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What they don't want you to know about the coming oil crisis

Soaring fuel prices, rumours of winter power cuts, panic over the gas supply from Russia, abrupt changes to forecasts of crude output... Is something sinister going on? Yes, says former oil man Jeremy Leggett, and it's time to face the fact that the supplies we so depend on are going to run out

By Jeremy Leggett

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A spectre is haunting Europe - the spectre of an acute, civilisation-changing energy crisis. The latest wobble over disruptions to gas supplies from Russia is merely the latest in a series of reminders of how dependent our economies are on growing supplies of oil and gas. On Wednesday, Gazprom's deputy chairman was in London reassuring Britain that there would be no risk of disruption to British gas supplies in the fall-out from the ongoing spat between Russia and Ukraine over pricing. The very next day, temperatures in Moscow broke a 50-year record, plunging to minus 30C. Gas normally exported was diverted to the home front. Supplies to the West fell.

In December, Sir Digby Jones, director-general of the CBI, warned that any shortfall in gas could cause disaster for British industry. The problem, he said, was the likelihood - as forecast by the Met Office - of a particularly cold British winter. This would mean more gas burning in homes and power plants than our liberalised energy market - or its infrastructure - might be able to supply. There aren't enough pipelines from the continent to carry the imported gas that we need now that our North Sea production is dropping. Tankers that are supposed to be bringing liquefied natural gas (LNG) to the UK are instead following market forces and going to the US, where gas prices have rocketed even higher than they have here. Meanwhile, not enough gas has been stockpiled, because market forces don't favour that kind of thing in relatively warm years.

We shouldn't panic, insisted energy minister Malcolm Wicks, because British Gas is being very grown up about it, and anyway all this will be sorted out by 2007 when a new pipeline and more LNG plants come on stream. Sceptics pointed out that our gas reserves were down to 11 days, compared with an average of 55 on the Continent. That was before the concerns about Russian supplies. If the thermometers fall in the UK it is still quite possible that UK firms may have to stop using gas for one day a week, or even that the suppliers will also have to introduce rolling power cuts by postcode.

Meanwhile, domestic gas bills, which rose by more than a third last year, are expected to rise even higher in the next few months. For many people, such fluctuations have lethal implications. Last winter, there were some 35,000 "excess winter deaths" in the UK, most of them attributable to old people not being able to keep warm enough; and last winter was a relatively mild one.

All this concerns gas, of which there are undoubtedly huge proved reserves left in the ground (even if half of them are in Russia and Iran). Consider oil. The geopolitical risks are the same. Only last week Iran threatened to retaliate by cutting oil supplies if Europe continued to meddle in what it sees as its right to develop a nuclear programme. Where oil differs from gas is that a debate is fast

emerging about whether we have enough reserves to meet needs in the short term - even if geopolitics don't kick in and the current infrastructure keeps working as it should. At the annual summit of the Organisation of the Petroleum Exporting Countries (Opec) in December, Kuwait told the world that, without urgent outside help, it could not continue to pump oil at its customary rate. The Kuwaiti oil minister invited Western oil companies back into his country to see if they could do better. The very next day the US government quietly slashed 11 million barrels a day (that's equivalent to the entire daily output of Saudi Arabia) from its forecast of oil production levels for 2025.

To most people who noticed them, such announcements will have seemed remote and academic. In fact, as I shall attempt to explain, they represent the tip of a very big iceberg indeed: one that holds the potential to sink the global economy.

We have allowed oil to become vital to virtually everything we do. Ninety per cent of all our transportation, whether by land, air or sea, is fuelled by oil. Ninety-five per cent of all goods in shops involve the use of oil. Ninety-five per cent of all our food products require oil use. Just to farm a single cow and deliver it to market requires six barrels of oil, enough to drive a car from New York to Los Angeles. The world consumes more than 80 million barrels of oil a day, 29 billion barrels a year, at the time of writing. This figure is rising fast, as it has done for decades. The almost universal expectation is that it will keep doing so for years to come. The US government assumes that global demand will grow to around 120 million barrels a day, 43 billion barrels a year, by 2025. Few question the feasibility of this requirement, or the oil industry's ability to meet it.

They should, because the oil industry won't come close to producing 120 million barrels a day; nor, for reasons that I will discuss later, is there any prospect of the shortfall being taken up by gas. In other words, the most basic of the foundations of our assumptions of future economic wellbeing is rotten. Our society is in a state of collective denial that has no precedent in history, in terms of its scale and implications.

Of the current global demand for oil, America consumes a quarter. Because domestic oil production has been falling steadily for 35 years, with demand rising equally steadily, America's relative share is set to grow, and with it her imports of oil. Of America's current daily consumption of 20 million barrels, 5 million are imported from the Middle East, where almost two-thirds of the world's oil reserves lie in a region of especially intense and long-lived conflicts. Every day, 15 million barrels pass in tankers through the narrow Straits of Hormuz, in the troubled waters between Saudi Arabia and Iran. The US government could wipe out the need for all their 5 million barrels, and staunch the flow of much blood in the process, by requiring its domestic automobile industry to increase the fuel efficiency of autos and light trucks by a mere 2.7 miles per gallon. But instead it allows General Motors and the rest to build ever more oil-profligate vehicles. Some sports utility vehicles (SUVs) average just four miles per gallon. The SUV market share in the US was 2 per cent in 1975. By 2003 it was 24 per cent. In consequence, average US vehicle fuel efficiency fell between 1987 and 2001, from 26.2 to 24.4 miles per gallon. This at a time when other countries were producing cars capable of up to 60 miles per gallon.

Most US presidents since the Second World War have ordered military action of some sort in the Middle East. American leaders may prefer to dress their military entanglements east of Suez in the rhetoric of democracy-building, but the long-running strategic theme is obvious. It was stated most clearly, paradoxically, by the most liberal of them. In 1980 Jimmy Carter declared access to the Persian Gulf a national interest to be protected "by any means necessary, including military force". This the US has been doing ever since, clocking up a bill measured in the hundreds of billions of dollars, and counting. With such a strategy comes a disquieting descent into moral ambiguity, at least in the minds of something approaching half the country. The nation that gave the world such landmarks in the annals of democracy as the Marshall Plan is forced by deepening oil dependency into a foreign-policy maze that involves arming some despotic regimes, bombing others, and scrabbling for reasons to make the whole construct hang together.

America is not alone in her addiction and her dilemmas. The motorways of Europe now extend from Clydeside to Calabria, Lisbon to Lithuania. Agricultural produce that could have been grown for local consumption rides along these arteries the length and breadth of the European Union. The Chinese attempt to emulate this model even as they enforce production downtime in factories because of diesel shortages and despair that their vast national acreage seems to play host to so little oil.

There is a similar picture with gas. The scale of the addiction - and of the resource - is smaller. But the patterns are the same: growing demand for a finite resource, most of which has to be imported from the Middle East and the former Soviet Union. Even a temporary blip in supply, such as occurred in Europe this week, is enough to create something close to panic among governments. But it is oil that keeps our civilisation functioning.

This half-century of deepening oil dependency would be difficult to understand even if oil were known to be in endless supply. But what makes the depth of the current global addiction especially bewildering is that, for the entire time we have been sliding into the trap, we have known that oil is in fact in limited supply. At current rates of use, the global tank is going to run too low to fuel the growing demand sooner rather than later this century. This is not a controversial statement. It is just a question of when.

Oil is a finite resource, and there will come a day, inevitably, when we reach the highest amount of oil that can ever be pumped. Beyond that day - which we can think of as the topping point, or "peak oil" as it is often called - will lie a progressive overall decline in production. Putting the same question a different way, then, at the current prodigious global demand levels, where does oil's topping point lie?

This is a question, I contend, that will come to dominate the affairs of nations before this first decade of the new century is

out.

Already, a battle is raging, largely behind the scenes, about when we reach the topping point, and what will happen when we do. In one camp, those I shall call the "late toppers", are the people who tell us that 2 trillion barrels of oil or more remain to be exploited in oil reserves and reasonably expectable future discoveries. This camp includes almost all oil companies, governments and their agencies, most financial analysts, and most business journalists. As you might expect, given this line-up, the late toppers hold the ascendancy in the argument as things stand.

In the other camp are a group of dissident experts, whom I shall call the "early toppers". They are mostly people who - like me - have worked in the heart of the oil industry, the majority of them geologists, many of them members of an umbrella organisation called the Association for the Study of Peak Oil (ASPO). They are joined by a small but growing number of analysts and journalists. The early toppers reckon that 1 trillion barrels of oil, or less, are left.

In a society that has allowed its economies to become geared almost inextricably to growing supplies of cheap oil, the difference between 1 and 2 trillion barrels is seismic. It is roughly the difference between a full Lake Geneva and a half-full one, were that lake full of oil and not water. If 2 trillion barrels of oil or more indeed remain, the topping point lies far away in the 2030s. The "growing" and "cheap" parts of the oil-supply equation are feasible until then, at least in principle, and we have enough time to bring in the alternatives to oil. If only 1 trillion barrels remain, however, the topping point will arrive some time soon, and certainly before this decade is out. The "growing" and "cheap" parts of the oil-supply equation become impossible, and there probably isn't even enough time to make a sustainable transition to alternatives.

Should the early toppers be right, recent history provides clear signposts to what would happen. There have been five price peaks since 1965, all of them followed by economic recessions of varying severity: after the 1973 Yom Kippur War; in 1979-80 after the Iranian revolution and the outbreak of the Iran-Iraq war; in 1990, with the first Gulf War; in 1997, with the Asian financial crisis; and in 2000, with the dot.com collapse. The most intense peaks were the first two. In 1973, the oil price more than doubled, reaching around $35 per barrel in modern value. The cause was an embargo by Opec, led by Saudi Arabia, and triggered through overt American support for Israel at the time of the Yom Kippur War. World oil supplies fell only 9 per cent, and the crisis lasted only for a few months, but the effect was simple and memorable for those who lived through it: widespread panic.

The embargo was short-lived, largely because the Saudis feared that if they kept it up they would create a global depression that would cripple Western economies, and hence their own. As it was, the short embargo created an economic recession. I spent much of it doing my homework by candlelight. I didn't see much of my father. He was queuing for petrol.

The second, and worst, oil shock was triggered by the toppling of the Shah of Iran in 1979, and prolonged by the outbreak of the Iran-Iraq War in 1980. The first shock did not push prices as high as those at the time of writing, but the second shock pushed them to more than $80 a barrel in today's terms. Again panic reigned, even though the interruption to global supplies was only four per cent.

The crisis ended in 1981 when the price fell for three main reasons. First, the Saudis opened their taps. With their huge reserves, mostly discovered in the 1940s and 1950s, they were able to act as a "swing producer", increasing the flow to bring prices down just as they had decreased it in 1973 to push prices up. Second, new oil came onstream from giant oilfields in more stable regions of the globe, including the North Sea. Third, large amounts of oil were released from government and corporate stockpiles.

These three reasons are high on the list of why we should worry today, because in the face of another shock things could not be resolved in a similar way. First, there are grounds to worry that the Saudis are pumping at or near their peak, no longer able to act as a swing producer. Second, the early toppers fear that there are no more giant oilfields left to find, much less wholly new oil provinces like the North Sea. Third, there is not much oil in storage, relative to current demand. The modern world works on the principle of just-in-time delivery (another factor in the short-term crisis facing Britain this winter). Our economies, overall, are more efficient in their use of oil than in the 1970s - a point much emphasised by late toppers - but the sheer weight of demand is much higher today, and it is still growing without an end in sight, or even strong governmental or corporate leadership demands that there should be one.

The cost of extracting a barrel of oil from the ground doesn't change much. A good rule of thumb might be $5 a barrel today, though obviously there are variations between oilfields in different geographic and political settings. What influences the price of oil most is confidence in supply and demand among oil traders. Oil prices are already at their second highest levels ever, in real terms, at the time of writing. Some pundits now profess that they will soon reach their highest ever levels, in modern value. This situation has arisen for many reasons - but these do not include the fear that the oil-production topping point is near. Early-topper arguments are not on the radar screens of the oil traders and analysts, as things stand. Should that happen, and should the mood of the packs on the trading floors flip to the view that we live no longer in a world of growing supplies of oil, but rather shrinking ones, the price will soar north of $100 a barrel very quickly.

An investor friend of mine has already concluded that this scenario is inevitable. He has switched his investment portfolio to anticipate the moment of "market realisation". This peak panic point, as he calls it, will not be limited to oil traders. The worlds of economics and business routinely assume a future in which oil is in growing and cheap supply.

Economists tend to assume that their "price mechanism" will apply. Higher prices will lead to more attractive conditions for exploration. This will lead to more oil being found, and the inevitable discoveries will bring the price down until the next cycle.

Massive corporations write five-year plans based on assumed access to cheap oil and gas. Think, for example, how important such access must be to a chemical company dealing in plastics derived from oil. Or a food-processing company reliant on oil for every stage of food transportation, including of perishable final products, plus almost all the bottling and packaging and many of the preservatives and additives.

But suppose the economists and corporate planners are wrong? Imagine the collapse of confidence when a critical mass of financial analysts, across the full breadth of sectors in a stock exchange, conclude that they are wrong?

If the topping point is indeed imminent, economic depression looms as a real prospect. The Saudis were right to be scared of this possibility in the 1970s. In the Great Depression of the 1930s, triggered in 1929 by the worst-ever stock-market crash, economic hardship was horrific. World trade fell by a breathtaking 62 per cent between 1929 and 1932. The widespread unemployment and social unrest bred Fascism in many countries, in some nations on a scale that would change the course of history. As for the stock markets, it took them 50 years to regain their pre-collapse value in real terms.

There are so many things to worry about in the fall-out from a premature peak in oil production. Here is one that gives me particular nightmares. When I and some of the oil-supply whistleblowers addressed a conference on oil depletion in the formerly oil-rich nation known as Scotland last year, five leaders of the British National Party sat in the audience. They said nothing. They just listened, and learnt, and no doubt reflected that the far right does well in tough times.

The stakes are high with energy policy. Higher than most people dream of when they flip a light switch.

The question of how much oil is left actually breaks down into three sub-questions. First, the existing-reserves question: how much oil is there in discovered oilfields, mapped out, proved and ready to be exploited? Second, the reserves-addition question: how much oil remains to be added via new discoveries, enhanced recovery techniques and so called unconventional oil? Finally, the speed-to-market question: how fast can the oil, once found, be delivered to fuel tanks?

One also needs to consider these questions both in relation not only to conventional oil - that is, liquid that sits underground in a reservoir under pressure - but also unconventional oil (which consists of sands and shales containing solidified oil or solid tar or bitumen deposits; is mostly found in Canada, the United States and Venezuela; and carries considerable environmental extraction costs). The same applies, strictly speaking, to deep water oil (much-hyped by Exxon a few years ago but already widely thought to have peaked) and gas, whose patterns of availability tend to mirror those of oil, and which already faces its own problems of increasing consumption (gas demand is expected to double by 2030, reaching 4.3 billion tonnes of oil equivalent a year, of which over 40 per cent will be used for power generation).

I find it hard to feel optimistic about any of the answers.

I say this as someone who, for most of the 1980s, was a creature of Big Oil. I taught petroleum engineers and geologists at the grandiose-sounding but in fact quite tatty Royal School of Mines, part of Imperial College of Science and Technology in London. My researches on the history of the planet included such issues as the source of oil, and was funded by BP and Shell, among others. I also consulted for oil companies. In those days, I was psychologically insulated in a quest for the respect of my peer group, and highly selective as a consequence with the information I allowed on to my radar screen. The build-up of greenhouse gases (a separate but scarcely less urgent reason for worrying about our dependence on oil) registered nowhere on my list of concerns. I had concerns about oil depletion, but only in the sense that this cloaked my quest to find more with a certain nobility, at least in my own eyes.

But one thing that was clear to me even then was that most of the planet has not a drop of drillable oil. Almost everywhere geologists have looked - which means everywhere by now, at least at some level of exploration - there is no oil because one or more of the key geological requirements is missing. Even when all the boxes can be ticked, you can end up finding no oil. Only one well drilled in every 10 finds oil. Only one in a hundred finds an important oilfield. And the more wells that are drilled in a province or country, the smaller the oilfields generally tend to become.

In my book, Half Gone, I examine in detail the prospects of future viability for each of the major sources described above. But one of the most important arguments against over-confidence in future reserves can be summarised simply.

Think of all that expertise that had been built up since the first oil was drilled in 1859. Think of all the trillions of dollars in oil revenues stacked up in the 20th century, and all the hundreds of billions spent on exploration and the hi-tech toys of exploration in the half-century since the biggest Saudi and Kuwait fields were discovered. Think of the sophistication of the seismic reflection profiling offshore. Consider the all-important oil source rocks, and how relatively limited they are in distribution. As BP's former reserves co-ordinator, Francis Harper, told the Energy Institute in November 2004: "We know how many world class source-rocks there are, and where they are." Wouldn't it be reasonable to think that with modern technology at least one more field of more than 80 billion barrels might have been found somewhere, in all the places the companies have looked these last 50 years?

The third-biggest oilfield in the world is Samotlor, discovered in 1961, with 20 billion barrels. The fourth-biggest is Safaniya, discovered in 1951, at which time it also supposedly contained 20 billion barrels. The fifth-biggest is Lagunillas, discovered in 1926, containing 14 billion barrels. Only around 50 super-giant oilfields have ever been found, and the most recent, in 2000, was the first in 25 years: the problematically acidic 9-12 billion barrel Kashagan field in Kazakhstan.

Let us reduce our scale of scrutiny from the super-giant to the merely giant. Half the world's oil lies in its 100 largest fields,

and all of these hold 2 billion barrels or more, and almost all of them were discovered more than a quarter of a century ago. Consider the recent record of discoveries of giant oil- and gas-fields of over 500 million barrels of oil or oil equivalent. Half a billion barrels - the definition of a "giant" field - sounds a lot. But since the world is eating up more than 80 million barrels of oil a day at the moment, it is in fact less than a week's global supply. In 2000 there were 16 discoveries of 500 million barrels of oil equivalent or bigger. In 2001 there were nine. In 2002 there were just two. In 2003 there were none.

On the basis of this kind of evidence, is the industry going to meet the steady increase in demand with new discoveries? Francis Harper, for one, doesn't seem to think so. "Worldwide, the frequency of finding giant oil provinces and super-giant oilfields has been declining for decades and will not be reversed," he told an agog audience at a November 2004 London conference on oil depletion held in the Energy Institute. "We've looked around the world many times. I'd say there is no North Sea out there. There certainly isn't a Saudi Arabia."

In January 2004, the early toppers' case suddenly looked a good deal more worryingly feasible to those who have tended to take the late toppers at face value. Shell's then chairman, Sir Philip Watts, told investors that the company had overestimated its reserves by more than 20 per cent. By March, internal e-mails had been requisitioned by lawyers and these made it clear that the chairman and his head of exploration had known about this problem for some time, and had deliberately lied about it. Both men departed the scene.

Shell's corporate scandal is dramatic enough. But there is a clear risk that it is only the tip of an iceberg. Today, many people in the oil industry appear to be under pressure when it comes to supplies of oil. "There is something strange going on in this industry," Shell's replacement boss, CEO Jeroen van der Veer, told the press in November 2004. He suspects that other companies have the same problems he inherited. The Economist drew the following conclusion: "Industry analysts and investors are quietly saying that Mr van der Veer may be right, and another big reserves scandal may be brewing somewhere."

Against this unpromising start, how much oil do we think the oil companies have found to date? Call BP for a bit of help with the answer and you'll be sent their annual BP Statistical Review of World Energy. In it, you'll see lists of data for national proven oil reserves. Add these up to a global total of oil reserves year by year, and you'll see the total creep reassuringly upwards over time. The chart on page seven shows those figures, from successive annual reviews split into the Middle East and the rest of the world. Global reserves rise from just over 600 billion barrels in 1970 to almost double that today: 1,147 billion barrels at the last count, up to and including 2003.

So what's the problem? The first hint that something might be amiss comes, as is so often the case in life, in the small print. Squinting through a lens if you have anything but perfect eyesight, you will find that the data in BP's own report are not BP's at all. The estimates have been compiled using "a variety of primary official sources, third-party data from the Opec Secretariat", and a few other places completely removed from BP's headquarters in St James's Square with all its accumulated research and knowledge. Think how many libraries of understanding BP must have gathered in over a century of aggressive oil exploration and production all over the world. And yet all they offer us as a guide to our own understanding of how much "proved" oil reserves there are left on the planet is a compilation of other people's data. And much of that itself is secondhand.

After this revelation comes another. The small print continues: "The reserves figures shown do not necessarily meet the United States Securities and Exchange Commission definitions and guidelines for determining proved reserves, nor necessarily represent BP's view of proved reserves by country."

They don't even believe the figures they are publishing! Referee! This is a publication used as an energy bible by researchers the world over. Students quote it as whole truth in undergraduate essays. Journalists quote it as gospel in legions of articles. They don't insert caveats like this. Neither have they seen such caveats in earlier reports.

You might end up with a few questions for the authors of the BP Review at this point. But then, at the end of the document, we read the following: "BP regrets it is unable to deal with enquiries about the data in the Statistical Review of World Energy."

So what is BP's real view of "proved" reserves? Could it go something like this?

Looking closer at the chart and zooming in, you'll see that the figures show that global reserves of oil went up particularly quickly between 1985 and 1990 (a big black oily arrow indicates the point). There must have been some big new oilfields discovered then, right? Wrong. The actual new discoveries in that period were less than 10 billion barrels. But the Middle East nations hiked their "proved" reserves from already discovered oilfields by fully 300 billion barrels collectively in that period, professing one after another that their national calculations had all somehow hitherto been too conservative. Three hundred billion barrels is a lot of oil. It is more than a decade of demand at current levels.

Here's how it happened. In the 1950s, the nations with oil organised themselves into the cartel known as Opec. Opec's main aim was and is to try and control the price of oil. They don't want it too low. That would cut their income. Neither do they want it too high. That might get the addicts thinking of maybe going elsewhere. They want it just right, perhaps around $30 per barrel in today's money. To do this they can't produce too much, because that would flood the market, causing the price to drop. They have to produce exactly the right amount collectively, and that means quotas. After much bickering in the early days, the Opec oil ministers decided in 1982 to allocate a quota to each country in the cartel according to the size of its reserves.

But in 1985, they began to - how shall I put it? - massage the data. Kuwait was the first to give in to temptation. They found that their reserves had gone up overnight from 64 to 90 billion 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 92 billion barrels. They surely must have employed some incompetent geologists. How could they have overlooked 60 billion barrels? Finally, in 1990, Saudi Arabia decided it

too had been conservative, hiking its total from 170 to 258 billion barrels.

You can also see in BP's data that the Middle East's reserves have been almost constant in size since then. What you don't see in the figure - but do see in the data - is that this is apparently the case not just for the sum of the reserves of the Middle Eastern oil producers but also for the figures of reserves for the individual nations.

Consider the enormity of this coincidence. It means that the billions of barrels found in new discoveries each year would have to match exactly the billions of barrels produced each year in each of the Middle Eastern OPEC nations, and do so consistently every year for more than a decade.

BP's Statistical Review of Everyone's World Energy Statistics Except Their Own invites us to believe all this without comment from them or recourse to questions by us. We are left to look at the total figure they cite for "proved" reserves, 1.1 trillion barrels, and think to ourselves ... "Er, really?"

The early toppers have a different view. Being in most cases old hands from the oil industry, they know a thing or two about the games that go on in their industry. They estimate the total of proved reserves to be 780 billion barrels, some 300 billion barrels short of "BP's" figures. This is less than the world has produced since the first oil was struck over a century ago: 920 billion barrels by the end of 2003 (a figure about which there is somewhat less controversy).

Let us take some opinions that ought to be difficult to discount, one from the top of the oil tree in the US and two from the Middle East. The Houston-based energy investment banker Matthew Simmons has been one of George W Bush's energy advisers. He has studied reports by Saudi engineers showing that pressure is dropping in Saudi oilfields. The four biggest fields (Ghawar, Safaniyah, Hanifa, and Khafji) are all more than 50 years old, having produced almost all Saudi oil in the past half-century. These days, Simmons says, they have to be kept flowing largely by injection of water. This is of explosive significance, he argues. "We could be on the verge of seeing a collapse of 30 or 40 per cent of their production in the imminent future. And imminent means some time in the next three to five years - but it could even be tomorrow."

The Saudis dismiss this, claiming that they have slightly more than the 258 billion barrels of "proved" reserves they claimed they had in 1970, with lots more yet to be found, and that they can lift the current extraction rate of around 9.5 million barrels a day to more than 10 with little difficulty. As Nansen Saleri, Manager of Reservoir Management at Saudi Aramco, puts it: "... we have lots of oil, not only for our grandchildren but for the grandchildren of our grandchildren."

Saudi Aramco has the largest reserves of all the oil companies in the world: 20 times the size of ExxonMobil's, if they indeed have 260 billion barrels. They also have the lowest discovery and development costs, some 50 cents per barrel, or 10 per cent of what the private companies pay in Russia or the Gulf of Mexico. And, being state-run, without much need for debt, they are under no pressure to divulge much to the financial markets.

Lately, in the face of concerns about their ability to ramp up production, they have been marginally more open. They say they can maintain spare capacity of 1.5 to 2 million barrels per day and would be content with a fair price of $32-$34 a barrel. Aramco's geologists have insisted they can hike output to 15 million barrels a day (adding more than 5 million to the 9.5 million reported today); 5 million of which come from the giant Ghawar field alone. Contractors report that drilling activity is increasing, as it needs to, given the age of the fields.

But consider what A M Samsam Bakhtiari of the National Iranian Oil Company (NIOC) has told the Oil & Gas Journal about the existing-reserves question: "I know from experience how 'reserves' are estimated in major Middle Eastern and Opec countries, and the methods used are usually far from scientific, as the basic knowledge for such a complex exercise is not to hand." Bakhtiari is withering about Saudi Arabia's reserves hike of 90 billion barrels in 1990. But he is not too keen on his own national figures either. The BP Statistical Review cited 92 billion barrels of "proved" oil reserves at the end of 1993, but Bakhtiari preferred the estimate of a retired NIOC expert, Dr Ali Muhammed Saidi, who could add the proved reserves up to only 37 billion barrels.

Dr Mamdouh Salameh, a consultant on oil to the World Bank, agrees there is a 300-billion-barrel exaggeration in Opec's reserves. More recently, a former director of Aramco has said that Saudi Arabia's proved developed reserves stand at 130 billion barrels. An anonymous informer talking to Dr Colin Campbell of the Association for the Study of Peak Oil goes further. His conclusion is that Saudi Arabia would have gone over its peak of production in the last quarter of 2004. This person speaks with front-line inside knowledge. "Saudi has at various times put 19 fields into production," he says. "Of these, eight are 'stars', being highly productive fields that produce around 90 per cent of the country's production. All the others are 'dogs' that have never worked well and probably never will. Recovery rates of up to 50 per cent may be appropriate for the 'stars'. For the 'dogs', 10, 15 or 20 per cent would be more appropriate. Make this adjustment and Saudi has depleted more than 50 per cent of its realistically recoverable reserves."

In February 2005, Matthew Simmons speculated that the Saudis may have damaged their giant oilfields by over-producing them in the past: a geological phenomenon known as "rate sensitivity". In oilfields where the oil is pumped too hard, the structure of the oil reservoir can be impaired. In bad cases, most of a field's oil can be left stranded below ground, essentially unextractable. "If Saudi Arabia has damaged its fields, accidentally or not," Simmons said, "then we may already have passed peak oil."

Is there any chance that the early topping point of oil production is somehow wrong, all just a bad dream? I am sorry to say that I think not. It is important to realise that the early toppers are not advocates or agitators by choice. They tend to have high residual affection for the industry they have spent their lives in. Colin Campbell, for example, the founder of the Association for the Study of Peak Oil (ASPO), worked for 40 years in the oil industry before retiring to western Ireland. Chris Skrebowski, the editor of Petroleum Review, a leading trade journal of the oil industry, spent nearly a decade arguing against Campbell before conceding that he was right. "In 1995 it all seemed pretty fantastic," says Skrebowski. "I tried hard

to prove him wrong. I have failed for nine years. I am now with him. In fact, I think he's a bit of an optimist." Other early-toppers include Richard Hardman, former chief executive of Amerada Hess; Roger Bentley, formerly of Imperial Oil in Canada; and Roger Booth, who spent his professional life at Shell, and who now believes that, when the peak does hit: "A crash of 1929 proportions is not improbable."

Chris Skrebowski believes that, from as early as 2007, the volumes of new oil production are likely to fall short of the combined need to replace lost capacity from depleting older fields and to satisfy continued growth in demand. In fact, given the time frames with which offshore oilfields are developed and depleted, it seems certain that there will be nowhere near enough oil to meet the combined forces of depletion and demand between 2008 and 2012. If there were, it would be from projects we would know about today (oil companies liking as they do to boast to their shareholders about every sizeable discovery). Given the inevitable time-lag from discovery to production, there is now no way to plug that gap.

There is worse: people in the oil industry must know this. They should be alerting governments and consumers to the inevitability of an energy crunch, and they aren't.

In July 2004, Campbell and Skrebowski tried to carry their warning jointly to the UK parliament. In the Thatcher Room they delivered a seminar to a pitifully thin audience, including only three MPs and a handful of researchers. I sat there listening to it with as surreal a feeling as I have ever experienced in all my years working on energy. Over the course of a decade at and around the climate negotiations, I have rarely been able to claim that the global warming problem is not reaching the ears it needs to. The same can manifestly not be said about the oil-depletion problem. This is the starting point for any analysis of how serious the problem is. How can evidence so compelling go almost unheard in one of the world's centres of government, even with a suspiciously high oil price at the time and so much obvious oil-related trouble brewing in the Middle East?

Having built their cases, the two spelt out the consequences of the early topping point. "The perception of looming decline may be worse than the decline itself," Campbell said. "There will be panic. The market overreacts to even small imbalances. Prices are set to soar in the absence of spare capacity until demand is cut by recessions. We will enter a volatile epoch of price shocks and recessions in increasingly vicious circles. A stock-market crash is inevitable."

"If the economic recovery continues," Skrebowski added, "supply will get very tight from 2008 or 2009. Prices will soar. There is very little time and lots of heads are in the sand."

In 1956, a Shell geologist called M King Hubbert famously calculated that oil production in the "lower 48" states of America would peak in 1971. Almost nobody believed him. Shell censored the written version of Hubbert's address to the American Petroleum Institute, changing the wording of his conclusion to read that "the culmination should occur within the next few decades". The US Geological Survey, in particular, did everything it could to hike the estimates of ultimately recoverable American oil to a level that would make the problem go away. The US had 590 billion barrels of recoverable oil, the survey said, in 1961, meaning that the industry had 30 years of growth to look forward to.

The years went by and the "lower 48" did indeed hit their topping point. It came a year ahead of estimate, in 1970, at 3.5 billion barrels. Since then, production has sunk down the second half of the curve at a steady rate. Many billions of dollars have been spent on ever more sophisticated exploration, including in areas where nobody imagined oil would be found at the peak of discovery in the 1930s, such as the deep water in the Gulf of Mexico. A frenzy of new domestic exploration began after the first Arab embargo in 1973 and the realisation that domestic production could be ramped up no more. Every enhanced production technique invented has been tried and tested in American oilfields. But it has all made no difference to the remarkable symmetry of the up-and-down curve that expressed Hubbert's thinking. The US is just short of halfway down the second half of the curve now. In other words, it has used up some three-quarters of its original endowment of recoverable oil. Given its almost total lack of attention to the efficiency with which oil is burned, the US becomes more dependent on foreign oil imports by the day.

The US Secretary of the Interior at the time, Stewart Udall, later apologised for having helped lull Americans into a "dangerous overconfidence" by accepting the advice of the US Geological Survey so unquestioningly. A long-serving US Geological Survey director who had led the campaign against Hubbert, V E McKelvey, was forced to resign in 1977.

We need to remember this sequence of events, and the windows it gives us into individual and collective behaviour, when we come to consider the global oil topping point.

The American pattern of historical oil discovery and production is only a loose guide to what is going on in the rest of the world. In the US, oil, once found, was pumped without much substantive effort at constraint. The curves for discovery and production are going to look different where conservative nationalised companies are doing the looking, or where - as in the case of Saudi Arabia - there has been so much oil that the taps can be turned up and down for long periods so as to moderate supply and thus influence price. Countries that have onshore and offshore oil can have two curves, because the technology for offshore oil exploitation was developed much later than that for onshore. Curves will also be disrupted by wars, big political events, even accidents. None the less, country after country follows a crude bell curve - like Hubbert's curve - in both discovery and production. Today, more than 60 out of the 65 countries possessing oil have passed their discovery topping points and 49 of them have passed their production topping points. The US has a particularly long gap between the two: 40 years (1930 to 1970). The UK has one of the shortest: 25 years (1974 to 1999). This is because the first discoveries were made much later in the UK, when technology for both exploration and production were more advanced. Growing supplies of British oil didn't last long, though. Britain is now a net oil importer just like the US.

Nor is there any comfort to be derived from gas. Gasfields deplete very differently from oilfields, gas being much more mobile than oil. It is normal for a gasfield to yield 70-80 per cent of its gas over its production lifetime, whereas an oilfield will typically yield only 35-40 per cent of its oil. Drillers normally set gas production far below the natural production capacity so as to give a long production plateau. But the danger in this is that the end of the production plateau comes abruptly, and without market signals.

Colin Campbell, a prominent early topper, estimates that the original global endowment of conventional gas was around 10,000 trillion cubic feet (equivalent to 1.8 trillion barrels of oil), of which about a quarter has been produced to date. He expects a global plateau in production of around 130 trillion cubic feet per year during the period 2015 to 2040, with production falling over a cliff beyond that. Jean Laherrère forecasts 12,000 trillion cubic feet for all gas including unconventional sources (2 trillion barrels of oil equivalent). He puts the peak of gas depletion in 2030, at 130 trillion cubic feet per year. But the exact figures need not concern us. What matters is that gas has all the same problems of dependence on overseas supplies as oil, and more besides.

Meanwhile, the five essential facts about global oil discovery can be summarised as follows.

1. The biggest oilfields in the world were discovered more than half a century ago, either side of the Second World War.

The big discoveries on the Arabian Peninsula opened with the discovery of the Greater Burgan field in Kuwait in 1938. At that time, it supposedly held 87 billion barrels. The slightly bigger Saudi Arabian Ghawar field, supposedly holding 87.5 billion barrels before extraction started, followed in 1948. These fields, the two biggest in the world, are so big that they dominate the global figures in their years of discovery.

2. The peak of oil discovery was as long ago as 1965.

How many people appreciate this? I invite you to do a bit of personal market research. Line up ten of your better-educated friends. Preface your question to them with a few reminders about how many millions of dollars the oil companies make in daily profit, tell them, if you can, an anecdote or two about the technical wizardry they use, and ask them to imagine how many billions of dollars they must have spent on exploration over the years - both of the companies' own money and of the massive tax-deduction subsidies available to them. Then ask: in what year would you guess the most oil was ever discovered?

3. There were a few more big discovery years in the 1970s, but there have been none since then.

The biggest irregularity on the downside of the global discovery curve involved the discovery of oil in Alaska's giant Prudhoe Bay field, and the North Sea, in the late 1970s. I was a geology student then. I remember the thrill as the giant fields were discovered one after the other. They all had such serious-sounding names. Forties, Brent, Piper. I look back on those days now and I see something of the primeval attractions of the hunt in it. As a junior trainee hunter, I used to listen to the tales of the senior hunters, and how they had found their quarry, quite atremble with admiration. However, what I and the other hunters didn't know was that the days of giant discoveries were more or less over.

4. The last year in which we discovered more oil than we consumed was a quarter of a century ago.

Since then, despite all those generations of eager brainwashed geology students, we have been burning progressively more, and finding progressively less. This is another one to try out on the 10 educated friends.

5. Since then there has been an overall decline.

A small rise in discoveries in the 1990s that must have looked promising at the time has dropped in the opening years of the new century. Does this sound like a world without a looming oil depletion problem, as portrayed by BP's CEO Lord Browne - who in March last year insisted "There is no physical shortage. The resources are there"? Are people are being lulled into a sense of false security about oil supply based on his speeches, and publications like the BP Statistical Review of World Energy? Or are we simply failing to pay sufficient attention to alarm signals such as last month's little-noticed announcement by the US government's Energy Information Administration, in which forecasts of Opec production between now and 2025 were slashed by 11 million barrels a day?

Let us suppose for a moment that the late toppers are correct. The topping point, as defined by reserves available in principle, is off in the 2020s or 2030s, and we can look forward to growing supplies of relatively cheap oil for a decade or more. There is another aspect of the problem: whether or not the production capacity is sufficient.

Oil-industry analyst Michael Smith, who took his PhD in geology just after me - sitting in the same chair as I did in the research lab - is an expert in this subject. He has spent most of his vocational life as an oil-industry geologist working around the world, particularly in the Middle East. "Reserves are largely irrelevant to the peak," he says. "Production capacity is the important thing - how quickly you can get it out. It is an engineering problem, not a geological problem."

Of the 11 countries in the Middle East, only five are significant oil producers: Iran, Iraq, Kuwait, Saudi Arabia and the United Arab Emirates, known sometimes as the Middle East Five. They produce around 20 million barrels a day today, a quarter of the global total. If global demand rises at the average rate of the past 30 years, 1.5 per cent per year, these five countries will have to meet around two-thirds of the demand, Smith calculates.

Let us assume they can do what they say they can, no more, no less. Where does that leave us? Saudi Arabia says it can lift production from 9.5 million barrels per day today to 12 million by 2016 and 15 million beyond that. This despite 50 per cent of the oil coming from the Ghawar field, where a water cut is already reported. Smith sums all the reported capacities in the Middle East Five and finds that if the rate of demand growth continues at 1.5 per cent they will fail to meet global

demand by as soon as 2011. If it rises to 2.5 per cent the demand gap appears in 2008. If it is 3.5 per cent - the rates in China and the US of late - the gap is already here.

"What's more," Smith adds, referring back wryly to the starting assumption, "I do not truly believe the claims of the Middle East Five. In fact, although I don't believe Saudi and Iranian claims in particular, I think their politicians do believe them. I don't think there is a conspiracy, more a division of labour such that no one knows the whole story, each part of which has wide error bars. The summed result is inevitably the most positive conclusion which goes to the politicians. I've seen this in all the oil companies I have worked for." At the November 2004 conference on oil depletion at the Energy Institute, Michael Smith showed a slide at the end of his presentation that gave a pictorial summary of his views. It showed a group of firemen posing for the camera outside a burning house.

The investment bank Goldman Sachs drew attention to the problem of access to oil on a global scale in a much-quoted 2004 report. "The industry is not running out of oil - reserves are large and continue to grow," it asserts - though failing to offer evidence of this analysis. "What the industry is running out of is the ability to access this oil." Two decades of chronic underinvestment in the 1980s and 1990s are responsible. During this time the industry was feasting on reserves discovered in the 1960s and earlier with infrastructure capitalised in the 1970s, after the first oil shock. Global oil demand is now closing fast on tanker capacity and refining capacity. The peak year for tanker capacity was way back in 1981. So, too, was the peak for refinery capacity. Global rig counts also peaked that year.

So, how much new investment is needed to fix the shortfall? Over the next 10 years, assuming oil demand increases as commonly projected, fully $2.4trillion will need to be spent, according to Goldman Sachs. This is nearly triple the level of capital investment by the oil industry in the 1990s. And if it isn't spent? "If the core infrastructure does not improve, energy crises are likely to become progressively more frequent, more severe and more disruptive of economic activity," the investment bank concludes.

Stated simply, it seems that even if an early topping point doesn't hit us, the results of two decades of negligence in investment in infrastructure and exploration will. You need to read between the lines of the Goldman Sachs report to smell the level of anguish about this. Even where substantial money has been invested, a further list of serious unresolved problems can often be quickly summoned up. Oil in the Caspian is central to every scenario that envisages oil supply meeting demand off into the 2020s. The oil industry has long regarded the Baku-Ceyhan pipeline from Azerbaijan to Turkey as essential if it is to get Caspian oil out to market without the need to go through Chechnya and Russia. By the time this pipeline begins to shift oil as planned in 2005, it will have cost $4bn, almost three-quarters of that in the form of bank loans. The problems for this pipeline begin with reports of its construction standard. Four whistleblowers recently told a UK national newspaper that the pipeline was failing all international construction standards, including installation of inadequately welded pipe before it had even been inspected. It passes through a major earthquake zone. Turkey has had 17 major shocks in the past 80 years, and the pipeline is supposed to last for 40 years.

At the time the pipeline was conceived, industry reports talked of several hundreds of billions of barrels in the Caspian region. Now estimates of around 50 billion barrels, about the same as the North Sea, are more common. After the discovery of the last of the super-giants, the Kashagan field in 1990, there was a burst of predictable interest in Kazakhstan. But now, in terrain where individual wells cost $1bn to drill, in conditions where only foreign companies have the know-how and technology to drill, the Kazakh government has introduced new legislation that makes investment unattractive. As an ExxonMobil executive told Petroleum Review, "...the jury is still out on whether all these obstacles will delay Kazakhstan's production".

This example of a real-world current problem for the oil industry raises the subject of the interplay between the early topping point and oil geopolitics. As the world's No 1 consumer, the United States will have much to say about how the crisis - whether of early depletion or inadequate infrastructure and investment, or both - plays out. The geopolitics of American oil dependency is well summarised by Michael Klare in his recent Blood and Oil. He sees four key trends in US energy behaviour: more imports, increasingly unstable and unfriendly suppliers, escalating risk of anti-American violence and rising competition for diminishing supplies. Imports we have talked about above. Increasingly unfriendly suppliers and escalating anti-American violence are linked.

The point here is that the US can have relationships with governments in unstable countries if it chooses the path of oil dependency, but not easily with their populations. Terrorism can be expected to grow with every American act interpretable as imperialistic in the Middle East and Central Asia. The Iraq-to-Turkey pipeline illustrates the problem perfectly. It suffered near daily attacks in 2003.

As for competition over diminishing supplies, therein lies the stuff of nightmares. The Pentagon established a Central Command in 1983, one of five unified commands around the world, with the clear task of protecting the global flow of petroleum. "Slowly but surely," Michael Klare concludes, "the US military is being converted into a global oil-protection service."

At $30 a barrel, the total bill for imported oil - now more than half the US daily consumption and rising fast - should reach $3.5 trillion over the next 25 years, and this does not include the Pentagon's overhead. Beyond the Middle East Five, the Bush strategy of supplier diversification will look to eight main sources, which Klare calls the Alternative Eight: Mexico, Venezuela, Colombia, Russia, Azerbaijan, Kazakhstan, Nigeria and Angola. These countries and their oil operations are characterised by one or more of the following attributes: corruption, organised crime, civil war, political turmoil short of

civil war, and ruthless dictators. The US military is being forced into deeper relationships with such regimes, including joint military exercises.

The bottom line for Klare is this. "Any eruption of ethnic or political violence in these areas could do more than entrap our forces there. It could lead to a deadly confrontation between the world's military powers." Because obviously, in a world as enduringly addicted to oil as ours is, others are going to be looking for their own supplies. Russia and China will be among them. As one global-security analyst recently put it: "I am afraid that over the years we will see China become more involved in Middle East politics. And they will want to have access to oil by cutting deals with corrupt dictatorships in the region, and perhaps providing components of weapons of mass destruction, ballistic missiles and other things they have been involved with, and that could definitely put them on a collision course with the United States." Oil dependency could yet prove to be the route to a Third World War. The stress associated with an unforeseen early topping point surely makes that horrific prospect more, not less, likely.

Humans are good at staying loyal to their theocracies, and a hundred years of fossil fuel addiction has created impressive theocracies. However, as Einstein said, you can't solve the world's problems with the same thinking that created them. We have to think outside the box. That means giving renewable energy, alternative fuels, energy efficiency and storage technologies the space they need to grow explosively.

The good news is that it will be possible to replace oil, gas and coal completely with a plentiful supply of renewable energy, and faster than most people think. Shell employs roomfuls of clever people just to think about the future. They are called scenario planners. In their 2001 book of scenarios, Shell's planners mention that renewable energy holds the potential to power a future world populated with 10 billion people, and do so with ease. The needs of the 10 billion can be met even in the unlikely and undesirable event that all of them use energy at levels well above the average per-capita consumption today in the EU. The Shell futurists mention this almost in passing, in the caption of a diagram showing the continent-by-continent potential for individual renewable-energy technologies to contribute to such a power-rich future. Working for an oil and gas giant as they do, it is perhaps no surprise that they fail to explore a scenario wherein something resembling this renewable-power-rich future comes to pass. Others are not so constrained.

When I began my time in Greenpeace, in 1989, the protestations my colleagues and I made that renewable energy could displace fossil fuels and run the world were ridiculed by energy experts and officialdom as naïve wishful thinking. Now, more than a decade later, such views can be found in the heart of government, at least in Europe. The Blair Government published a report in 2003 that concluded: "It would be technologically and economically feasible to move to a low carbon-emissions path, and achieve a virtually zero-carbon-energy system in the long term, if we used energy more efficiently and developed and used low-carbon technologies."

Among the low-carbon technologies on offer, the government report placed heavy emphasis on renewable energy and hydrogen, rather than nuclear power. Of solar energy, the report concludes: "[It] alone could meet world energy demand by using less than 1 per cent of land currently used for agriculture." Tony Blair used these same words in the speech he gave launching the UK Energy White Paper. I sat there watching him do it, 10 feet away in the front row. I was momentarily tempted to leap to my feet and shout: "So why don't you invest in it like the Germans and Japanese, then?" But he hasn't. Not then. Not now.

Microcosms of what could be done can be found already on the local government scene. Take the small town of Woking. Its borough council has cut carbon-dioxide emissions by fully 77 per cent - yes, more than three quarters - since 1990 using a hybrid-energy system involving small private electricity grids, combined heat and power (CHP), solar photovoltaics (PV), and energy efficiency. Woking has turned its town centre, its housing estates, and its old people's homes into inspirational islands of energy self-sufficiency. The UK grid could go down for ever, and these folks would have their own heating and electricity year-round. The technologies work in perfect harmony. The CHP units generate heating when needed in winter, and lots of electricity along with it when the PV is not working at its best. The PV generates plenty of electricity in the summer, when the heating isn't needed, meaning the CHP can't generate much electricity. Because the use of private wires is so much cheaper than using the national grid, the whole package costs fractionally less than the equivalent heating and electricity supply would cost from the big energy suppliers.

Compare such out-of-the-box ingenuity with what nuclear has to offer. Even if there were no environmental problems associated with it, and we could afford the billions needed in perpetuity from the public purse to make the voodoo economics stack up, a new fleet of stations couldn't come on-stream in the UK much before 2020. And if we and the Americans can't solve the energy crisis without resorting to nuclear, the whole world will follow our example. Bad as the terrorist threat is now, it would be compounded many times as a result. We would live with much increased risk of losing whole cities to suitcase bombers.

There is a part of me that looks at the prospect of a cold snap in Britain this winter, and of a consequent fuel-supply crisis, and thinks "Bring it on." Maybe this is what we need to stop our sleepwalk towards catastrophe, and to make us rethink our energy policy. Perhaps the government can be judo-thrown into the Wokingisation of Britain now, and dissuaded from the nuclearisation of Britain 15 years from now.

But then I think of all the grans and granddads that would die in a one-in-ten winter, and I just feel sad. Sad, and mad with our hot-air Government.

Adapted from "Half Gone: Oil, Gas, Hot Air and the Global Energy Crisis", by Jeremy Leggett (Portobello Books, £12.99). To order a copy for the special price of £11.99 (inc P&P), call Independent Books Direct on 08700 798 8897