



Oil Reserves: Where Ghawar goes, the rest of OPEC follows

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In May 2007, the work of [Stuart Staniford](#) and [Euan Mearns](#) culminated in a new and unprecedented assessment of oil reserves in Ghawar, the world's largest oil field. This article (also written in May 2007 and well overdue for TOD posting) combines their assessment with additional information sources, to produce a revised estimate of reserves in Saudi Arabia and the other OPEC countries.

Oil Reserves in Saudi Arabia

In their 1986 study "Giant Oil and Gas Fields", Carmalt and St John (American Association of Petroleum Geologists²) published a list of the largest five hundred oil and gas fields known at the time. This included field size estimates for 24 major fields in Saudi Arabia (crude oil and condensate).

Table 1: Saudi Arabia Oil Field Size Estimates²

Field Name	Discovery Year	Size billion barrels (Gb)
Ghawar	1948	82.0
Safaniya	1951	36.1
Manifa	1957	17.0
Abqaiq	1941	12.8
Berri	1964	12.0
Zuluf	1965	10.6
Khurais	1957	8.50
Abu Sa'fah	1963	7.50
Shaybah	1968	7.00
Qatif	1945	6.00
Marjan	1967	4.58
Khursaniya	1956	4.10
Jaladi	1978	3.00
Harmaliyah	1972	2.00
Abu Hadriya	1940	1.84
Dammam	1938	1.50
Fadhili	1949	1.00
Mazalij	1971	0.68
Rimthan	1974	0.60
Abu Jifan	1973	0.56
Lawhah	1975	0.55
Maharah	unknown	0.50
Jana	1967	0.50
Barqan	1969	0.25
TOTAL		221

Unless otherwise stated, reserves here refer to P50 estimates, ie. proven plus probable (2P)
Gb = Billion Barrels

In SPE Paper 255803, Saudi Aramco reference this Carmalt and St John paper when they claimed that the Berri field “ranks as the 22nd largest in the world”. While this does not specifically endorse any of the reported field sizes, that Saudi Aramco have seen fit to reference this paper provides it with a significant level of credibility.

It is also important to note that Carmalt and St John, using a variety of sources including industry databases, performed their study before the widespread revision of OPEC reserves in the 'quota wars' of the mid/late 1980's. This suggests that the data they were using would have been free from any of the 'political pollution in technical databases' which Jean Laherrere has roundly criticised more recently.

[Stuart's analysis](#)¹ revises the field size estimate for Ghawar up to 96 billion barrels (Gb). Some of this increase may have occurred in the southern sections of Ghawar, especially Haradh which has

only been extensively drilled and developed since 1986. It is significant that, despite this additional development, the total field size estimate has only increased by 17% in two decades. Euan's base case analysis⁴ revises Abqaiq reserves to 14.8 Gb, which represents a 16% increase on the 1986 estimate.

That the Carmalt and St John estimates are only modestly lower than these two new estimates, is encouraging, but not all that surprising given that most of the listed fields were already 20-40 years old and extensively developed by the time of their study.

While some fields may come in below the 1986 expectations, which is to be expected among a mix of P50 estimates, others may yield yet larger percentage increases. At this stage it is reasonable to extend the observed average increase to the other 22 fields in the list. While this is based on results from only two fields, the sample covers 43% of the resource so it is quite significant. The result is in an additional increase of 21 Gb in the size of the other listed fields (in addition to 14 in Ghawar and 2 in Abqaiq), bringing the revised sub-total to 259 Gb.

The cumulative additional resource in very much smaller fields and those discovered since 1986, of which the Hawtah trend fields are the only known significant oil find, are estimated to amount to 6 billion barrels.

This yields a total initial reserves estimate for Saudi Arabia of 265 billion barrels.

Cumulative production of crude oil and condensate to end of 2006 is 113 Gb. Therefore, 43% of initial oil reserves have been produced, with end 2005 reserves of 152 Gb (2P). This is more than 110 billion barrels short of the 264 stated by OPEC and widely reported as Saudi Arabian 'proven' reserves (although 264 includes an amount of NGLs also).

Coincidentally, there is a close match between Saudi claimed reserves and the initial reserves in this analysis. This tends to support a claim made previously by Colin Campbell that in the OPEC 'quota wars' in the 1980's, some members started reporting initial rather than current reserves. This makes some sense in the context of allocating quotas, rather than haggling over production revisions each year. But there is no official confirmation of that interpretation, so we can only conclude that OPEC reserves are substantially overstated. It's only a pity that these are the most widely quoted figures for the countries holding the largest share of the world's most important energy commodity.

However, even the dramatically lower reserves figure of 152 Gb may seem high to those with a pessimistic view of Saudi resources. While we may question recent claims that Shaybah has over 20 billion barrels of oil, the figure of 7 Gb reported by Carmalt and St John still seems robust. The growth increment applied here to their figures appears justified but even discounting that, the evidence does not support an initial reserves estimate of anything less than the 221 Gb estimated in 1986, given that Ghawar and Abqaiq estimates alone have now come in a combined 16 billion barrels higher.

1979 US Senate Committee Report

The 1979 staff report to the US Senate Subcommittee on International Economic Policy on "The Future of Saudi Arabian Oil Production" supports the figures in the 1986 Carmalt and StJohn paper. Aramco (prior to nationalisation and operating in line with standard US industry practice) estimated to the Senate Subcommittee that Saudi Arabia had 2P reserves of 177 Gb and 3P reserves of 245 Gb (proven plus probable plus possible).

Cumulative production to the time of the report was 35 Gb, so the corresponding initial reserves estimates were 212 Gb (2P) and 280 Gb (3P). Seven years later, Carmalt and St John's combined assessment was 9 Gb higher, which provides confirmation that their field sizes were close to

Even including NGLs, it is impossible that minimum initial reserves of 384 Gb could be valid, but that is what Saudi Arabia imply now with 120 Gb of cumulative production and 264 Gb now claimed as 'proven' reserves. On the other hand, it is encouraging that the new figure presented here (265 Gb) falls within the range identified by Aramco in 1979. After three decades of field development, it is perhaps not surprising that the new estimate falls in the high end of their range, but as the fields mature the opportunity for further gains diminishes.

While reserves of 152 Gb are well below official statements, it is still an enormous volume. However, not all barrels are created equal and this analysis in no way implies that Saudi Arabia has the ability to maintain higher levels of production. As Matt Simmons states repeatedly, it is clear that the high quality, high flow rate fields which have been the mainstay of Saudi production are now very mature. While production from these fields may be declining, there is still a large remaining resource of lower quality oil that is more difficult to produce. Saudi Arabia may never sustain crude and condensate production of much more than ten million barrels per day, but they do have the resources to support flow rates of half their current level for several decades.

Because production has been limited to well below the theoretical Hubbert profile (fig 1), the large and conservatively exploited initial reserves base of 265 Gb allows for a relatively modest 2% long-term average annual decline. Crucially though, this analysis and the chart presented in figure 1 have no immediate predictive ability with respect to production. This analysis only indicates that reserves are sufficient to support a moderate production level well into the future. In the near-term, Saudi Aramco is engaged in an epic struggle to offset declines in mature fields with new production from several large field re-development projects over the next five years.

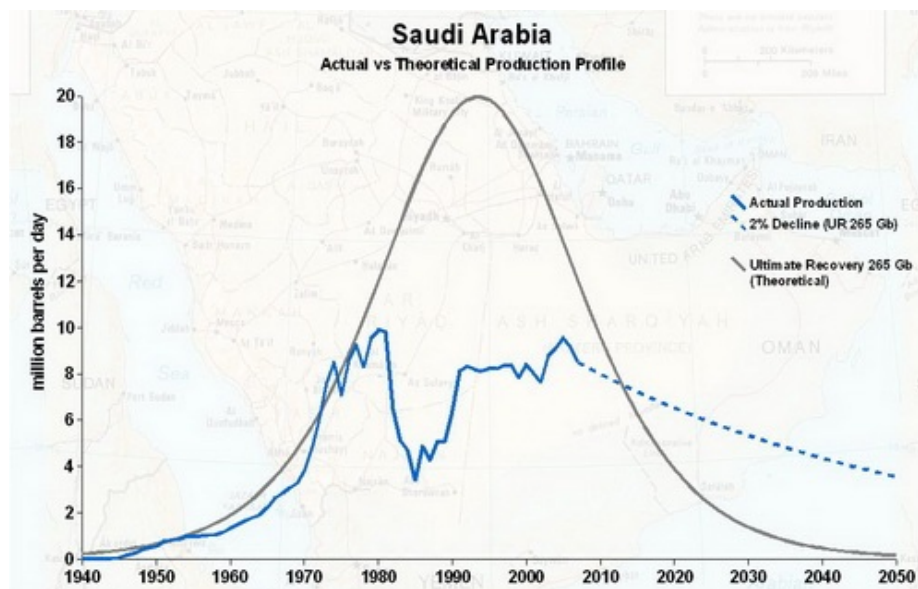


Figure 1: Saudi Arabia - Actual Production vs Theoretical (Click to Enlarge)

One interesting interpretation of Figure 1 is that some kind of oil crisis in the 1970's was inevitable. World consumption and Saudi production was growing at a breathtaking but unsustainable rate. The crises in 1973 and 1979 served to drastically cut consumption and it wasn't until the Chinese and world demand surge 25 years later that Saudi Arabia again reached its resource and capacity constraints. If they do succeed in regaining higher production levels, it will only ensure that future decline rates are greater than 2%.

OPEC Reserves

Importantly, it is not only Saudi Arabia for which there is evidence that reserves have been grossly overstated. Quoted reserves for the six largest OPEC members, and large upward revisions during the 1980's in particular, give cause for concern. The International Energy Agency⁵ has supported this interpretation, saying that “the hike in OPEC countries’ estimates of their reserves was driven by negotiations at that time over production quotas, and had little to do with the actual discovery of new reserves.”

More revealing is recent IHS data, in this case specifically for Kuwait⁶ (fig.2). This suggests that Kuwait's reserves are barely half the 101 billion barrels reported publicly. Further confirmation comes in the IEA’s definitive World Energy Trends 2005 – Middle East and North Africa (MENA)⁷. They estimate remaining proved and probable (2P) reserves in Kuwait (including half share of Neutral Zone) at 54.9 billion barrels from 9 named and two 'other' fields. For the UAE, proven and probable reserves (2P) are put at 55.1 billion barrels from 9 named fields and one 'other'. These estimates for the end of 2004 are sourced from IHS Energy and IEA databases.

Estimating World Oil and Gas Resources

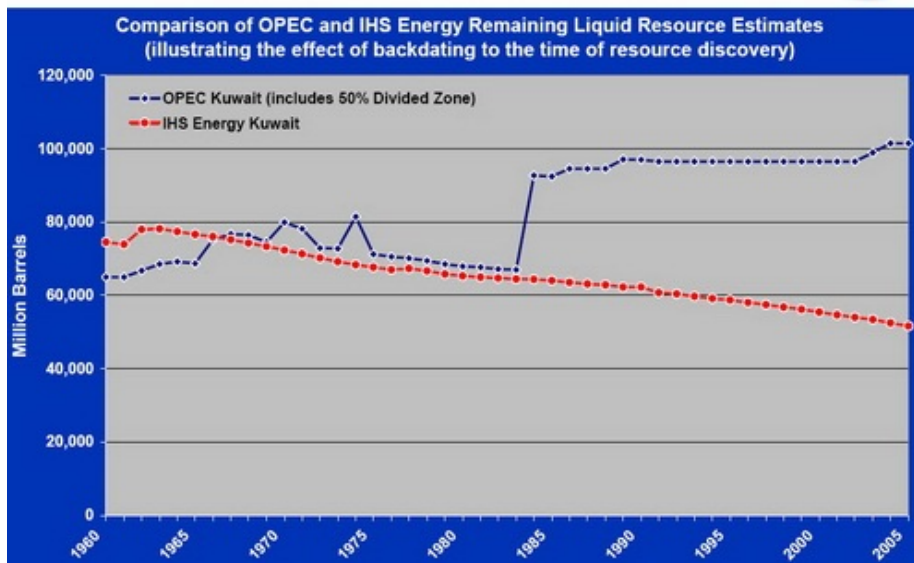


Figure 2: Kuwait Reserves – OPEC vs IHS (Click to Enlarge)

It is almost certain that reserves in Iran, Iraq and Venezuela are overstated to a similar degree. Reserves for other OPEC members Algeria, Indonesia, Libya, Nigeria, Qatar and now Angola appear somewhat more realistic, although these are still are not provided with any form of audit or verification that they meet external reporting standards.

Table 2: Stated and Revised OPEC Member Reserves

OPEC Country	OPEC 2005 ⁸	Revised Assessment	Difference
Saudi Arabia	264.2	152	112
Kuwait	101.5	54.9	47
United Arab Emirates	97.8	55.1	43
Sub-total	464	262	202
Iran	136.3	combined estimate	combined estimate
Iraq	115		
Venezuela	80		
Sub-total	313	177	136
Total OPEC-6	777	439	338
Total OPEC-11	904	566	338

Claimed OPEC reserves are overstated by approximately 340 Gb. They are, with a high degree of certainty, rather much closer to 570 billion barrels than the 904 claimed. Combining this with the Oil and Gas Journal's non-OPEC conventional oil reserves estimate of 280 Gb⁹, yields a global reserves base of 846 billion barrels, well short of the 1140 level assumed.

The implications of this circa 340 billion barrel reserves shortfall for global forecasts of petroleum supply cannot be overstated. With cumulative consumption at 1180 Gb¹⁰ and reserves of less than 850 Gb, we have consumed well over half our conventional oil reserves base.

With those kinds of numbers, peak oil cannot be far away, and [exploration](#) and [reserves growth](#) will not be enough to get us out of the woods.

This article is available as a PDF [here](#).

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[Depletion Levels in Ghawar \(Updated\)](#)

[GHAWAR: an estimate of remaining oil reserves and production decline \(Part 2 - results\)](#)

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