# How realistic are Opec's proven oil reserves?

**Questions have increasingly been raised about the actual size of Opec's proven reserves, which stood at 819bn barrels at the start of 2003 despite a lack of significant discoveries between 1980 and 2002 and a production of 186bn barrels during the same period. Many experts are also questioning how the oil cartel's reserves have suddenly jumped from 467.39bn barrels in 1982 to 760.48bn in 1988, an increase of 293.11bn barrels at a time when not much exploration or drilling was conducted. Furthermore, some oil industry insiders estimate Opec's current spare capacity at no more than 0.92mn b/d, rather than the 'official' figure of 3mn b/d. Here, *Dr Mamdouh G Salameh** suggests that Opec's proven reserves have been overstated by 300mn barrels.****

In the late 1980s there were huge and abrupt increases in the announced proven reserves for several Opec countries. Between 1982 and 1988 proven reserves jumped suddenly from 467.39bn barrels to 760.50bn barrels.[1] These sudden reserves additions coincided with Opec's decision – informally in 1982 and then formally in 1983 – to adopt a production quota system in defence of the oil price, which was coming under heavy pressure. Members suddenly added huge amounts of reserves in order to secure for themselves a bigger production share. Opec's idle production capacity was rising, leading to fears that a production free-for-all would precipitate a downward price spiral. Indeed, the oil cartel's fears began to materialise over the period 1985–1986. The producers, following a natural tendency to increase production in order to offset the damaging effect of weakening prices on revenues, brought about a collapse of price.[2]

| Country | Proven reserves (1982) | Net reserve additions (1982–1988) | Proven reserves (1988) |
|---|---|---|---|
| Algeria | 9.44 | –0.24 | 9.20 |
| Indonesia | 10.53 | –1.53 | 9.00 |
| Iran | 56.15 | 36.71 | 92.86 |
| Iraq | 59.00 | 41.00 | 100.00 |
| Kuwait | 67.15 | 27.38 | 94.53 |
| Libya | 22.19 | 0.61 | 22.80 |
| Nigeria | 16.75 | –0.75 | 16.00 |
| Qatar | 3.45 | 1.05 | 4.50 |
| Saudi Arabia | 165.48 | 89.51 | 254.99 |
| UAE | 32.35 | 65.76 | 98.11 |
| Venezuela | 24.90 | 33.61 | 58.51 |
| **Total Opec** | **467.39** | **293.11** | **760.50** |

*Source:* Opec Annual Statistical Bulletins*, 1982–2003*

Table 1: Opec's net reserve additions, 1982–1988 (bn barrels)

Earlier, each Opec nation was assigned a share of production based on its own annual production capacity. However, the organisation changed the rule in the early 1980s to also consider the oil reserves of every member country. As a result, most Opec member countries promptly increased their reserve estimates. Between 1982 and 1988, Venezuela raised its proven reserves by 33.61bn barrels to 58.51bn. Then Iran announced an addition to its reserves amounting to 36.71bn barrels and the UAE added 65.76bn. Iraq joined the fray next, by adding a total of 41bn barrels, to be followed in 1988 by Saudi Arabia adding 89.51bn. All in all, Opec added 293.11bn barrels of reserves during the period 1982–1988 (see **Table 1**).

*[The latest edition of the* BP Statistical Review, June 2004*, claims to have gone back to the original sources for the large reserve revisions now incorporated. As a result Opec reserves at end 2002 rise from the 819bn barrels reported in BP's June 2003 edition to 881.6bn barrels as reported in the 2004 edition. The end-2003 figure quoted in the 2004* Review *is 882bn barrels. The principal revisions within the Opec official reserves are: Iran rises from 89.7bn barrels to 130.7bn barrels; Algeria from 9.2bn barrels to 11.3bn barrels; Libya from 29.5bn barrels to 36bn barrels; and Nigeria rises from 24bn barrels to 34.3bn barrels. All other Opec reserve estimates were essentially unchanged. To give some idea of the magnitude of the reserve changes in the four countries, they are equivalent to the entire initial North Sea reserves, or the equivalent of two and a half years of global production. There will be a range of opinions as to the plausibility of these revisions. Ed.]*

Several explanations have been suggested for the sudden jump in Opec reserves between 1982 and 1988, none too satisfactory. One explanation is that these reserve additions were clearly not the result of new discoveries made during the years in question and are regarded by many as 'political reserves', ie reserves that were 'proven' either to support each country's demands for

| Country | Opec reserves (1988) | Reserve additions 1982–1988 | Production 1989–2002 | Drawdown 60% | Additions 40% | Actual reserves 2002 |
|---|---|---|---|---|---|---|
| Algeria | 9.20 | –0.24 | 4.15 | 2.49 | 1.66 | 10.86 |
| Indonesia | 9.00 | –1.53 | 6.68 | 4.00 | 2.67 | 11.67 |
| Iran | 92.86 | 36.71 | 18.86 | 11.32 | 7.54 | 63.69 |
| Iraq | 100.00 | 41.00 | 7.92 | 4.75 | 3.17 | 62.17 |
| Kuwait | 94.53 | 27.38 | 10.00 | 6.00 | 4.00 | 71.15 |
| Libya | 22.80 | 0.61 | 8.43 | 5.06 | 4.25 | 25.56 |
| Nigeria | 16.00 | –0.75 | 10.63 | 6.38 | 3.92 | 20.25 |
| Qatar | 4.50 | 1.05 | 2.83 | 1.70 | 1.13 | 4.58 |
| Saudi Arabia | 254.99 | 89.51 | 40.92 | 24.55 | 16.37 | 181.85 |
| UAE | 98.11 | 65.76 | 12.50 | 7.50 | 5.00 | 37.36 |
| Venezuela | 58.51 | 33.61 | 14.50 | 8.70 | 5. 80 | 30.70 |
| **Total** | **760.50** | **293.11** | **137.42** | **82.45** | **54.97** | **519.84** |

*Sources:* Opec Annual Statistical Bulletins*, 1982–2003;* BP Statistical Review of World Energy*, June 2003*

**Table 2: A revision of Opec's current reserves (bn barrels)**

higher output allocation within the Opec quota system, or as a result of excessive upward revisions of earlier estimates.[3]

Another explanation may be that the assessment of Opec reserves was originally based on a recovery rate of 20% of oil-in-place and was later re-evaluated at a recovery rate of 50% – far above the current global rate of 29% and, therefore, unjustifiable.

However, the abrupt increase in announced Opec reserves in the late 1980s was probably a mixture of upward revision of old underestimates and some wishful thinking.

In countries of the Gulf, there has been a lack of consistency and transparency regarding reserves. The statistics reported could change due to revised estimates of oil-in-place or changes in the recovery factor. Together with some other technicalities, there are also grounds for arguing that some reserves are overstated.[4]

## Reserves reduction

Prior to the introduction of the Opec quota system, net additions to Opec reserves during the period 1978–1982 amounted to only 19.5bn b.[5] However, they suddenly jumped by 293.11bn barrels between 1982 and 1988 – although there was no evidence of major discoveries or extensive exploration or drilling during that period.

A more reasonable estimate of current Opec reserves should be 519bn barrels *not* 819bn – a reduction of 300bn barrels. This is based on an average global recovery rate of 29%, rather than on a rate of 50%, and also on my calculations of Opec's own production, consumption and discovery figures. The reserve estimate of 519bn barrels may also be arrived at by using a calculation process devised by Prof. Kenneth S Deffeyes of Princeton University (see **Table 2**). This entails subtracting out any abrupt jump during 1982–1988 from each Opec country's reserves. After the 1980s, Prof. Deffeyes estimated that 60% of the production was a drawdown from the reserves and 40% was either corrections for previous underestimates or the addition of new oil reservoirs. The 60:40 split is intended as an average performance figure for those Opec countries that reported abrupt reserve increases.[6]

Consequently, some 300bn barrels must be deducted from Opec's current proven reserves of 819bn barrels to give a realistic figure of 519bn barrels. In so doing, global proven reserves of some 1tn barrels of oil must also be reduced by an equivalent quantity. This will, in turn, reduce the ultimate global reserves from the consensus figure of 2,100bn barrels to 1,800bn, with adverse impact on global oil supplies and the price of oil.

## Peak production

The current global reserves/production (R/P) ratio is 37 years based on global proven reserves of 1047.7bn barrels (at the beginning of 2003) and an annual production of 28bn barrels. A downward revision of Opec reserves by 300bn barrels will reduce the R/P ratio by 10 years to 27. *[On the basis of BP's latest reserve revisions there are now 1147.7bn barrels of global reserves giving an R/P ratio of 41. However given rising demand and oil's depletion pattern R/P ratios are largely meaningless. Ed.]*

However, whether the figure is 37 years or 27 years, one has to realise that oil production will not stay flat during that period and then suddenly drop to zero. Rather, it will rise to a peak after which mankind is faced with an era of declining production. Thus it is clear that 'peak production' will be an important turning point in our future

| Year | Added in year | Annual production | As % of annual production |
|---|---|---|---|
| 1992 | 7.80 | 23.98 | 33 |
| 1993 | 4.00 | 24.09 | 17 |
| 1994 | 6.95 | 24.42 | 28 |
| 1995 | 5.62 | 24.77 | 23 |
| 1996 | 5.42 | 25.42 | 21 |
| 1997 | 5.92 | 26.22 | 23 |
| 1998 | 7.60 | 26.75 | 28 |
| 1999 | 13.00 | 26.22 | 50 |
| 2000 | 12.60 | 27.19 | 46 |
| 2001 | 8.90 | 27.81 | 32 |
| 2002 | 9.00 | 26.99 | 31 |
| 2003 | 2.27 | 28.11 | 8 |
| 1992–2003 | 89.08 | 311.97 | 29 |
| **Average** | **7.42** | **26.00** | **29** |

*excluding the US and Canada

*Sources: IHS Group's 2003* World Petroleum Trends Report (WPT)*;* BP Statistical Review of World Energy*, 1993–2003*

**Table 3: Global crude oil reserve additions*, 1992–2003 (bn barrels)**

| Country | Current capacity | Current production | Capacity utilisation | Spare capacity |
|---|---|---|---|---|
| Algeria | 1.66 | 1.66 | 100% | – |
| Indonesia | 1.20 | 1.18 | 98% | 0.02 |
| Iran | 3.50 | 3.45 | 99% | 0.05 |
| Iraq | 2.00 | 1.40 | 70% | 0.60 |
| Kuwait | 2.15 | 2.15 | 100% | – |
| Libya | 1.45 | 1.45 | 100% | – |
| Nigeria | 2.18 | 2.18 | 100% | – |
| Qatar | 0.90 | 0.90 | 100% | – |
| Saudi Arabia | 9.25 | 9.00 | 97% | 0.25 |
| UAE | 2.50 | 2.50 | 100% | – |
| Venezuela | 3.00 | 3.00 | 100% | – |
| **Total** | **29.79** | **28.87** | **97%** | **0.92** |

*Sources: Energy Intelligence Group (EIG); International Energy Agency (IEA)*

Table 4: Opec's current sustainable capacity and capacity utilisation (in mn b/d)

reliance on oil and, therefore, consumers and governments alike should be made aware how close such a date might be.

The world is currently consuming 28bn barrels of oil a year on a rising trend, yet on average finding only 7.42bn barrels a year.[7] Over the period 1992–2003, only 29% of the global oil production has been replaced by new discoveries. The cumulative shortfall over the period 1993–2002 amounted to 222bn barrels (see **Table 3**).

According to the IHS Energy Group's 2003 *World Petroleum Trends Report (WPT)*, 2003 was probably the first year to have recorded no large discoveries at all, with only 2.27bn barrels of new reserves added. We would have to go back to the early 1920s to find a year when fewer large oil discoveries were made.[8]

## Impact on ultimate global reserves

Global oil production will probably reach a peak sometime during this decade. After the peak, the world's production of crude oil will fall, never to rise again. The world will not run out of oil, but developing alternative oil sources on a large scale will take at least two decades, if not more. The slowdown in oil production may already have started; the current price fluctuations for crude oil and natural gas may be the preamble to what may be the 'final energy crisis'.[9]

A growing body of opinion among energy experts suggests that global conventional oil production will peak sometime during this decade, probably between 2004 and 2009. Declining production will cause a global oil shortage. However, my own research indicates that the peak in global oil production may even occur much earlier, probably between 2004 and 2005. That, however, will depend on two factors:

- the reality of Opec proven reserves, and
- Opec sustainable production capacity.

## Opec oil production capacity

At present, Opec is thought to have a spare production capacity of 3mn b/d. However, oil industry insiders maintain that Opec's spare capacity is far less than that – the latest estimate for current capacity being 29.79mn b/d. 'Capacity' here is defined as 'being attainable within 30 days and sustainable for three months'. With a current production of 28.87mn b/d, Opec's readily available spare capacity is now estimated at only 0.92m b/d (see **Table 4**). The spare capacity would have been even smaller if not for the frequent disruption of Iraq's oil production and exports due to the sabotaging of the country's production and export facilities. At present, there is no non-Opec spare capacity as new reserves have been brought rapidly into production.

However, three leading Opec producers have capacity problems. Venezuela's production capacity shrank from 3.5mn b/d in 1997 to 3mn b/d in 2003 because of a lack of investment funds and also annual output declines ranging from 15%–25%. The country has an ambitious five-year plan to raise capacity to 5.5mn b/d by 2008. This involves the expenditure of up to $43bn on oil exploration, with western oil companies providing some $23bn and Venezuela contributing the balance. Venezuela, however, does not have the funds to contribute $20bn and, given current political circumstances in the country, the foreign investors would not be that keen to stump up a further $23bn. Venezuela's plan to expand capacity is, therefore, unrealistic. At best, it may be able to raise capacity to 4mn b/d by 2010.[10]

Iran also appears to be having difficulty maintaining production levels, which are subject to large month-to-month swings. Iran's current sustainable production capacity is estimated at no more than 3.5mn b/d. Some independent experts maintain that the country is facing technical problems at its major onshore oil fields, to an extent that Iran's production capacity is falling below its Opec production quota. Production declines from these ageing oil fields currently amount to 250,000 b/d a year. The opening up of Iran's oil sector to foreign investment is partly spurred by plans to increase oil production capacity to 6mn b/d by 2010 from current levels of 3.5mn b/d. Many analysts, however, believe that this target is not achievable.

Even the mighty Saudi Arabia is having problems maintaining its capacity. The country's readily available spare capacity is estimated at no more than 250,000 b/d, and not the 3mn b/d previously assumed. Any new addition to capacity will go to offset the production decline in its giant Ghawar oil field, which accounts for 59% of Saudi production. There are persistent reports that the country is facing serious water incursion problems in the Ghawar oil field. Ghawar, the world's largest oil field, needs 7mn b/d of seawater injected to prop up the reservoir pressure.[11]

Almost 90% of Saudi oil production comes from just eight ageing oil fields. Saudi Arabia is now drilling only horizontal wells in an effort to maintain production flows, with around 200 additional horizontal wells drilled each year.[12] To many this sounds like a country that was working hard just to maintain production rather than one capable of increasing production by simply opening the tap when more production is needed.

Some experts believe that the Saudi 'miracle' of almost effortless, cheap production is nearing its end. These experts think that the Ghawar oil field, with a production of 5mn b/d, could be running down. They also suspect that most of the other big Saudi fields, including Abqaig and Berri, could be past their peak. They speculate that the Saudis may soon have to develop fields once deemed marginal, just to maintain capacity.

## Impact on global oil price

There is no more truly 'global' market than oil – a fluid commodity easily shipped between producers and consumers spread all over the planet. Every little jump in supply or demand can send ripples around the world and cause spikes in the oil price.

A downward revision of Opec reserves and sustainable production capacity are bound to impact on global oil prices. Opec is supposed to be the 'global swing producer' of last resort, with so much spare capacity that it can flood the oil market any time. The revelation that its proven reserves are overstated by 300bn barrels could have a huge psychological impact on the global oil market and could trigger a sharp rise in the oil prices.

Deducting 300bn barrels from Opec reserves is equivalent to taking a major oil producer like Saudi Arabia out of the global oil markets. Coupled with far less spare capacity than was previously assumed, this could add \$10–\$15/b to the price of oil by 2010, with oil prices ranging from \$40–\$45/b according to my calculations. Such a development could also undermine global oil security and lead to panic buying reminiscent of the 'Spot Market' in 1979–1980, where major oil users bid against one another for the dwindling oil supply.

If there is a continuing use for oil, what can we do to extend the supply? More oil can be squeezed out of existing fields, oil can be produced from tar sands and oil shale – but will it be enough to offset a real shortage?

## What is the alternative?

While technological advances such as horizontal drilling and seismic imaging could help reduce drilling costs, it will not find oil that does not exist. And while some unconventional oil such as extra heavy oil, tar sand oil and GTL (gas-to-liquids) oil will eventually be available, it is reckless to believe, on the basis of evidence available at present, that there will be enough to replace shortfalls in conventional oil.

In 2003, unconventional oil contributed 1% to the global conventional crude oil consumption. However, unconventional oil will be hard pressed to meet 2% of the global demand for oil in 2005, or about 3% and 4% in 2010 and 2020 respectively. As for renewable energy sources, they contributed a mere 1% to the global primary energy demand in 2003. Their contribution may not exceed 7% in 2025, possibly rising to 13% by 2050. In other words, the combined contribution of unconventional oil and renewable energy sources will make only a modest dent in the future need for energy.[13]

This much is certain – no initiative put in place starting today can have a substantial effect on the peak production year. No Caspian Sea exploration, no drilling in the South China Sea, no renewable energy project, no unconventional oil can be brought on at a sufficient rate to avoid a bidding war for the remaining oil.

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## Footnotes

1. *Opec Annual Statistical Bulletin*, 1998, p10.
2. 'Opec quotas: The end of an era?', *Opec Issues*, Centre for Global Energy Studies (CGES), London, 1996, p11.
3. *Global Oil Report*, CGES, Vol. 8, Issue 2, Mar–Apr 1997, p5.
4. Gilbert Jenkins, 'World oil reserves reporting 1948–96: Political, economic and subjective influences', *Opec Review*, Vol. XXI, No 2, June 1997, p97.
5. *Opec Annual Statistical Bulletin*, 1998, p10.
6. Kenneth S Deffeyes, *Hubbert's Peak: The Impending World Oil Shortage*, Princeton University Press, Princeton, 2001, pp147–148.
7. IHS Energy Group's 2003 *World Petroleum Trends Report (WPT)*.
8. *Petroleum Review*, February 2004, p2 & p46.
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10. Priscilla Ross, 'Venezuela wake-up call', *Petroleum Review*, June 2002, p20.
11. Mathew R Simmons, 'The mystery of oil'. Paper presented at the 26th Annual IAEE conference in Prague, Czech Republic, June 4–7, 2003, acetate No 26 entitled 'Saudi Arabia's oil & gas challenges'.
12. *Petroleum Review*, March 2004, p2 & p33.
13. Mamdouh G Salameh, 'Can renewable and unconventional energy sources bridge the global energy gap in the 21st century?' *Applied Energy,* 75, 2003, pp33–42, Elsevier Science.

*…continued from p25*

Oklahoma to Chicago. By reversing the flow along these systems, Enbridge hopes to eventually be able to ship Canadian crude as far as the Gulf Coast, where it would compete with local and offshore supplies of heavy oil.

Similarly, Terasen, a pipeline company based in Vancouver, hopes to expand its system in British Columbia. It currently owns the TransMountain pipeline that moves 200,000 b/d of crude west from Alberta to the Pacific coast. It has plans to increase the flow to as much as 800,000 b/d. The extra supply could then be moved, by tanker, south to California or east to Asian markets.

## Full coffers

With the continued strength of energy prices, Canadian companies are currently facing an embarrassment of riches. Coffers are full, yet there are only so many energy projects available domestically to absorb the cash.

Increasingly, the major players are looking abroad. In May, Petro-Canada paid C\$1.15bn to buy a stake in the Buzzard field in the North Sea, about 100 km northeast of Aberdeen. The acquisition gives it a 29.9% interest in the joint venture, which is led by Calgary's EnCana. Oil production from the field is expected to start in late 2006 and peak at around 180,000 b/d. Similarly, Talisman will spend a record C\$2.3bn on capital investments and exploration this year in an effort to boost production to 450,000 b/d. Half will be spent in North America, one-quarter in the North Sea, and the rest on projects in Malaysia, Vietnam, Algeria and Colombia.

## The future

All good things eventually come to an end, however. Is the Canadian oilpatch concerned that the cycle of high prices has peaked? 'The industry as a whole has been fairly robust, and we expect it to continue to be so,' says Onno DeVries, General Manager of oilsands and markets for CAPP.

'Generally, the energy sector has been in a bullish upturn in the 2000s,' agrees Martin King, an analyst at FirstEnergy Capital. 'They're looking at better returns and better prices in the next five to six years.'

But Louis Thériault, Head Statistician at the Conference Board of Canada, sounds a more cautious note. 'I have met with ten senior vice presidents of major oil companies recently and they are very nervous. They don't take anything for granted. Prices don't have to go down much to make current drilling levels relatively expensive.'