added over 300bn barrels of oil to global reserves, without providing reliable public data to back up their claims. Despite this, the IEA has based approximately one third of its estimate of global reserves upon these claimed, but never substantiated, figures. In 1982, OPEC oil ministers came to an agreement about each member country's production quota, based on the size of members' reserves. Former oil industry geologist Jeremy Leggett, in his book *Half Gone,* describes what happened next, *"... in 1985, they [OPEC] began to – how shall I put it? – massage the data. Kuwait, as it happens, was the first to give in to temptation. They found that their reserves had gone up overnight from 64 to 90bn barrels. In 1988 Abu Dhabi, Dubai, Iran and Iraq all played the same card. Abu Dhabi had been so needlessly conservative that their reserves went up from 31 to 92bn barrel." And in the case of Saudi Arabia, "The desert Kingdom hiked its total from 170 to 258bn barrels."*[64]


TUESDAY Jury may be picked today to

St. Petersburg T

'I thought we were all go

Flier fired on Libyan jets before order

Saudis boost estimates of oil and gas reserves

By DONALD WOUTAT

Dietzman and others said the timing of the announcement dramatically boosting the Saudis' official oil-reserve estimate strongly suggests that it was inspired by the need to hold their ground within OPEC for the purposes of determining quotas.

Article from the Los Angeles Times, appearing in the St Petersburg Times, January 1989: Saudi Arabian and other OPEC members' reserve hikes raised eyebrows at the time, but now these reserve claims are reported as fact.[65]

These dramatic rises in OPEC's reserve estimates, together with the lack of data to justify them, caused much surprise and scepticism within the international oil industry. Up until 1982 most of the member countries made detailed field-by-field data available on an annual basis, but only very occasionally after that point. Energy industry investment banker Matthew Simmons, in his forensic analysis of the state of the Saudi oil industry, *Twilight in the Desert*, notes that "*Ever since then, official OPEC production and reserve data has been sparse and utterly unverifiable.*" He adds: "*Most oil observers have always assumed OPEC members stopped reporting data to make it easier for individual members to cheat on assigned production quotas.*"[66]

Despite the lack of official data from OPEC states, some evidence does emerge, via technical advisory agencies, such as IHS,[67] and from individuals who work on projects in OPEC countries. As a result, there is a substantial academic debate about OPEC reserve claims, generating many detailed analyses. These are far too complex for extensive inclusion in this document, but the following commentary about Kuwait and Saudi Arabia from a former oil company engineer, Phil Hart, is illustrative of the lack of credibility of the restatement of reserves: "*This* [IHS data] *suggests that Kuwait's reserves are barely half of the 101bn barrels reported publicly*." [68*,†] On Saudi Arabia, Hart suggests that at the end of 2005 the country would be likely to possess "*... reserves...110bn short of the 264bn barrels stated by OPEC and widely reported as Saudi Arabian 'proven' reserves.*" [69] Hart is equally dismissive of claims by some of the other OPEC members, including Iran and Venezuela: "*It is almost certain that reserves in Iran, Iraq and Venezuela are overstated to a similar degree.*" He concludes: "*Claimed OPEC reserves are overstated by approximately 338 Gb* [billion barrels]. *The implications of this 338bn-barrel reserves shortfall for global forecasts of petroleum supply cannot be overstated.*"[70, 71, 72]

Whatever the real reasons for ending the publication of verifiable data, it remains a fact that OPEC countries have provided no substantiating official evidence to support their dramatic increases in claimed reserves. Dr Sadad al-Huseini, former Vice-President of Exploration and Production at the Saudi state oil company, Saudi Aramco, which controls all of Saudi Arabia's oil production, contends that a quarter of the world's stated oil reserves – some 300bn barrels – are overstated. Speaking in October 2007, he noted that oil production had barely increased, despite soaring prices and huge investment: "*It's telling us something. We should be listening to what the numbers are telling us, not what the politicians say... It's not about economics alone, you can increase prices, but you will not necessarily drive production up.*" He added: "*Reserves are confused and in fact inflated. Many of the so-called reserves are in fact resources. They're not delineated, they're not accessible, [and] they're not available for production*."[73]

* To see IHS' view about Kuwait's claimed reserves see the presentation by Ken Chew and Philip Stark: "Perspective on Oil Resource Estimates", given at the November 2006 Hedberg Conference, pp 11–12, http://energy.ihs.com/NR/rdonlyres/55456487-C77B-47DC-8858-CC5542793BA1/0/Hedberg_Stark_IHS_Data_final.pdf

† Over time, Kuwait has continued to increase its claimed reserves.

2.2 Declining discoveries

"If we are to meet the projections of EIA [the US Government Department of Energy's Energy Information Administration] for 2030, given the decline rates in existing fields, we would need to find the equivalent of four or five new Saudi Arabias – and that strikes me as against the odds."[74] James R. Schlesinger, former US Energy Secretary, September 2007.

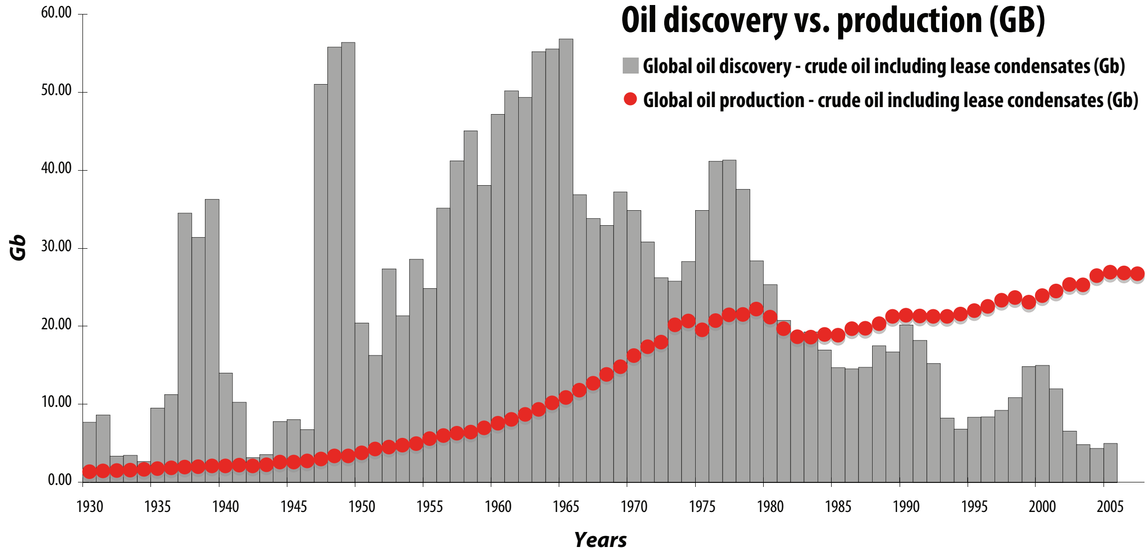
The era of ever-increasing discoveries of new large oilfields has long since ended, as illustrated in *Figure 1*, which shows annual discoveries (grey)* and global production from 1930 to 2005 (red circles). The year in which the greatest volume of oil was discovered was 1965. During the intervening 45 years, apart from some exceptional years, the number of annual discoveries, and their average size have been in decline. Global oil consumption exceeded the volume of discovery by 1984 and the gap between annual discovery and annual consumption has widened since.[75] With global oil production from producing fields also declining, the rate of discovery of new fields has become insufficient to offset these declines. Thus an era of increasing resource abundance and ease of access to them has been replaced by an era of decreasing abundance, and increased effort to obtain those resources.

Since the 1980s, when global consumption began to exceed the rate of discovery, the world has been consuming its "oil capital" at an increasingly unsustainable rate. Since 2000 annual discoveries, on average, have declined to just under one third of total world annual consumption.† However, these fundamental problems have been masked by the ability of the international oil industry to keep up with the world's exponential growth in oil demand until 2005.

As if this situation was not bad enough, an increasing amount of energy is being required to obtain each barrel of oil, which means that the *net* energy content of each barrel is declining. Thus 100 barrels of oil extracted today are in effect worth less than 100 barrels of oil extracted in the past – it therefore follows that to sustain the net energy input obtained from oil requires ever-increasing volumes of oil.

"We estimate that [global] EROI [Energy Return On Investment] at the wellhead was roughly 26:1 in 1992, increased to 35:1 in 1999, and then decreased to 18:1 in 2006. These trends imply that global supplies of petroleum available to do economic work are considerably less than estimates of gross reserves and that EROI is declining over time and with increased annual drilling levels."[77] Nathan Gagnon, Charles A. S. Hall, Lyslie Brinker.

Figure 1: **Past discovery and production of conventional crude oil worldwide.**[76]



* Backdated and averaged over three years.

† Annual discoveries have averaged 9 billion barrels, against the annual global consumption of more than 32 billion barrels.

2.3 Increasing demand

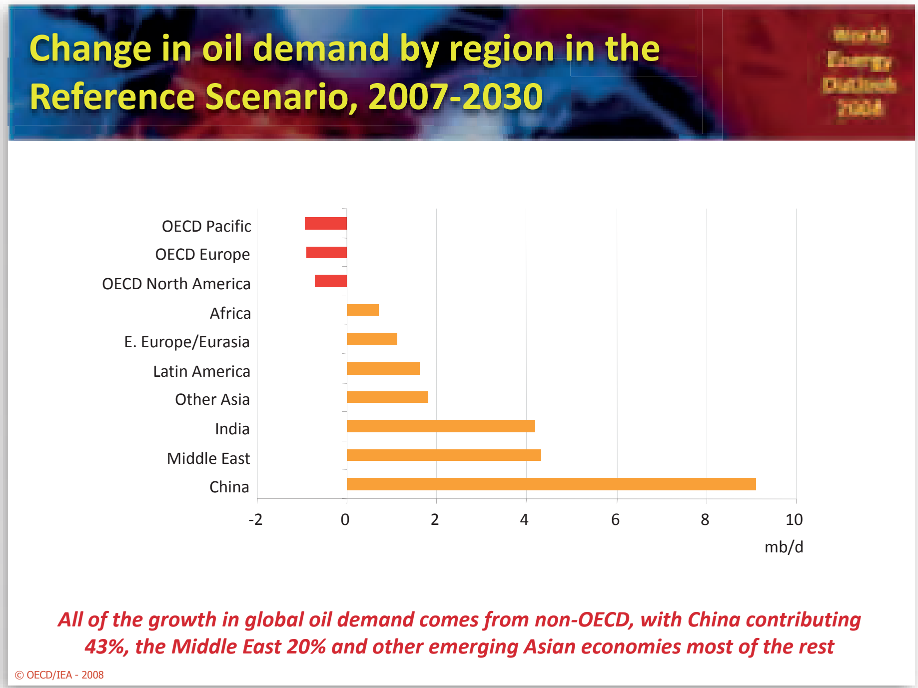


Figure 2: **Change in oil demand by region in the IEA's Reference Scenario, 2007-2030. From** *World Energy Outlook 2008*, © OECD/IEA, 2008.[82]

"I don't think we are going to see the supply going over 100 million barrels a day…where is all that going to come from?"[83,84] James Mulva, CEO of ConocoPhillips, the third-largest US oil producer, November 2007.

"On the Saudis, look, I have made the case that, you know, the high price of oil injures economies. But I think we better understand that there's not a lot of excess capacity in this world right now."[87] Then US president, George W. Bush, on Saudi Arabia's limited capacity to increase oil production, April 2008.

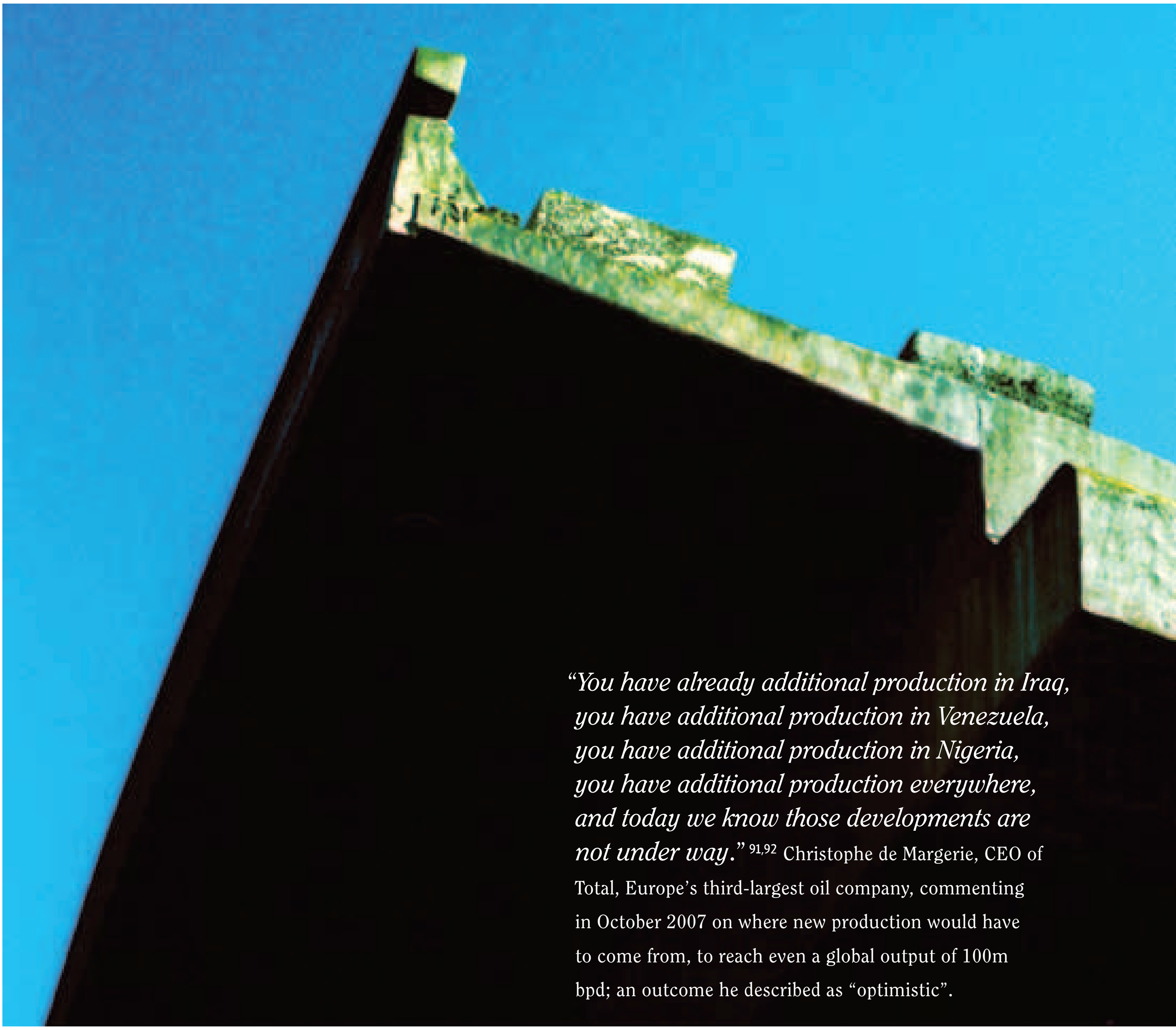
Despite the current recession, the trend for global oil demand remains upwards and is projected to increase by almost 27% by 2030.[78] This is part of an overall 45% increase in world demand for energy projected by the IEA by 2030; at which point, the Agency expects that approximately 80% of total world energy demand will be met by fossil fuels.[79] It is hard to see how a growth in fossil fuel dominated energy demand of this scale is remotely compatible with governments' stated priority to address the climate crisis. In the past, whenever demand has increased, with few exceptions (for political/stability reasons) supply has generally followed. Few have questioned why this situation should not continue indefinitely. However, given the combination of declining production, declining discoveries and shrinking net energy content of new oil production, it seems unlikely that this can continue.

The IEA estimates a total global demand of 104m bpd by 2030 (*Figure 2*). This is a significant increase from the 2008 global production high of approximately 86m bpd; it has since temporarily declined because of the world recession.[80‡] Demand from OECD countries is estimated to drop by 3m bpd but this is more than offset by an estimated 23m bpd of additional demand that the IEA expects from the rest of the world. Note the significant increased demand expected in the Middle East, pointed to by some commentators as a factor likely to reduce the volumes of oil available for export, as these countries meet their domestic needs.[81]

The failure to increase conventional oil production between 2005 and 2008, despite all the right incentives is unprecedented in the history of the oil industry. During the two years to mid-2007, conventional oil production declined by approximately 2m bpd before only just recovering to 2005 levels as the oil price breached the US$100 mark in early 2008. Finally, during the first half of 2008, the global oil industry achieved a slight increase in net conventional crude oil production, mainly from Saudi Arabia,[85,86] which had come under intense international pressure to increase production to ease high oil prices.

‡ Note that during the years to 2030, the world population is expected to grow dramatically, in turn increasing global energy demand. Currently, the world population grows annually by approximately 140 million.

2.4 Oil projects in development cannot bridge the demand gap



"You have already additional production in Iraq, you have additional production in Venezuela, you have additional production in Nigeria, you have additional production everywhere, and today we know those developments are not under way." [91,92] Christophe de Margerie, CEO of Total, Europe's third-largest oil company, commenting in October 2007 on where new production would have to come from, to reach even a global output of 100m bpd; an outcome he described as "optimistic".

A detailed analysis of the status of future oil projects, and their estimated flow rates gives a very sobering picture, in which global oil production is rapidly approaching the point at which output will be unable to meet demand. The *Mega Projects Database*, created by Chris Skrebowski, Consulting Editor of the journal *Petroleum Review*, is a comprehensive listing of 258 projects due to come on stream by the end of 2016. Skrebowski's analysis from October 2008, is contained in the first report of the UK Industry Taskforce on Peak Oil and Energy Security,* which concluded that there will be *"no net increases in oil production after 2011, even if all planned projects come on stream more or less on time, and achieve the anticipated production flows…The immediate conclusion from the analysis is that the peaking of oil supplies is imminent and will occur in the window 2011-2013."*[88]

Policymakers should take Skrebowski's analysis very seriously. His 2011-2013 projection was based on the as-

* The UK Industry Taskforce on Peak Oil & Energy Security (ITPOES) consists of the following companies: Arup; First Group; Foster and Partners; Scottish and Southern Energy, Solarcentury; Stagecoach Group; Virgin Group and Yahoo.

"The world will never be able to produce more than 89m bpd."[93] De Margerie's 2009 downward revision of his view about future production, due to the impact of the economic recession and oil price collapse.

sumption that all projects come on stream – and on time. This is not a foregone conclusion, especially given the cancellation and delays of new projects that have resulted from the collapse of the oil price and the global recession. Although the point at which new production flows are unable to offset the combined effects of declining production and demand may have changed because of the global recession, the underlying fundamentals remain unchanged. The *Mega Projects Database* incorporates the net contribution of *all* but the smallest, and therefore insignificant, new viable projects. Thus because there is, literally, nothing else in the pipeline, the fundamental problem created by restricted new supply remains.[89,90] Production appears to be approaching a maximum output volume – a point otherwise known as "peak oil" – while demand for the next few decades continues to be projected to rise.†

† The *WEO-2008* forecast for global oil demand in 2030 at 104m bpd, represents a significant reduction from its 2007 forecast. Nevertheless, this represents a 21% increase in world demand over the maximum global oil output achieved in 2008. Given concerns about the potential to increase world oil production, is this remotely likely?

What is peak oil?

The concept of peak oil is extremely contentious for many governments and multilateral agencies but, among its detractors, there is widespread ignorance about what the term implies. It has been written off, in a not dissimilar way to how climate change was denied for many years, with those geologists raising the issue being derided as peak oil alarmists. The issue is frequently dismissed as being about attempting to identify the date when oil production would run out, but in fact the core issues are the underlying fundamentals of depletion and declining discoveries. These factors have either not been understood or have been ignored by detractors. It is therefore worth explaining what is meant by peak oil: it does not mean that oil is running out. Peak oil is the point where further expansion of oil production becomes impossible, because new flows are fully offset by production declines or depletion. Peak oil is often referred to in derogatory terms as a "theory" – but there is nothing theoretical about this entirely natural process, which is very familiar to the oil industry as field after field reaches maturity, with production volumes dropping away, regardless of expanded investment. Eventually, the costs do not justify the minimal volumes being returned and fields are abandoned.

Oil depletion can be viewed on both a national and a global basis. Countries typically experience an increase in net production with each new field until the point where there are insufficient new upcoming fields to replace those in decline. At this point, the country's output peaks and thereafter goes into decline. This point has already occurred in many countries (see *Countries past the peak*). Global oil production will have reached a peak when all new projects coming on stream fail to offset the annual decline from older fields, at which point global oil output will start to decline. The timing and ultimate rate of post-peak decline will be determined by shrinking discoveries, increasing rates of depletion, inadequate investment (and limited investment possibilities) and the decrepit state of the global oil industry, together with the rate of global demand. These will be the key limiting factors for world oil supply.[94]

The first credible effort at estimating maximum oil production was made by M King Hubbert, a US-based geologist. In 1956, while working for Shell, he calculated that oil production in the US "Lower 48" states (continental USA, excluding Alaska) would peak in 1971. Considerable effort was made at the time to persuade him not to make his assessment public. Despite this, Hubbert went ahead, incurring considerable derision, which continued until his analysis proved correct in 1970, though one year earlier than he had suggested.[95] *

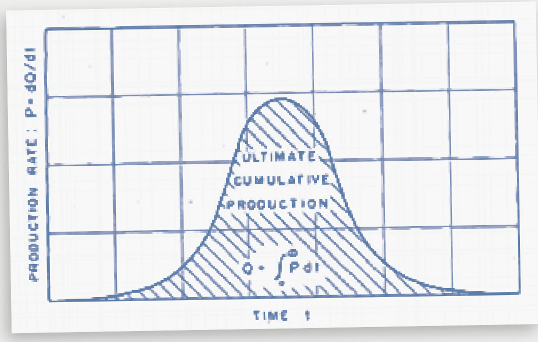


Figure 3: **A "Hubbert" curve. This graph of production versus time is taken from Hubbert's 1956 paper "Nuclear energy and the fossil fuels", in which he predicted the US Lower 48 states' oil production peak as 1971. His approach relied on "the mathematical relations involved in the complete cycle of production of any exhaustible resource", and used baseline data for the volume of total producible oil, otherwise known as Ultimate Recoverable Oil (URR). This approach can be used to predict the timing and volume of maximum production for a region, or for the world as a whole.**[96]

After Hubbert, the next serious analytical focus on the limits to oil production, this time for the world, was presented by two former senior oil industry geologists, Colin Campbell and Jean Laherrère, in their groundbreaking paper, "*The end of cheap oil*," published in the journal *Scientific American* in 1998.[97] They argued that just as individual oil fields and production regions reach a peak of production, after which output declines, so too would this be the outcome for world oil production. Campbell's recent analysis points to a global oil production peak of approximately 89m bpd,[98] whereas Laherrère suggests a range of 85-90m bpd.[99] For comparison, oil production reached approximately 86m bpd during 2008, before declining due to shrinking demand because of the world recession. Ultimately, the volume of highest production and its precise timing, and indeed how long it can be sustained, will depend on the complex interaction of variables such as world demand, the price of oil, the rate of new discoveries, and the level of investment and subsequent pace of project development.

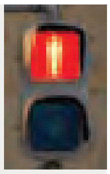
Conclusion

To understand the serious nature of the oil supply crunch, it is necessary to remain focused on the four underlying fundamental problems of oil field depletion, declining discovery rate, insufficient new projects, and increasing demand. There are other important factors which include, oil price, level of investment and the extent of the current global recession. However, these do not change the underlying point that an imminent oil supply crunch is very likely.

* Jeremy Leggett, in his book *Half Gone*, notes that The US Secretary of the Interior at the time, Stewart Udall, later publicly apologised for having helped lull the American people into a dangerous overconfidence by accepting the advice of the US Geological Survey so unquestioningly. This might give some current senior politicians pause for thought; see Section 4 and Appendix.

The good ol' days in Texas!

Countries past the peak[100]



There are four categories of countries producing oil, listed below: countries where oil production has peaked, and is declining for geological reasons; countries where output is declining for political reasons; countries where production has reached a plateau; and key countries that the world must now rely on for most of its oil production. This latter group consists of nations where production has not yet peaked and is either rising or where it is possible that it could increase. However, there are major concerns about the ability of some of this latter group of countries to continue to do so beyond a short time.

Note, the list to follow includes the world's top thirty oil-producing countries, which account for approximately 94% of daily output. Ten years ago, only four of these top thirty countries were in decline; now that figure is eleven and growing.

Countries where oil production has peaked:

Argentina, Australia, Brunei, Columbia, Congo-Brazzaville, Denmark, Egypt, Gabon, Indonesia, Mexico, Norway, Oman, Papua New Guinea, Peru, Romania, Syria, Trinidad & Tobago, Tunisia, United Kingdom, USA, Uzbekistan, Vietnam, Yemen.

Countries where oil production has peaked for political reasons:

Iran: In 1976 output peaked and then declined. Despite some recovery, it has never again attained the volumes of the mid 1970s. Lack of transparency about reserve claims and continuing political issues raise doubts about the likelihood of sufficient new investment to seriously raise Iran's oil production.

Nigeria: Production has declined since 2005, due to political tensions and violent uprisings, which have included attacks on oil platforms, pipelines and installations. These have shut down a large percentage of Nigeria's potential output. Without addressing key concerns in oil producing regions, these circumstances appear unlikely to stabilise soon. Despite some large off-shore discoveries Nigeria will likely peak before 2020.

Venezuela: Production is declining, although in theory it could increase through the development of unconventional resources.

Countries on a production plateau:

Algeria: Production alternating, with peak output within a few years.

Ecuador: Production has been gradually declining since 2006; it seems unlikely that it will rise significantly.

India

Iraq: Sanctions, conflict and instability have left Iraq's output stagnated, though with stability and investment, it could be tripled. But when will this happen?

Malaysia

Russia: Declined in 2008, though production is now on a plateau. Insufficient investment is likely to cause production declines in the near future.

Key countries the world relies on – but for how long?

Angola: Production is rising, but is likely to reach a plateau within a decade.

Azerbaijan: Output is slowly rising, but with few new projects planned, no additional large increases in output can be expected.

Brazil: Brazil's large off-shore discoveries will significantly raise its output. But note, though these are significant finds for Brazil, they are technically difficult and will be expensive to develop. These finds are likely to take a long time before production begins, and overall, new output will be insufficient to offset global decline rates.

Canada: Many assume the vast tar sand deposits will produce high volumes of non-conventional oil. But oil extraction from tar sands is very expensive and is an environmental disaster. The global recession and drop in oil price has led to project cancellations. Other limiting factors mean that the rate of oil production in Canada will be insufficient to offset global declines.

China: Production is increasing, but thought to be near peak, because the old production base of large fields has peaked.

Kazakhstan: Rate of output significantly increased between 2006 and 2008 as the Karachaganak and Tengiz fields ramped up production. Production growth has significantly slowed because no new production is expected to come on stream until at least 2014.

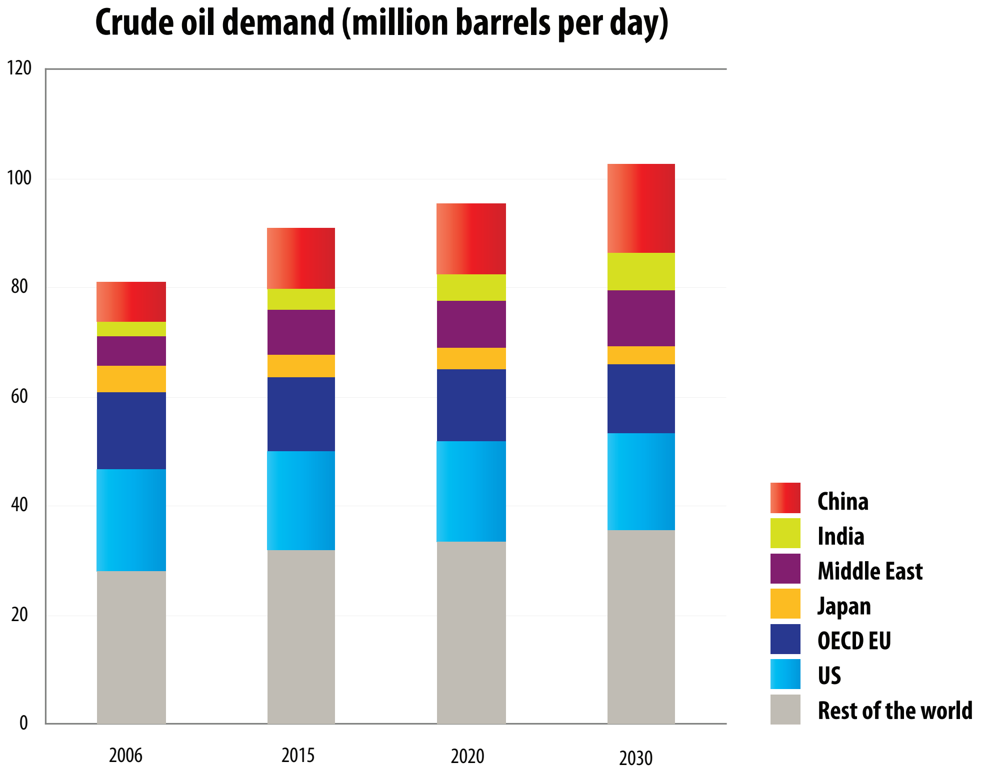
Kuwait: Output rising, but peaking of largest oil field, together with lack of transparency, doubts about reserve claims, and a lack of investment, raise questions about how long Kuwait can sustain its output.

Libya: Although new investment may well lead to increases in output, the timing and volume of production are very hard to assess.

Quatar/UAE: Production is rising, but Qatar's gains are all LNGs.

Saudi Arabia: Doubts about reserve claims and lack of transparency raise questions about how much longer Saudi Arabia can sustain its globally significant role as a swing producer, able to increase production as required to meet demand.

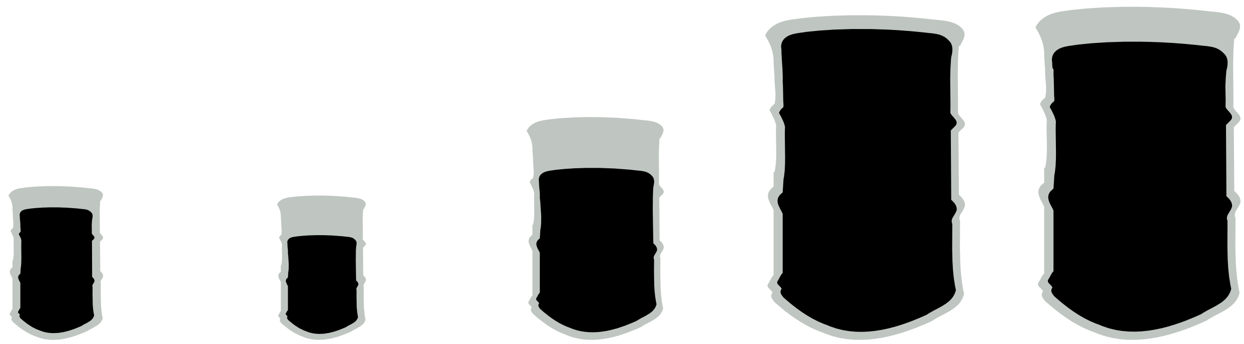
Crude oil demand to 2030 for key consuming countries and regions[101]



China, India, Japan, Middle East, OECD EU, US make up 65% of world oil demand

Status of certain geo-strategic producer countries/regions[102]

This feature shows the peak year and output volume for some key, strategically valuable, producer countries/regions. In each case it also shows their 2008 output (black), together with the decline from peak output (grey) expressed as a percentage.



Mexico: Currently the US' second source of imported oil but unlikely to remain an exporter past the next 5-6 years on current performance.	**Venezuela**: Potentially a country that could increase production but lack of investment and political tension raise major doubts about how their 30+% decline in production can be reversed.	**North Sea**: All key North Sea oil producing countries have now peaked, which means that Europe changes from being a largely self-reliant region for oil to a region increasingly dependent on oil imports.	**Saudi Arabia**: The world's key swing producer – but it is not clear for how much longer this will be possible.	**Russia**: Following declines in output during 2008, production appears to have stabilised. But with lack of investment, it seems likely that Russia will experience further declines in output over the next few years.
2004 – 3.82m bpd	**1970** – 3.75m bpd	**2000** – 6.39m bpd	**2005** – 11.11m bpd	**1987** – 11.48m bpd
2008 – 3.17m bpd	**2008** – 2.58m bpd	**2008** – 4.33m bpd	**2008** – 10.42m bpd	**2008** – 9.99m bpd
⬇ 17% fall	⬇ 31.2% fall	⬇ 32.2% fall	Can still raise output	⬇ 13% fall

3

The IEA might now be ringing the alarm, but is anyone listening?

Time for governments to reconsider

© Global Witness

Business As Usual: luxury limousines ready and waiting for the officials at the Poznan 2008 climate negotiations.

During the past decade, apart from a few notable exceptions, governments have failed to take into account the increasingly obvious signs of a looming oil supply gap. These indicators, including declining output from aging oilfields, declining discoveries, project delays, and sharply increasing global demand are all factors that should have been ringing alarm bells (see Section 2, The rise and fall of *Homo petroliensis*). Instead, the majority of governments appear to have relied upon the misleadingly overconfident projections of the International Energy Agency (IEA) which until very recently has asserted that oil production could meet increasing demand. This has resulted in the loss of the best part of a decade when action to develop sustainable alternatives could have been taken.

Unfortunately, despite the recent but belated warnings of the IEA, a number of factors indicate that governments continue to hold an overly optimistic view about future oil supplies. For example, the wording of the 2009 G8 Communiqué suggests that the industrialised countries continue to view security of oil supply mainly in terms of producer and consumer cooperation. Whilst these factors are important, the Communiqué gives little indication of concern about whether sufficient future supplies can actually be delivered.[103]* The IEA's 2008 Reference Case Scenario projects a fossil-fuel dominated 45% increase in the world's demand for energy by 2030.[104] It is based on the Agency's interpretation of the net consequences of existing government policies during 2008. The impression that governments view the energy supply future as some sort of "business-as-usual" arrangement is also supported by the minimal domestic GHG reduction targets being discussed at the UNFCCC negotiations.†

Section 3 of this report is divided into two main parts: an outline of the scale of the imminent gap between the capacity of the global oil industry to supply, and the IEA's projections for demand; and an assessment of the inability of investment to bridge this gap.

* The Major Economies Forum Leaders declaration, from the G8 meeting in Italy in 2009, is replete with good sounding intent but sparse of clear language appropriate for the urgency of the climate crisis, and time-lined targets for deliverables.

† Although the UNFCCC Secretariat put a more optimistic spin on the status of negotiations at its September 2009 meeting in Bangkok, Global Witness was told by various observers to the meeting that a more realistic assessment of overall ambition by the participants at that point in time indicated a net GHG reduction commitment by 2020 of 8-14% below 1990 emission levels.

3.1 The IEA sounds the alarm on oil supply

"We are on the brink of a new energy order…We should not cling to crude down to the last drop – we should leave oil before it leaves us. That means new approaches must be found soon... The really important thing is that even though we are not yet running out of oil, we are running out of time." [107] Dr Fatih Birol, the IEA's chief economist stated in March 2008.

In 2008 the IEA for the first time projected a 50% drop in production from existing conventional oil fields by 2020.* This alarming figure was partly the result of the IEA's first field-by-field analysis of a large number of oil fields. This fall in production coupled with projected increased demand for oil is likely to result in a large gap between supply and demand.† Policy makers should note the underlying problem is that there will be a gap, the size of which will constantly vary depending on economic conditions. It is hard to overstate the significance of these warning signals, first raised in 2007, given the Agency's previous misplaced confidence and assurances that oil supply could meet the world's expanding demand (see Section 4 and Appendix).

Global Witness has focused its analysis on the work of the IEA, because, as it boasts, *"Governments and industry from all across the globe have come to rely on…* [its WEO series and wider IEA commentary] *to provide a consistent basis on which they can formulate policies and design business plans."*[105] Established during the 1973-74 oil crisis to *"co-ordinate measures in times of oil supply emergencies…,"* it has become the leading global authority on energy issues, covering all major energy producing and consuming countries.[106]

What is the scale of the problem? In November 2008, the IEA projected a 7m bpd gap by 2015, which equates to 7.7% of projected world demand by that year.‡ This gap was estimated from the combined impacts of declining production from existing fields, long-term projections for increased global demand, and insufficient new production coming on stream to cope with this situation. The global recession has temporarily altered projections for global demand, but has not changed the underlying fundamental problems with increasing production. As the IEA put it, "*…the gap now evident between what is currently being built and what will be needed to keep pace with demand is set to widen sharply after 2010. Around 7 mb/d* [m bpd] *of additional capacity (**over and above that from all current projects**)* [Global Witness emphasis] *needs to be brought on stream by 2015."*[108] To appreciate the implication of a gap of this size from a national or regional perspective, see Table *Mind the Gap!*

A 50% projected drop in conventional oil production in just 11 years is truly astonishing.§ It represents a drop from 2008's output of 74m bpd¶ to just 37m bpd by 2020. The IEA project this steep rate of decline to begin almost immediately (see *Figure 4*, dark blue segment). To put this in context, the Agency also projects total world oil demand to reach 104m bpd by 2030.[109] What is even more remarkable is that such a vast and imminent loss of conventional oil production has not caused wider comment. It should be making governments seriously question why the Agency, established in reaction to the 1973 oil crisis, appears until very recently to have missed the start of the next one.

"The portion of the world where private industry is open to explore and produce is mature, fighting decline rates of seven per cent with limited exploration success. OPEC has a different set of problems, beyond the scope of this note to describe, but only a limited production increase can be expected. Last year I indicated in a presentation that peak would be 95-100, I think 90-95 mmbod [m bpd] is more like it."[111] Ray Leonard, illustrating how changing global circumstances impact on the overall potential for oil production.**

* See blue trace, *Figure 4*

† See earlier discussion about growth in world demand in Section 2.3, *Increasing demand*.

‡ Total global demand in 2008 reached 86 m bpd; the IEA project an increase to 91 m bpd by 2015.

§ Given that approximately 87% of current total world crude oil output is made up from conventional crude oil production, it is difficult to overstate the consequences of a 50% decline of conventional crude oil output in just over a decade.

¶ Total (which includes conventional and non-conventional) oil production stood at approximately 86m bpd in mid-2008.

** Ray Leonard is CEO of Hyperdynamics Corp, an oil and gas exploration company, with assets in West Africa. He was formerly a Vice President at Yukos, and also at Amoco Corp.

3.2 The IEA's vision for bridging the gap is flawed

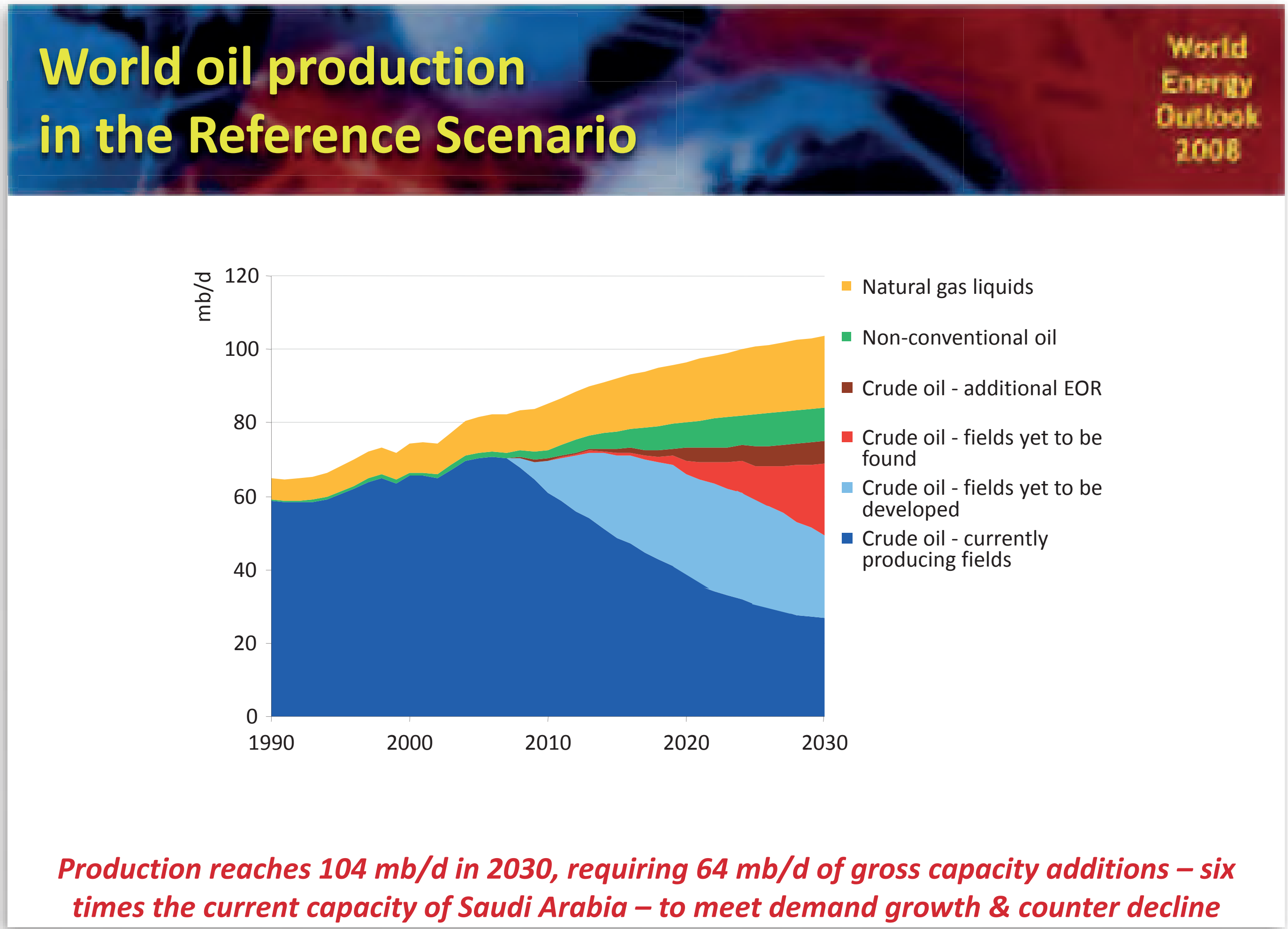


Figure 4: **Current conventional oil production drops off a cliff. From *World Energy Outlook 2008*,** © OECD/IEA, 2008. [110]

Having finally identified an imminent oil crunch, the IEA proposes massive annual investment of US$450bn to 2030 to develop new oil production sources, which it says could solve the supply-demand gap, lifting world oil production to 104m bpd in 2030. This would require US$1.2bn per day, every day, between now and 2030. However, as the analysis below demonstrates, regardless of the level of investment, it seems extremely unlikely if not impossible, that the increasing global demand for oil can continue to be met. As previously mentioned, a continued recession, or a pro-active reduction in demand might shrink the gap, or delay its timing, but neither would remove the underlying problem of declining production.

The IEA's projections for future new production are summed up in *Figure 4*. Global Witness has analysed the IEA's comments and stated assumptions for each of their projections for new production, set out below with colour references that link to the IEA's graph. The first three segments of the IEA's projected new production (pale blue, red, and brown in *Figure 4*) relate to potential replacement sources for the lost conventional crude oil production shown in dark blue.†† Together, the IEA projects that new flows of oil from these three replacement sources could reach 45m bpd by 2030. Thus, it is suggesting, these sources alone could sustain overall conventional crude oil production at a similar order of magnitude as that of today, potentially solving the imminent crisis arising from rapid declining conventional crude oil production.[112] The final two segments of projected new production in *Figure 4* (green and yellow) are from unconventional sources and natural gas liquids (NGLs). Production from these sources, the IEA suggests, could meet the Agency's projected world demand of 104m bpd by 2030.

†† Note for discussion of current conventional crude oil production (shown in dark blue, *Figure 4*), see *The IEA sounds the alarm on oil supply* in Section 3.

1. New conventional crude oil production from known fields, yet to be developed (Figure 4, Pale blue segment)

The IEA projects new production from known fields could reach 29m bpd by 2020.[113] Although this output might theoretically be achievable, a number of factors relating to costs, levels of investment and the timing of its availability make such an outcome highly questionable.

Between 2002 and 2008, exploration and production costs rose sharply due to a rapid increase in global demand for new oil production, massively inflating the cost of drilling rigs and other equipment, which were in short supply. The cost issue has been exacerbated because many of the new sources of conventional oil production are in regions with high development costs. For example, in October 2008, in Angola, these costs were just above US$70 per barrel, and in Nigeria just under US$80 per barrel, in contrast to approximately US$20 per barrel in Saudi Arabia, and other Middle East countries.[114] Oil development costs remained high,[115] despite demand contracting and the oil price dropping as of the first quarter of 2009 by 70% from oil's highest ever price in mid-2008. The sustained period of high development costs, together with reduced global demand for oil and the low oil price (although by the second quarter of 2009 the oil price had begun to climb),[116] has caused significant delays and cancellations to new oil projects. By January 2009, the IEA's Chief Economist, Dr Fatih Birol, estimated that project cancellations of a combined value of approximately US$100bn had occurred since the oil price collapse in the last half of 2008.[117] As discussed in *Oil projects in development cannot bridge the demand gap* in Section 2, the analysis of Chris Skrebowski indicates that regardless of the volatility of the oil price, and rises and falls in world demand, the fact is that there will soon be insufficient new projects in development to add to the overall volume of oil coming onto the market. The long lead-in times to organise and finance large-scale new oil development means that, even if a world recovery leads again to favourable conditions, reversal of project cancellations and delays will take significant time.

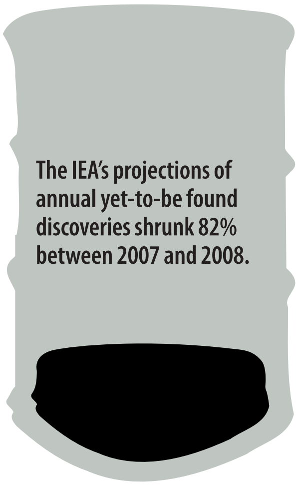
Taken together, the factors discussed above raise serious doubts about the likelihood of the IEA's projected 29m bpd of new production coming on stream from these known fields by 2020. And as the Agency itself points out, the lack of sufficient new oil development projects (as of the last quarter of 2008) caused it to project a potential 7m bpd gap between projected world demand and capacity to supply by 2015.

Welcome to the world of tough oil: Kazakhstan's Kashagan oil field development in the Caspian Sea. At 13bn barrels it might have been one of the largest oil discoveries of recent decades but technical difficulties have meant massive delays and increased costs to its development which, after nearly a decade, has yet to pump oil.

2. New conventional crude oil production from fields that are yet to be found (Figure 4, Red segment)

The IEA has massively downsized by 82% its projections for future average annual conventional discoveries to 2030. To repeat, projected future discoveries have been downgraded by 82% per year over the next 23 years, whilst current production has been downgraded by 50% over the next 11 years. These factors should be matters of urgent concern for governments and yet they appear to have not been widely commented on, or even noted, by the media. They should be driving (forgive the pun) reform of the energy sector and, more crucially, underpinning more stringent targets under the UNFCCC negotiations; and yet the pace of change associated with the targets under discussion in the negotiations show this not to be the case.

The IEA's projection plummeted from 880bn barrels to 114bn barrels in just two years, though these figures are complicated because they cover slightly different projection periods. In 2006, the Agency projected that 880bn barrels would be discovered over the 30 year period 1995-2025; by 2008, this projection was sharply reduced to just 114bn barrels over the 23 year period to 2030.* The IEA suggests that total production from these 114bn barrels will reach 19m bpd by 2030.[118] Although the Agency appears to have finally provided a more realistic estimate of future discoveries, unfortunately, it now appears to be projecting unrealistic estimates of the potential flow rates from these unknown and yet-to-be discovered fields. A crude calculation to achieve the IEA's production volume from these new discoveries shows that it would require an average production flow rate almost 50% higher than that which it suggests will come from existing known fields.[119]† Global Witness finds this a little unlikely. If, instead, the average production rate for known fields is used, then a perhaps more realistic and precautionary estimate of likely future production from these yet-to-be discovered fields would be 12.88m bpd, rather than the 19 m bpd the IEA projects.



Academic analysis also suggests that the IEA's 2030 projections for production flow rates are too optimistic. One study gives a range of likely production volumes by taking into account the IEA's suggested mix of on and offshore finds, and OPEC and non-OPEC production, for new discoveries. The study's "optimistic" view projects 15.5m bpd, which is 20% lower than the IEA's projection, through to what it describes as a more "realistic" outcome of just 9.6m bpd (just 49.5% of the IEA's estimate).[120]‡

There is nothing contentious about the idea that new oilfields will continue to be discovered, developed and put into production. However, the IEA has a history of promoting an overconfident vision for potential new global oil discoveries, an issue that is discussed further in Section 4 and in the Appendix. The reader would be well advised to view the Agency's projections through this prism of past overconfidence.

When asked to comment on the difference between their projections, the IEA responded, "*Our projections for yet-to-be-found fields are based on assumptions about the development profiles of oilfields according to their size and location based on actual data (we carried out a detailed analysis of oilfield production profiles based on a 798-field dataset)… As the average size of fields that are found over the projection period are expected to be considerably smaller than existing reserves (and more often found offshore), they are assumed to reach a higher peak output relative to reserves, but also to decline at a much faster rate. In no sense could one describe this approach as inflating projected output; rather it reflects how oilfields are actually developed and takes account of current trends in exploration results.*"[121]

* An annual average 5.18bn barrels would need to be discovered to achieve the total 114bn barrels over the new 23 year projection period to 2030. In 2006, the Agency was still projecting an overall future discovery volume that would require an average annual discovery rate of 29.3bn barrels. The IEA's 2008 projection for future discoveries is thus an 82% reduction in the average annual discovery rate in just two years.

† For known fields, the IEA's projection of 29m bpd of production by 2030 would require a production volume of 1.13m bpd from each 10bn barrels of *known* reserves. For the IEA's projections for unknown fields to become reality, a production flow rate of 1.67m bpd of production for each 10bn barrels of reserves would be required. This represents an inflation of 47.8%.

‡ According to this study, an optimistic production of 15.5m bpd would require a more or less constant discovery rate of 10-11bn barrels annually up to 2030. IEA's projection of 114bn barrels of total discoveries to 2030 represents an average annual discovery rate of just over 5bn barrels.

3. The use of Enhanced Oil Recovery (EOR) techniques to add production from existing fields (Figure 4, Brown segment)

The IEA forecasts that Enhanced Oil Recovery (EOR) techniques, in particular through the use of CO_2 injection (CO_2-EOR), will add an approximate 6.4m bpd of conventional oil production to the world total by 2030.[122 §] However, this figure is unlikely for a number of reasons:

- It relies upon the speculative deployment of yet-to-be proven large-scale Carbon Capture and Storage (CCS) technology to provide the CO_2 needed for injection into the oil fields.
- There is an oil industry-wide problem of lack of experienced staff.
- It requires 9.8Gt (billion tons) of CO_2, which is nearly 1.4 times the US annual CO_2 output from the burning of oil, gas and coal in 2006.
- Approximately 79% of the captured CO_2 would be re-released into the atmosphere from burning the produced oil (for this and above point, see *CO_2-EOR is a Disaster for the Climate*).
- The Energy return on energy invested (EROI) is lower for oil recovered using high energy input technologies, such as CO_2-EOR, thus 6.4m bpd of new production from this method contains less net energy than normal conventional oil production (see EROI discussion in Section 4 below).

There is thus a stark choice:

- Assuming CCS deployment is achieved on a large enough scale (a debatable point), it seems theoretically possible to produce 6.4m bpd of additional oil production. But doing so would in effect render a major part of the global effort to reduce GHGs null and void – because the bulk of the captured CO_2 would then be re-released to the atmosphere through burning the additional produced oil.
- Or, decide that these emissions should be permanently sequestered (a wise decision), but this means that there will be no additional oil produced by this method.

CCS technology remains in its infancy and currently there are no full-scale CCS equipped power stations. As such, the IEA's assumption that sufficient volumes of CO_2 to produce 6.4m bpd of oil will become available seems optimistic. Even if CCS technology is successfully expanded, the sheer volume of CO_2 required will negate CCS as a climate mitigation strategy.

Will Carbon Capture and Storage be conjured up in time, and does it really make climate sense to use it to pump out more oil?

§ 6.4m bpd is 6.15% of the IEA's projected 104m bpd total world production in 2030.

CO_2-EOR is a disaster for the climate

The *WEO-2008* emphasises the benefits of an increased use of CO_2 from Carbon Capture and Storage (CCS) to extract oil. However, even if this speculative technology were to be rolled out on a big enough scale in the four countries suggested by the IEA (the United States, Saudi Arabia, Kuwait and China),[123] the resultant re-emission of CO_2 from the burning of the produced oil would be a disaster for the climate. The IEA suggests that the rising price of carbon, due to efforts to deal with the climate crisis, will provide large volumes of CO_2 for use in CO_2-EOR injection. The IEA even suggests that the cost implication of such expensive technologies could be offset through the production of oil: "The economics of CO_2-EOR are attractive, as the injection of one tonne of CO_2 into a suitable reservoir leads to an incremental recovery of between two and three barrels of oil."[124] *

"The value of this oil could be set against the cost of capturing the CO_2 from power plants and transporting it to the injection fields, which is estimated to range from US$50 to US$100 per tonne"[125] The IEA discusses the economics of CO_2-EOR, *WEO-2008*.

The IEA expects a large amount of CO_2 will be required: "In total, about 9.8 Gigatonnes (Gt) [billion tons] of CO_2 is captured and stored in CO_2-EOR oil projects over the projection period." [126] In other words, to produce 6.4m bpd of additional oil, 9.8 billion tons of CO_2 will be required. Unfortunately, the burning of the produced oil will result in approximately 79%[127] † of the CO_2 that would have been emitted from the power stations, had CCS not been deployed, ending up in the atmosphere. Thus the IEA's suggested method to obtain these additional volumes of oil takes on an almost surreal flavour: on the one hand, the *WEO-2008* expresses considerable concern about the need to address the climate crisis, but on the other, its pre-occupation with the effort to squeeze those last additional drops of oil from depleted reserves, has potentially catastrophic consequences for the climate.‡ [128,129]

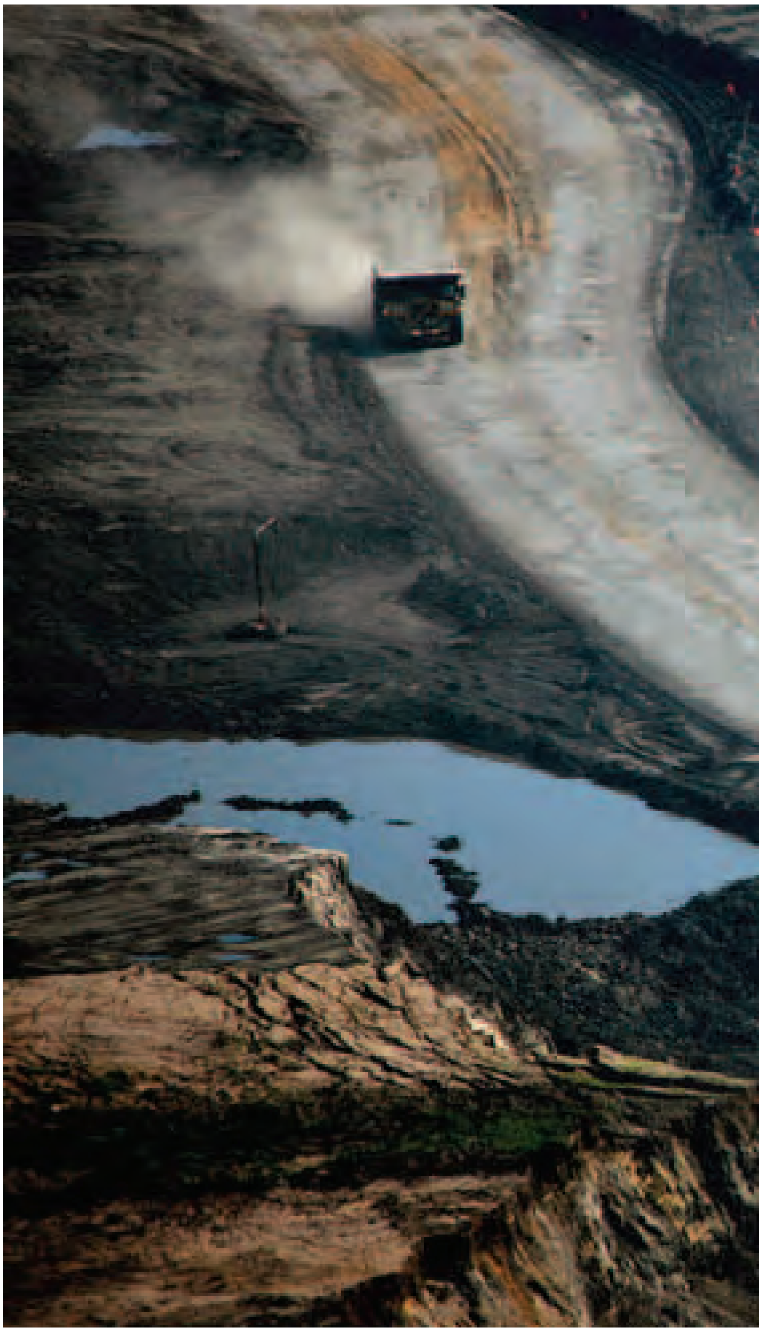
* Even with oil at for example, US$60 per barrel, it is easy to see how the economics can be made to work. But economics is not the only factor that should be considered.

† The combustion of one barrel of oil produces approximately 317 Kg of CO_2. The IEA estimates that 2-3 barrels of oil will be produced for each ton of injected CO_2 . Based on these figures, and assuming 2.5 barrels of oil are produced for each ton of injected CO_2 , then the subsequent combustion of the produced oil would emit 793Kg of CO_2 into the atmosphere. On the same assumptions, it follows that the injection of 9.8 Gt of CO_2, will produce enough oil to release 7.7 Gt of CO_2 into the atmosphere. If on the other hand, 3 barrels of oil are produced for each sequestered ton of CO_2 , then the amount of released CO_2 would almost be equivalent to that which was used in its production.

‡ 7.7Gt of CO_2 is a massive volume it represents 1.36 times the entire annual emissions of CO_2 from oil, gas and coal combustion in the United States during 2006, or 13.9 times the United Kingdom's own estimates for its emissions during the same year.

4. Non-conventional oil production (Figure 4, Green segment)

The IEA projects new non-conventional oil production to reach 8.8m bpd by 2030, with most expected to come from Canada's tar sands, where output is forecast to rise to 5.9m bpd by 2030. This is a large increase from just 1.2m bpd production in 2007.[130] The overall resource base for non-conventional oil sources is vast. As explained by the IEA: *"Assuming a potential 20% recovery factor, these two countries* [Canada and Venezuela] *would hold more recoverable resources than all the conventional reserves in the Middle East."*[131] These non-conventional oil sources play a significant role in meeting the demand projected by the IEA. They are widely assumed by many to be the "answer"



to the oil supply gap. But the amount in the ground does not equate to either the possible production volume, or the rate at which it can be produced. In addition, because of the smaller energy return on energy invested, overall produced volumes of oil are worth a fraction, in energy terms, in comparison to conventional oil.

The main types and sources of non-conventional oil resources include:

Tar sands

Tar sands, also known as oil sands, can be converted into a synthetic crude oil (syncrude). But this process requires a much larger energy input than that required for conventional crude oil production. The largest deposits are located in Canada, with the Province of Alberta holding some 174bn barrels of proven reserves, and ultimately recoverable resources of an estimated 315bn barrels, according to the IEA.[132]

Extra-heavy oil

The biggest deposits of extra heavy oil are found in Venezuela's Orinoco belt - an estimated 1.7trn barrels, of which approximately 250bn barrels is estimated as recoverable, according to the IEA.[133]

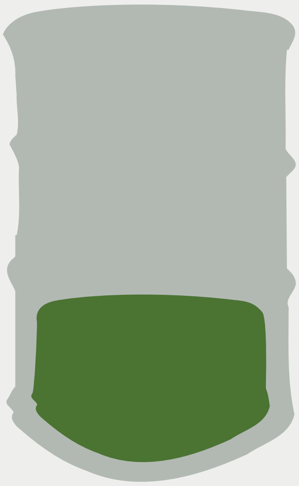
Oil shales

These are found in the United States (about 60% of the total), Brazil, Jordan, Morocco and Russia. The IEA does not project oil shale development to add a significant volume of new oil to global production by 2030.[134]

Tar sands extraction
Is this really a solution to the oil supply crisis?

Could tar sands production be increased as the IEA suggests?

In terms of net energy content, the replacement of 5.9m bpd of conventional crude oil output by production from tar sands, would at best be the equivalent of just 1.69m bpd – a drop in available energy of more than 70%.



Given that the IEA expects the bulk of new non-conventional oil production to come from Canada's tar sands, are the Agency's projections for Canada realistic? Many commentators, including the IEA, have emphasised the vast resources locked up in Canada's tar sands but it is hard to imagine a better example to illustrate the notion that size is not everything. Limiting factors, which are discussed further below, make it unlikely that Canada's tar sands production will grow to more than 3m bpd during the next decade.[135] By comparison, annual global depletion rate in 2008 stood at approximately 3.7m bpd. The inability of Canada's tar sands output to address the global oil supply/demand crisis is thus obvious. Given that such projects are not likely to represent any kind of salvation for global supplies of oil, it is hard not to conclude that their promotion has more to do with supporting the value of oil companies.

The following factors should be considered:

Shrinking energy return on investment (EROI) – a fatal blow to the mathematics of tar sands Estimates for the energy return on energy invested (EROI) for tar sands (the ratio of units of energy input required to produce each unit of energy output) range from 10:1 to 2:1, depending on the location and the extraction process.[136,137]* Assuming an optimistic EROI for tar sands at 10:1, the extraction of oil from tar sands requires 3.5 times more energy input per unit gained, than the average for global conventional oil production, which has an estimated EROI of 35:1.108 On this basis, even if the IEA's projected output from Canada's tar sands did in fact reach 5.9m bpd by 2030, in net energy terms, its contribution would only be worth the equivalent of 1.69m bpd of conventional oil output.

Water and gas availability The IEA projects non-conventional production to already reach approximately 4.5m bpd by 2015, with at least 3.2m bpd of that total being produced from tar sands in Canada alone.[138] Half of Canada's increased output is expected to come from so-called in situ extraction methods, which require vast quantities of natural gas to heat water for steam production. The supply of both water and gas are limited; indeed, in their 10th October 2007 statement, Canada's National Energy Board, noted an anticipated gas output reduction of 7-15% between 2007-2009.[139]

Environmental impacts The process of extracting syncrude from tar sands is also environmentally very damaging.

Cost, delays, and cancellations IHS CERA estimated that by the second half of 2008, extraction costs† for Canada's tar sands had risen to approximately US$85 per barrel.[140] Following the world recession, the collapsed oil price no-longer supports investment in tar sands projects. This has resulted in massive delays and cancellations to existing and new projects.[141]

"We are witnessing a collapse in oil sands-related construction. As far as we can tell, as much as 75 percent of the oil sands-related work slated for 2009 has been cancelled."[142] Gil McGowan, President of the Alberta Federation of Labour, in April 2009.

* Note, some analysts consider tar sands EROI to lie in the range 4:1 to 2:1.

† CERA's cost estimates included a reasonable expected return on the investment.

5. Natural gas liquids (NGLs) (Figure 4, Yellow segment)

Although the IEA's suggested production volume for NGLs seems to be feasible, policymakers need to understand that reductions in the available volume of conventional crude oil coming onto the market cannot simply be replaced by NGLs. This is not a case of replacing like with like. For example, NGLs are short-chain hydrocarbons which means that they are not ideal for manufacturing diesel, gasoline (petrol) and jet fuel.

3.3 The IEA's 2008 projections show an imminent oil crunch

The ill-informed debate in the US Congress during July 2008: regardless of the political imperative of being seen to address the high cost of fuel, the debate between the parties simply demonstrated a lack of understanding about the underlying fundamentals.‡

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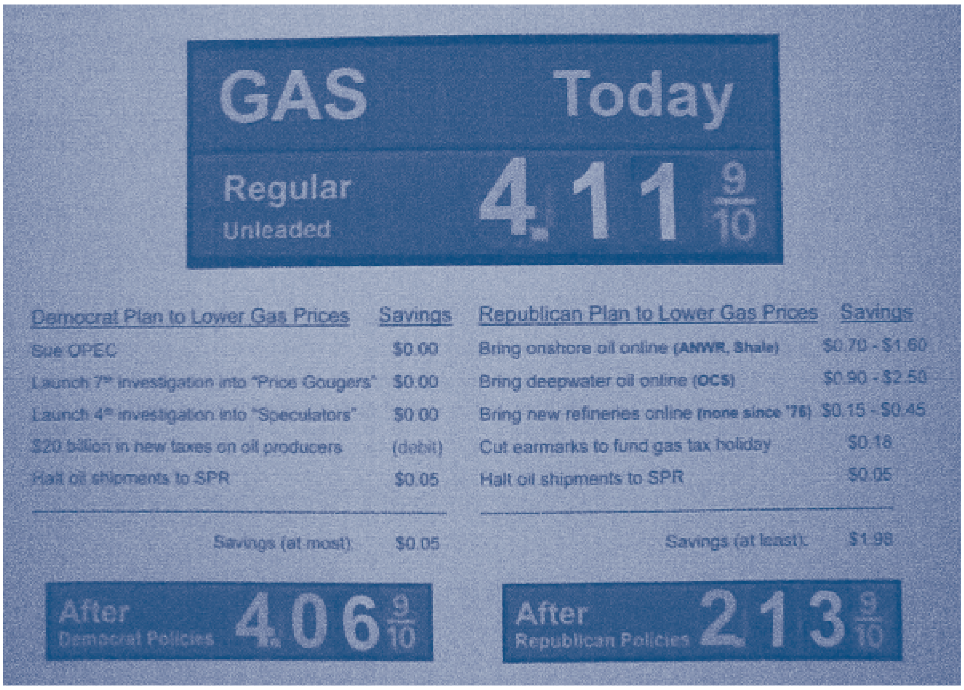


The IEA's November 2008 projections clearly show an imminent oil supply crunch, marking a significant shift, first begun in 2007, away from its past overconfidence (see Section 4 and Appendix). Governments should take these warnings very seriously. Nevertheless, Global Witness' analysis demonstrates that the Agency continues to retain an overly-optimistic, and therefore misleading, view about potential future oil production – predicated on massive and sustained investment. For example, the *WEO-2008* reference-case scenario calls for overall investment in excess of US$26 trillion to 2030 for the overall global energy sector, of which just under 48% (US$12.4 trillion) needs to be earmarked for oil and gas.[143] At the press launch of the *WEO-2008*, the IEA's chief economist emphasised the need to spend at least US$450bn per year on oil exploration and production alone.[144] The legacy of the IEA's past over-confidence means that it is worrying that the Agency continues to project a rosier than likely outcome for future production. It sustains the myth that timely and sufficient investment will address a belatedly recognised oil supply crisis, and is seductive for those who continue to believe that the world can spend its way to a sustained and growing oil supply.

However, as the above analysis shows, the cumulative projected volumes of new oil supply from the sources outlined in the *WEO-2008* report are highly questionable, regardless of expenditure. And even if some of these projected outputs were in fact to be produced, shrinking EROI means that these volumes are worth significantly less in energy-content terms than the volumes of conventional oil they seek to replace. Beyond a short-term, strictly limited period to sustain supplies to minimise the consequences of a supply gap over the next few years,§ any attempt to meet these projections in the longer term is likely to fail. This would lock in vast amounts of capital expenditure for years – investment that could be better spent on creating an alternative, safe and sustainable energy system. Thus in effect, the *WEO-2008* shows that conventional crude oil production has, for all intents and purposes, either already peaked – or soon will do.

‡ In this poster, the Republican Party urged the opening up of the Arctic National Wildlife Refuge (ANWR) for oil drilling (a long-standing ambition), together with American off-shore drilling and to develop oil shale deposits, which it suggests would reduce oil dependence from overseas, and reduce prices. In reality, development of ANWR would be a decade-long process. Projects on the US off-shore continental shelf would also take around 6-7 years to bring to production, and Shale-Oil production is unlikely to be viable for decades. Thus any oil produced would be far too little, far too late to make any practical difference to US dependence. Given the clear influence of oil money in the US Congress (an issue regarding both parties), it is hard not to view such proposals as a cynical life-saving exercise for oil companies, themselves desperate for access to new drilling opportunities.

§ Climate science shows that the world urgently needs to move on from fossil fuel use as a matter of highest priority. Thus beyond the immediate future, where sustaining supplies is necessary to avoid potential global chaos (as discussed earlier in Section 1), the priority must be to realise a world where oil ceases to be the pre-eminent primary energy resource.


4

The IEA's history of overconfidence leaves a legacy of missed opportunity

This section analyses the IEA's history of overconfidence about future oil discoveries, one of the key factors that has in turn led to governments' false confidence about future oil production. Between 2002 and 2007, the Agency's *WEO* report series reference case analyses consistently painted a picture of resource abundance, and the message to governments was, in effect, that oil supplies could be assured until 2030, given sufficient and timely investment (see Appendix for a further analysis). The Agency's over-confidence, despite credible data, external analysis and underlying fundamentals all strongly suggesting a more precautionary approach, has had a disastrous global impact.

THOUGH THE EVIDENCE CLEARLY DEMONSTRATES THE IEA AS BEING AT FAULT, GOVERNMENTS do not remain blameless. It is governments that must bear the responsibility for having failed to adequately question the Agency's underlying assumptions and for having failed to recognise and address the problem itself. Today, governments with few exceptions, remain almost completely unprepared for the consequences of an oil supply crunch and subsequent decline in global supplies of oil. Thus they have seen little imperative to change their national reliance on liquid fossil fuels, in turn severely delaying the mitigation of oil's key contribution to the climate crisis, and the creation of a set of safe, sustainable energy supply systems.

4.1 The IEA's misrepresentation of data led to its overconfidence – persistent offender?

One of the core reasons for misplaced confidence has been the IEA's use of data produced by the *US Government's United States Geological Survey* (USGS) in 2000 – the "*World Petroleum Assessment 2000*." It is worth paying close attention to how the IEA chose to interpret the USGS' findings and their subsequent presentation because this has had the effect of suggesting a greater than likely rate of new discoveries over the next few decades. This in turn has resulted in governments assuming a greater than likely volume of available oil. When senior USGS study authors published an update suggesting real oil discoveries were significantly trailing the USGS mean estimate from their original study, the IEA failed to revise its estimates for future discoveries downwards. In addition, correspondence with the IEA confirmed that the Agency was aware of a low actual discovery rate.[145] It should also be noted that the USGS 2000 study proved contentious when it was published, with some experts raising concerns that some of its future production numbers were too high.[146,147]

What is wrong with the IEA's use of USGS data?

From 2002-2006, the IEA presented mean projections of future discoveries from the USGS 2000 study as a likely outcome. This was misleading because the USGS had also provided a lower discovery estimate, at a 95% probability level, which by definition is a more likely outcome than the mean.[148] * The folly of the Agency's choice is all the more important given the constraints of the 30 year projection period of the USGS study, within which all this oil would have to be discovered. Despite this, the IEA did not use the more likely 95% probability lower discovery estimate. Given that one of the key functions of the IEA is to provide governments with accurate information from which they can make economic plans, their misrepresentation of data in this way was intellectually dishonest.

Whilst Global Witness does not here attempt to suggest a reason for the IEA's choice of an inflated future discoveries estimate, it is all the more incredible given the 40 year trend of shrinking world discoveries (see *Figure 1*). Governments, for their part, have failed to adequately question the IEA's assumptions about likely future discoveries of oil and the way in which the Agency presented its conclusions. Global Witness wrote to the governments of 27 countries, together with the European Commission, to enquire about their understanding of the status of the global oil industry and risks to global supplies of oil. At the time of going to press, very few had replied, none of which gave formal recognition to an imminent oil supply crunch.

In the *WEO-2002*, future discoveries over the 30 year period to 2025 are projected at 939bn barrels[149] – the USGS 2000 study mean estimate. The IEA suggested that if this mean estimate for future discoveries was taken together with the Agency's estimate of already discovered conventional oil reserves, which it put at 959bn barrels (Global Witness has concerns about this figure – see *OPEC's phantom barrels*, Section 2), then the world could look forward to future production of a further 1,898bn barrels. At roughly 1.8 times the volume of oil produced to date, such a high figure would indeed be an attractive proposition to governments concerned about security of supply.

The USGS 2000 mean estimate of 939bn barrels of future world discoveries included both conventional crude oil and NGLs, and was comprised of the following volumes: [150]

649bn barrels mean estimate for crude oil discoveries (excluding the United States).

207bn barrels mean estimate for global NGLs (excluding NGLs for the US).

83bn barrels mean estimate for conventional crude oil together with NGLs for the United States.†

* As USGS 2005 update paper made clear, "*Estimates of unknown, undiscovered oil and gas accumulations are inherently uncertain. The US Geological Survey reported its estimates as mean values with probabilistic ranges. The minimum estimate (the 95th fractile) represents undiscovered resource at a 95% probability, and the maximum estimate (the 5th fractile) represents the undiscovered resource at the 5% probability.*" The document continues: "*As of December 1995, the undiscovered technically recoverable conventional oil available for discovery in the 128 provinces (exclusive of the United States)* [i.e. the study region] *was estimated to range from 334 to about 1,107bn bbl* [billion barrels], *with a mean value of 649 billion bbl.*"

† In the United States, conventional crude oil and NGLs data are published as combined figures. This can complicate the process of comparing like with like. Thus, the overall estimate for future discoveries includes the combined estimate for the US, together with separate estimates of conventional crude oil and NGL's for the rest of the world.

4.2 The IEA's projections for discoveries compared to the real world

By 2005, the IEA dropped its projection for future discoveries from its 2002 estimate of 939bn barrels, down to 883bn barrels. In 2006, this estimate was reduced again to 880bn barrels. It is when these projections are compared to the real world of actual annual discoveries that it becomes clear just how unlikely they were of ever becoming a reality during the 30 year period they were supposed to occur in. For example, to achieve the 2002 projection of 939bn barrels would require an annual average discovery of 31.3bn barrels. Given that the last time annual global discoveries were sustained at this level was in the mid-1970s, it is hard to imagine how the IEA, and for that matter, governments using its analysis, could possibly have concluded that such a discovery rate was remotely likely.

When asked why the IEA's 2002 estimate of 939bn barrels had dropped to 883bn barrels in 2005, the IEA responded, "*The 939 figure was adjusted for the amount of oil discovered since 1 January 1996 (the reference data for the USGS 2000 assessment) using IHS data.*"[151] In other words, as far as the IEA was concerned, it had obtained data showing that actual discoveries between 1996 and 2005 (a ten year period, or one third of the USGS study period)

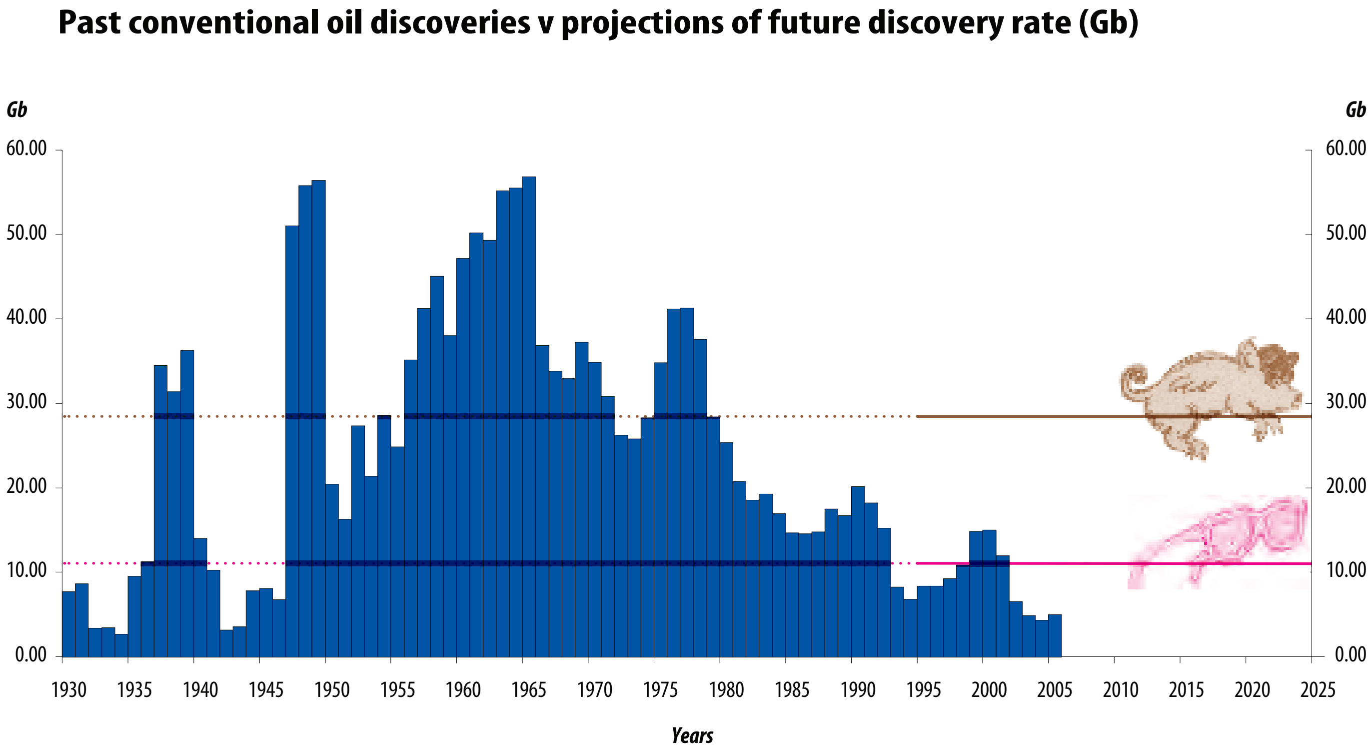


Figure 5: **Past actual discoveries (blue) against two projections (see bullets) for future discoveries to 2025.**[152,153]

Figure 5 is a graph of past discoveries (**blue**) plotted against two projections for future discoveries:

- The **flying pig** illustrates the volume that would need to have been discovered annually (29.3bn barrels) over the 30 year period to 2025 to realise the IEA's 2006 projection for future world crude oil discoveries. This projection included NGLs (880bn barrels).*

- **The rose-tinted glasses** show the volume that would need to be discovered annually (11.13bn barrels) to realise the USGS 95% confidence estimate for world conventional crude oil discoveries. This figure excludes both a projection of conventional production from the United States, and world NGLs. Despite excluding these projections, it is clear from the history of past declining discoveries (**blue**), that to sustain the discovery of even this volume of oil over the projection period would be an enormous achievement.[154]

amounted to only 56bn barrels.[†,‡] If this small actual rate of discovery is taken into account, then for the IEA's 2006 mean estimate of 880bn barrels to become reality, this volume [880bn barrels] would now have to be discovered in the remaining 19 years of the study period to 2025. To achieve this would require an average sustained annual rate of discovery of just over 46bn barrels – a rate of sustained discovery not achieved since the mid-1960s. Despite this absurd suggestion, and even though the IEA knew by 2005 that the actual rate of discovery amounted to a mere 18% of what would have been required,[§] it continued to present its downward revision of the USGS 2000 mean estimate as a likely outcome in 2005 and 2006 (see *Figure 5* for a comparison of the IEA's 2006 projection for discoveries against actual discoveries).

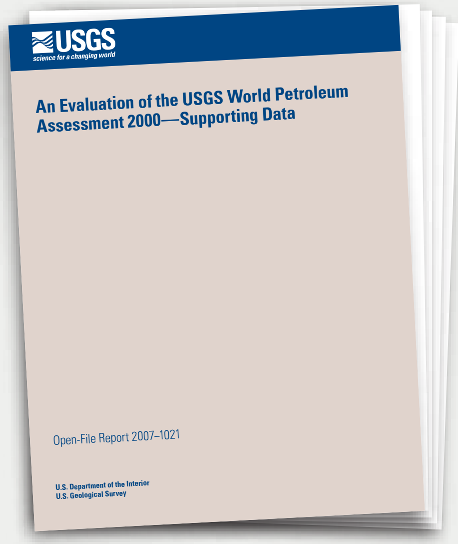
* Because this mean estimate includes NGLs, the column height of annual discoveries to achieve this volume (at 29.3bn barrels) is not directly comparable with that of actual discoveries (blue). However, NGLs make up approximately 20% of the 880bn barrels total. But, even if this band was reduced to just 75% of its height in this graph, thus excluding the contribution of the NGLs, the annual rate of discovery would still need to be at least 22bn barrels a discovery rate not sustained since the early 1980s.

† The 56bn barrel figure was obtained by subtracting 883bn barrels (the IEA's 2005 estimate) from 939bn barrels (the IEA's 2002 estimate). In 2006, the IEA's projection for future discoveries was reduced again to 880bn barrels, implying that an additional 3bn barrels had been discovered between 2005 and 2006.

‡ Whereas, for the mean estimate provided in 2002 to have been on track, 313bn barrels should have been discovered by that time.

§ 56bn barrels is just under 18% of 313bn barrels.

USGS 2000 study lead authors provide a reality check on actual discoveries



In August 2005 USGS geologists published a ten-page document,[155][*] which noted significant shortfalls of new actual world (excluding the United States) conventional oil discoveries in comparison with the mean global discovery projections presented in the USGS original 2000 study. These partial update findings were then repeated in a further update paper published in 2007.[156] In their 2005 paper, the USGS geologists stated[†] that actual discoveries during the first eight years of the USGS study period averaged 8.63bn barrels per year as opposed to an annual 21.6bn barrels that would need to have been discovered each year for the original USGS 2000 mean estimate for world discoveries (excluding the United States) to be realised. In other words, actual discoveries were fully 60% below the USGS mean estimates.[‡]

If the reduced average annual discovery rate of 8.63bn barrels were to continue over the entire 30-year study period (a perhaps generous assumption, given the rate of decline of annual global discoveries since the 1960s), world discoveries of conventional crude oil (excluding the United States) to 2025 would be limited to approximately 259bn barrels. This outcome is significant in that it is in close proximity to the USGS' much lower original 95% higher confidence level world discoveries (excluding the United States) estimate of 334bn barrels. This suggests that the USGS original high-confidence 95% projection was a reasonable assessment of the likely rate of future discoveries over the 30 year projection range of the study. In turn, it also further demonstrates just how much the IEA had presented an over-inflated projection for future discoveries as a likely outcome.

Given well-publicised concerns about future oil production, and that the USGS update paper was published prior to the launch of the *WEO-2005* report, why did the IEA not assume a more precautionary approach to the original USGS 2000 study data? When asked why the IEA's *WEO-2005* report did not appear to have incorporated the update comments of the USGS geologists, the IEA responded, "*The USGS has not yet updated its global estimate of total ultimately recoverable resources (URR)* [This is the total amount of oil expected to be found that can be extracted]. *There was no reason (and no basis on which) to make adjustment to the figure for URR, as the disappointing rate of discoveries does not mean that the oil will never be found*."[157] This response is interesting because it appears to suggest that unless the USGS were to provide a formal update report, perhaps along the lines of a new full world geological survey, the IEA was prepared to ignore key real-world events. As for the point that a low level of discoveries does not imply that the oil will never be found – the key question here is surely whether it is at all likely to be found during the remainder of the projection period.

In a presentation in 2007, oil industry executive Ray Leonard gave an insight into industry estimations of likely future discoveries, in comparison with the USGS mean estimates.[159] Senior oil industry executives, including Leonard, met and discussed, amongst other issues, their thinking about potential future oil discoveries at a November 2006 private industry meeting, known as the Hedberg conference. According to Leonard, the industry representatives presented discoveries data, drawn from both their own exploration experience between 2000 and 2005, and internal company data. Leonard summed up the comparison between industry views and the USGS mean estimate in a slide, reproduced here as *Figure 6*, which shows industry estimates of potential discoveries in selected regions. For each region, the industry view was significantly lower than the USGS 2000 study mean estimate. According to Leonard, company thinking about future discover-

* The 2005 update paper by the USGS geologists, compared actual world conventional oil discoveries, excluding those in the United States and excluding NGLs, for the period 1995 to end 2003; slightly shorter than the first third of its original 2000 study projection period.

† The geologists stated, "*The new discoveries are reported to contain about 69bn bbl of oil… as of December 2003,*" continuing, "*… these data indicate that only 11% of the estimated undiscovered oil & resources were discovered in just under 27% of the forecast span.*"

‡ 8.63bn barrels is the average actual rate of discovery over these first 8 years. 21.6bn barrels is the average annual discovery rate that would be required for the USGS 2000 mean estimate for world (excluding the United States) conventional discoveries, at 649bn barrels, to be achieved.

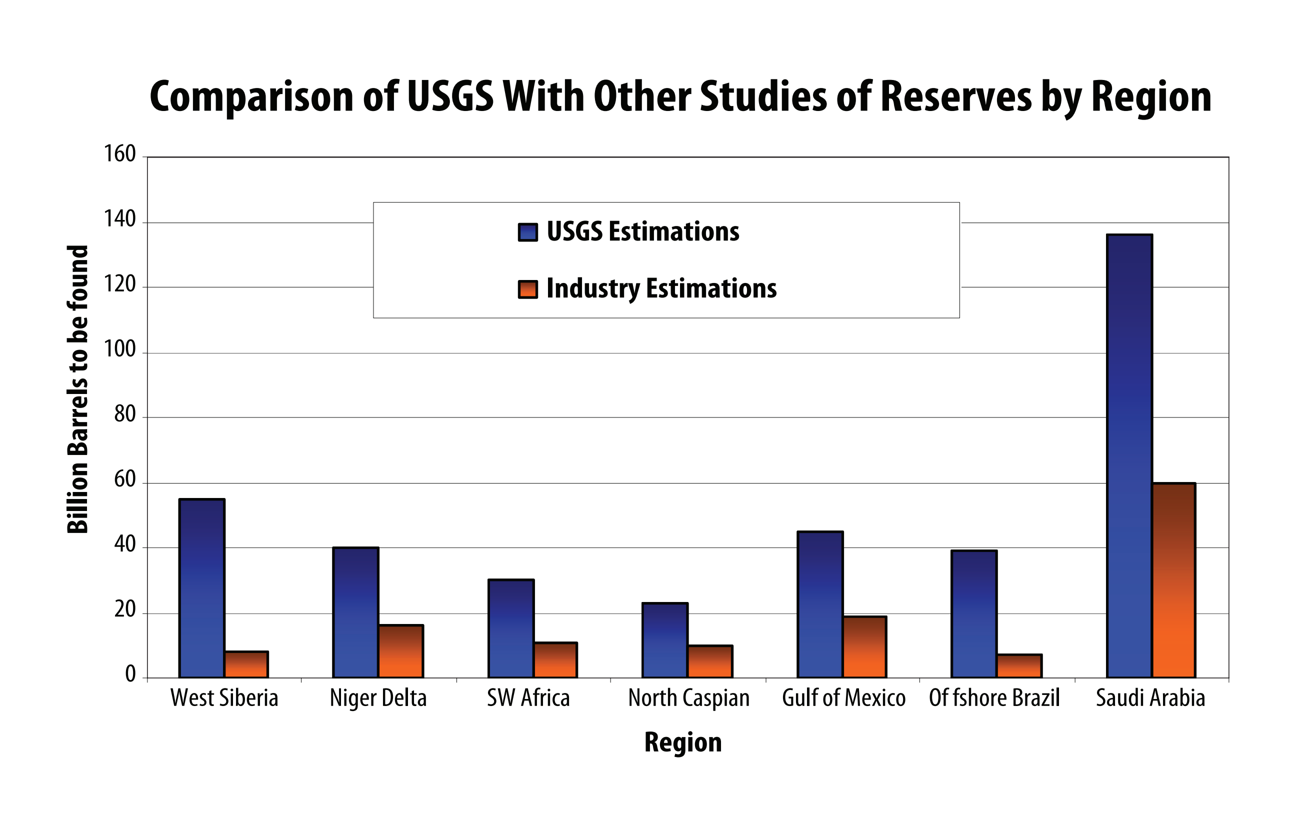


Figure 6: **A comparison of USGS reserves estimations (USGS 2000 study) and industry estimates based on actual discoveries (2000-05) and internal industry proprietary data – with thanks to Ray Leonard, adapted from his presentation on Hedberg conference conclusions in Cork, September 2007.**[158 §]

ies indicated a more likely 200bn-300bn barrels of overall discoveries in the period to 2025[160] – a figure which lies within close proximity to the higher probability USGS 95% confidence estimate of 334bn barrels for conventional crude oil (excluding the United States).

To sum up, it seems likely, that had the IEA taken a precautionary approach to the reported actual discoveries data provided in both the USGS 2005 update document, together with its own internal knowledge of actual discoveries, it would have drastically reduced its projection of future likely discoveries in 2005. But even in 2002, had the IEA compared actual world discovery rates with the rate that would be required to produce the USGS' mean estimate for discoveries (which the IEA projected as a likely outcome), they would surely have noted the folly of their projections.

The combined impact of governments being "asleep at the wheel," together with intellectually lame thinking about projections that should have caused alarm, has led to the world losing the best part of a decade where action could have been taken to move on from oil. The concern now is that instead of an ordered, though difficult to achieve transition out of the oil age, which according to some experts is likely to require 10-20 years,[161] this transformation could be forced on humanity with potentially hugely negative consequences.

§ Ray Leonard, now CEO of the oil and gas exploration company, Hyperdynamics Corp, was formerly Vice-President Exploration and New Ventures for Yukos; though now defunct, Yukos was formerly Russia's most successful private oil company.

Visionary leadership could put men on the moon, but its absence has been a disaster for the earth's climate. When will governments finally acknowledge the imminent oil crunch?


© NASA

Conclusion

THIS REPORT HAS SOUGHT TO DEMONSTRATE THAT THE FOUR underlying fundamentals of oil field depletion, declining discovery rates, insufficient new projects, and increasing demand, though obvious for a long time have not been acknowledged, or acted upon, by virtually any governments with a few notable exceptions. This failure has resulted in a lost decade, with the potential for very serious social and geopolitical consequences from the inability of oil supply to keep up with global demand. In reality there has been a double loss, whereby a proper understanding of the scale and imminence of the oil supply crunch could have injected a sense of urgency to the desperately slow pace and inadequate ambition of governments in the international negotiations to address the climate crisis.

This report has also sought to clarify how the IEA has overstated the significance of data about possible future discoveries, which in turn has led to a misleading overconfident interpretation of future oil availability. The consequence has been a failure by governments to put in place adequate alternatives, as borne out by future projections for increased demand for oil, not to mention other fossil fuels.

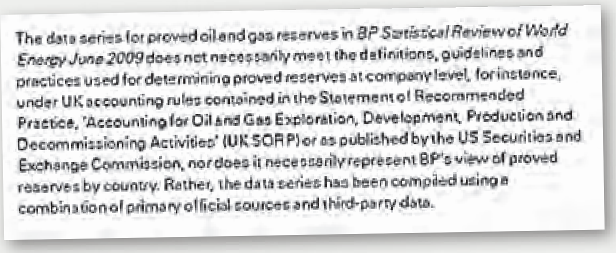
The main recommendation of this report is that individual governments need to officially recognise the scale and imminence of an oil crunch. This is a necessary first step because without a comprehensive acceptance within each government that there is a problem, it is hard to envisage how progress can be made to address it. Individual governments have an overwhelming responsibility to their present and future citizens to take urgent action. It is therefore imperative that any resultant international agreements or negotiations about energy do not delay work to mitigate the consequences of a decline of available oil. Though the collective record in addressing the climate crisis to date has been disastrously inadequate, the likely rate of decline in available supplies of oil is a game-changer. This is because governments and politicians, possibly within election cycles, are likely to have to deal with the fallout. The data presented in this report shows that "business-as-usual" is not possible, and therefore a radically increased pace of change is required to deliver safe and sustainable global energy systems.

Appendix A detailed analysis of a range of the IEA's 2002-2007 WEO statements

Introduction

This appendix provides a more detailed look at the IEA's data presentation in its *World Energy Outlook (WEO)* reports for 2002, 2005, 2006 and 2007. The concern here is the way in which the IEA chose to present its findings, and its associated commentary, as these have played such a key role in creating misapprehension about international security of future supplies of oil.

Global Witness has focused on the work of the IEA because it is the leading international energy policy and information agency. There are a number of other authoritative sources of energy data, including the US Government's Department of Energy (DoE) Energy Information Administration (EIA), and BP's annual Statistical Review. Global Witness has not focused on the work of the EIA because it is part of the US Government. In the case of BP, they like to claim that their Statistical Review "*. . . has established a reputation as one of the most reliable sources of objective energy data worldwide*."[162] But as pointed out by Jeremy Leggett in his book Half Gone: "*The first hint that something might be amiss comes, as is so often the case in life, in the small print. . . You will find that the data in BP's own report are not BP's at all.*"[163] BP caveats its Statistical Review, stating that the data provided "*. . . does not necessarily represent BP's view of the proved reserves by country.*"[164]


The data series for proved oil and gas reserves in *BP Statistical Review of World Energy June 2009* does not necessarily meet the definitions, guidelines and practices used for determining proved reserves at company level, for instance, under UK accounting rules contained in the Statement of Recommended Practice, 'Accounting for Oil and Gas Exploration, Development, Production and Decommissioning Activities' (UK SORP) or as published by the US Securities and Exchange Commission, nor does it necessarily represent BP's view of proved reserves by country. Rather, the data series has been compiled using a combination of primary official sources and third-party data.

BP's 2009 caveat in "small print", from its 2009 Annual Statistical Review.[165]

Throughout the series of *WEO* reports from 2002-2006, the IEA's use of language and presentation imparts a vision of future oil supply abundance. This fits neatly with the IEA's persistent suggestion that the escalation of global energy demand will be dominated by fossil fuels. For example, in the Executive Summary of the *WEO-2002* report, the IEA states that, "*. . . energy use continues to grow inexorably, fossil fuels continue to dominate the energy mix . . .*".[166] Whilst the repeated reference to the continued domination of fossil fuels may reflect the reality of the energy mix at the time of publishing, it is problematic because the repetition of a fossil-fuel dominated future could be seen as a self-fulfilling prophecy. Paradoxically the Agency established to address the consequences of oil shocks has reinforced the global reliance on oil and only very late in the day has it recognised the next looming oil shock.

In each of these *WEO* reports, both a "*Reference Scenario*" and an "*Alternative Scenario*" are provided. The former is the IEA's view about likely demand and production potential, assuming that existing laws, government strategies and projects at that time continue as planned. The latter provides an alternative outcome, should various criteria be changed. Global Witness' analysis focuses on the "*Reference Scenarios*", because these are what the IEA considered a potential outcome with a continuity of business as usual, as defined by the policies and practices at that point in time.

WEO-2002

"Oil resources are ample."

The WEO-2002 report in its "*Key Assumptions*", on page 40, includes a caveat about future energy demand, "*the energy projections in this outlook are highly sensitive to the underlying assumptions about macroeconomic prospects*".[167] Setting out its energy projections to 2030, the document continues: "*Fossil fuels will remain the primary sources of energy, meeting more than 90% of the increase in demand. Global oil demand will rise about 1.6% per year, from 75m b/d in 2000 to 120m b/d in 2030.*"[168] It states: "*Oil resources are ample,*" and "*Most of the projected 60% increase in global oil demand in the next three decades will be met by OPEC producers, particularly those in the Middle East.*"[169]

The "*Oil Market*" section provides further detail about the IEA's assertion of the continued ability of the Middle East to meet the projected increase in demand. Page 96 contains a table showing data for expected production, suggesting that output from Middle East OPEC countries alone would increase by 145% on top of existing production. Output would rise from 21m bpd to 51.4m bpd between 2000 and 2030.[170] Though the report queries the likelihood of sufficient timely investment to maximise output in Middle East OPEC countries, it does not appear to question the almost incredible notion that these countries, even with maximum investment, could find and put into production sufficient new resources to both offset depletion in existing fields and still achieve such a vast increase. Such a large projected increase in production seems quite a challenge, given the unverified and massive increases in stated OPEC reserves during the 1980s (see *OPEC's Phantom Barrels*).

The February 2003 meeting of the *UK-US Energy Dialogue*, between the two governments, is an example of how the IEA's projections are very influential. Documents obtained by the UK newspaper *The Guardian* under US Freedom of Information laws show that the meeting discussed world oil demand reaching 120m bpd by 2030, and it concluded: "*To meet future world energy demand, the current installed capacity in the Gulf (currently about 23m bpd) may need to rise to as much as 52m bpd by 2030.*"[171] Note the similarity between these figures and those in the *WEO-2002* above.

WEO-2005

"Global oil production is not expected to peak before 2030."

By 2005, in the post-Iraq invasion world of escalating threats against Iran, the oil price had increased 100% since 2002. Meanwhile, global spare production capacity, necessary to protect against unexpected production problems, had plummeted from a 2002 high of roughly 6m bpd, to little more than 1m bpd.[172] Global oil production was clearly not keeping up with depletion and increased demand. Despite these changes to the oil market, the *WEO-2005* continued the Agency's confident line on the resource base. For example, page 89 provides the assurance: "*Global oil production is not expected to peak before 2030.*"[173]

The *WEO-2005* reinforces its confident outlook about future production in the section "*Resources and Production Potential*". The Agency states, "*The US Geological Survey estimates that worldwide 'ultimately recoverable resources' of conventional oil and NGL total 3,345bn barrels*".[174] Given that world production to date [2005] stood at 1,045bn barrels, the reader is thus informed that the world can look forward to an additional 2,300bn barrels of production. Of this 2,300bn barrels, the IEA suggests that nearly 40% [or 883bn barrels] will be obtained from yet-to-be-discovered resources.[175] But, as already discussed in Section 4, the IEA's use of the USGS' mean estimate for future discoveries [883bn barrels – later reduced in 2006 to 880bn barrels] is highly unlikely. Nevertheless, the way in which the data is used, especially in the table, gives the reader the impression that future world oil production is likely to amount to a further 2.2 times the volume of oil that has been produced and consumed to date. This is an example of how false confidence about future oil abundance has developed.

WEO-2006

"2,300bn barrels… more than twice the volume […] so far produced."

The *WEO-2006* remained bullish about projections of future supply, though it began with a cautionary note: "*The energy future which we are creating is unsustainable. If we continue as before, the energy supply to meet the needs of the world economy over the next twenty-five years is too vulnerable to failure from under-investment, environmental catastrophe or sudden supply interruption*".[176] This is a powerful warning, especially as it comes in the first paragraph of the *WEO-2006* foreword, written by the IEA's then Executive Director, Claude Mandil. The tone appears reflective of prevailing concerns about the failure of the global oil industry to raise production, despite increased demand, a rising oil price and significant increased investment. But it does not highlight the underlying fundamental problems of aging oil fields and decreasing discoveries.

Later in the foreword, Mandil states: "*The International Energy Agency does not hold out any of the scenarios depicted here as* ***forecasts*** [IEA emphasis] *of the energy future*." He continues: "*But they are reliable indications of what the future* ***could be*** [IEA emphasis] *on the given assumptions.*"[177] Following this, in a confident tone, the IEA again cites the 2000 USGS study: "*According to the US Geological Survey, undiscovered conventional resources that are expected to be economically recoverable could amount to 880bn barrels (including natural gas liquids, or NGLs) in its mean case… Together with reserves growth and proven reserves, remaining ultimately recoverable resources are put at just under 2,300bn barrels.* That is more than twice the volume of oil – 1,080bn barrels – that has so far been produced.*"[178] Note here that although the IEA mentions that the figure for undiscovered reserves is the USGS' mean estimate (880bn barrels), the construction of the rest of the sentence leads the reader to conclude that the overall total of 2,300bn barrels is a likely outcome. Once again, this is how false confidence has developed. As noted before, is the fact that during 2005, the USGS had published an update document showing that actual new discoveries were trailing their 2000 estimate for new discoveries by approximately 60%.

Thus, despite the caveats, the message to the reader is that the IEA's "scenarios" are *de facto* forecasts, predicated on the assumption of continuity of existing government policies and plans at that time. Overall, the *WEO-2006* "forecasts" that increased demand for oil would need total world production to reach 116m bpd by 2030 – a 4m bpd drop from the IEA's 2002 estimate.[179] This supply would be forthcoming, the IEA reassured its readers, thanks in part to the abundance of resources demonstrated by its interpretation of USGS data, and to the assumption that producer countries would rise to the challenge by increasing their output.

* Although these figures can be confusing, note that the 2,300bn barrels cited by the IEA in 2006 is the Agency's projection for potential oil which is yet to be produced: from both known reserves and the Agency's interpretation of the volume of oil that is yet to be discovered. The Agency's 2005 figure for URR (see discussion in *WEO-2005*) at 3,345bn barrels consists of 2,300bn barrels of oil which is yet to be produced, together with the volume of oil which had already been produced by that point in time, which stood at 1,045bn barrels [by 2006, the produced volume of oil had risen to 1,080bn barrels].

WEO-2007

"It is possible that the supply crunch could be deferred, but not by much."

By July 2007, however, the IEA's optimistic stance had begun to wobble. "*Despite four years of high oil prices, this report sees increasing market tightness beyond 2010, with OPEC spare capacity declining to minimal levels by 2012*," was its mid-year warning. And then: "*It is possible that the supply crunch could be deferred, but not by much*."[180] As the oil price continued its relentless upward trajectory, the IEA finally appeared to be in the throes of a rethink. But by November, in its *WEO-2007* the Agency pulled back a little from its mid-year warning about a post-2012 oil crunch, though it continued to refer to a likely energy "*crunch*" by 2015.[181] These differences might reflect the fact that the IEA's *WEO* series and its medium-term *Oil Market Reports* are produced by different teams, but there is nevertheless little room for comfort from this three-year deferment.

Despite the heightened concern, the IEA continued to try and hold the line that the resource base was not at issue, instead suggesting that if the correct policies and sufficient investment streams were made available, that these potential problems could be overcome. In this way, global oil production could be increased from the 2007 output of 84.6m bpd to approximately 116m bpd by 2030.[182,183]

The more overt references to the USGS 2000 study in the IEA's previous *WEO* reports seemed to have been dropped. Instead, the IEA reassured its readers with: "*World oil resources are sufficient to meet the projected growth in demand to 2030*."[184] The discussion continued with the suggestion that OPEC, commensurate with its share of remaining global reserves, would increase production from "*36m b/d in 2006 to 46m b/d in 2015 and 61m b/d in 2030*".[185] The Agency caveated these estimates with the statement, "*The Outcomes depend critically on investment and production policies in key OPEC countries.*"[186] However, it justifies the estimates by referring to its *WEO-2005* report, which as previously noted, relies on its interpretation of the USGS 2000 study.

Nevertheless, reading between the lines, and despite the IEA's continued assurances about the resource base, the Agency's 2007 stance appeared increasingly to question its previous confidence about future production potential. Occasionally, the reader gets an insight: "*The prospects for net installed capacity and, therefore, the oil supply/demand balance are very sensitive to future decline rates*."[187] It continues: "*In total, 37.5m b/d of gross capacity (including that needed to compensate for natural declines)* [the IEA estimated that the global mean decline rate was 3.7% in 2007] *needs to be added between 2006 and 2015. But decline rates may, in fact, turn out to be somewhat higher. An increase of a mere 0.5 percentage points in the average observed decline rate would lead to a cumulative shortfall in capacity growth of 2.6m b/d by 2015 enough to eat up most of the world's current spare oil production capacity of around 3m b/d*."[188]

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Global Witness investigates and campaigns to prevent natural resource-related conflict and corruption and associated environmental and human rights abuses.

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"There is a direct relationship between the price of energy and tyranny in oil-producing countries – tyranny historically supported by other (mainly Western) countries hungry for the oil produced there. One way to get unstuck from the tar-baby of the world's most trouble-producing regions is therefore to find, and to find fast, alternatives to oil. It might seem remarkable to detached observers that this process, only just now beginning, did not happen after the dramatic and world-destabilising oil price rise of the early 1970's. But one has only to think of the oil wells, the fleets of ocean-going tankers, the refineries, the vast networks of distribution and hundreds of thousands of petrol stations all over the world, to see what a weight of investment keeps the world at war; not just to sustain the oil companies' returns on their investments, but to keep turning the very wheels of economic life on which all – each one of us – depends. Thus considered, it would seem that the first urgency is to find other ways of powering our factories, homes, cars and lives, to free us from the place where a deeply unhappy mixture of fundamentalist religion and rich-poor power inbalances is as volatile and explosive as the substance it feeds on."[190] A.C. Grayling, from *Liberty in the Age of Terror*, June 2009.

War over oil
the shape of things to come...

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Glossary

Bn Billion
CCS Carbon Capture and Storage (aka Carbon Capture and Sequestration).
EIA Energy Information Administration, a division of the US Government's Department of Energy (DoE).
EOR Enhanced Oil Recovery
EROI Energy Return on Investment.
GDP Gross Domestic Product
GHG Greenhouse Gas
Gt Gigatonne (billion tons)
Homo petroliensis A recently evolved sub-division of *Homo sapiens*. This species is entirely dependent on oil and its products, but its prognosis as the dominant species is shrinking fast.
IEA International Energy Agency
IOC International Oil Company
LNGs Liquified Natural Gas
m bpd Million barrels per day (others use Mb/d).
NGLs Natural Gas Liquids. The bulk of NGLs are short-chain hydrocarbons.
NOC National Oil Company
OPEC Organization of the Petroleum Exporting Countries
ppm Parts per million
Reserves The volume of oil that can be extracted
Resources The volume of oil in the ground
UNFCCC United Nations Framework Convention on Climate Change
URR Ultimately recoverable resources

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