



Saudi production laid bare

Posted by [Euan Mearns](#) on March 19, 2007 - 10:00am in [The Oil Drum: Europe](#)

Topic: [Supply/Production](#)

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A couple of weeks ago I made a comment saying that we needed data on producing wells and drilling history in order to further analyse Saudi oil production. In answer to my wish [Kyle](#) posted a [comment](#) with this link to the [OPEC Annual Statistical Bulletin](#) which contains all this information - well almost.

So is Saudi production about to [nosedive](#)?

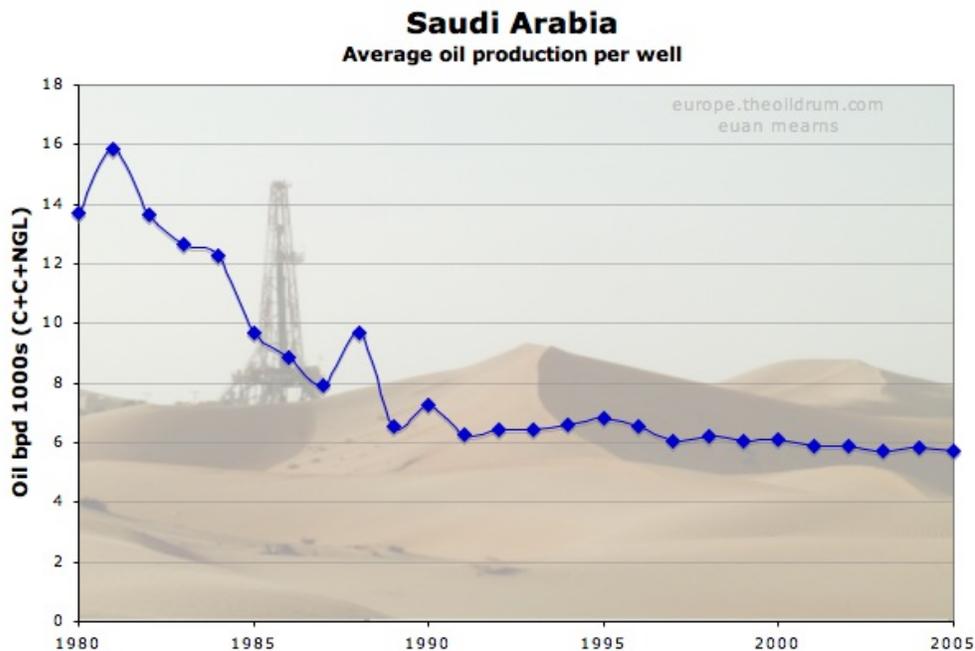


Figure 1 Saudi Arabian average oil production per well. The average well flow rates are drifting down slowly from just above 6000 bpd in 1991 to just below 6000 bpd in 2005. No sign of a pending nosedive here!

Background

This is the fourth article on Saudi Arabia in this recent series on The Oil Drum. Stuart Staniford set the ball rolling with his post:

[Saudi Arabian oil declines 8% in 2006](#)

I responded with:

[Saudi Arabia and that \\$1000 bet](#)

To which Stuart replied with:

[A nosedive toward the desert](#)

There's nothing like a good controversy to stimulate research. But where does the truth lie?

Stuart's position Oil production peaked in Saudi Arabia in 2005. Recent sharp declines in production are involuntary and Saudi Arabia has switched from swing producer to supply constrained producer.

My position Sharp falls in Saudi production since April 2006 are in part voluntary achieved by retiring wells. I say "in part voluntary" because it seems likely that the Saudis will welcome the chance to rest wells with high water cut or low reservoir pressure. When called upon to do so, I believe Saudi Arabia will increase future production through bringing wells out of retirement and a rolling program of drilling new wells.

This post looks in detail at the drilling and production record of Saudi Aramco since 1980.

Summary

1. Cross checking OPEC production and rig count data with International Energy Agency (IEA) and Baker Hughes data shows excellent agreement suggesting there is no reason to doubt the reliability of the OPEC data source.
2. In 2005, Saudi Arabia had 1923 producing wells that on average produced 5740 barrels oil per day per well. This is astonishing high well productivity for an area that has been producing oil for over 50 years.
3. The average well productivity has drifted down from just above 6000 bpd in 1991 to just below 6000 bpd in 2005 (Figure 1). There is no sign of a looming productivity crisis in these data and it would appear that increasing production may be achieved quite simply by drilling more wells.
4. The data provide insight into Saudi Aramco reservoir and resource management in relation to their roll as swing producer. In the past, production has been reduced by retiring production wells and raised again by bringing wells out of retirement. All the while, Aramco have a rolling program of drilling new wells thereby increasing the total number of wells that are available for production.
5. In [my post of 7th March](#) I suggested that the most likely explanation for falling Saudi production since April 2006 was voluntary restraint executed through a program of resting wells with high water cut or low pressure. The data presented here contain no evidence of a pending production crisis and voluntary restraint is still considered to be the most likely explanation for recent falls in Saudi production.

Data

The [OPEC Annual Statistical Bulletin](#) provides access to many data tables pertaining to OPEC and global oil and gas production. Click on the Oil and Gas Data tab to access Tables 36 and 37 which are the source of data presented in this post. Amongst other things these tables provide

information on "The number of producing wells" in Saudi Arabia from 1980 to 2005 and the number of wells drilled each year.

As is often the case, not all the data you may wish to have is provided. In the drilling statistics, wells by type (oil, gas, dry and other) are specified for 1980 to 1991 and for 2002 and 2003 but for the other years only a total number is provided which slightly obscures the oil well drilling history. Furthermore, the producing wells are not broken out by oil or gas which adds marginal uncertainty to the data presentation.

The production data used in this post is that taken from the 1986 [BP statistical review](#). These production figures are for crude oil, condensate and natural gas liquids (C+C+NGL). In the OPEC drilling data, I have combined the number of gas wells and oil wells. This meshes with the BP data - as a growing amount of liquids production in Saudi Arabia is from NGL that is produced from gas wells. This adds marginal uncertainty to the data analysis but does not prejudice the validity of the overall conclusions.

One data anomaly, deemed to be a data error, is present in the 1985 producing wells (table T37) where a figure of 731 is recorded. 1985 was the production nadir for Saudi and this figure is highly anomalous compared with the adjacent years. It has been arbitrarily changed to 371 to bring the data in line.

Data reliability

A number of commentators are sceptical about the accuracy and reliability of information produced by OPEC. I have therefore conducted a couple of cross checks between the OPEC data with other sources. In the charts below, the OPEC production data for Saudi Arabia is compared with BP and [IEA](#) data and information on Saudi rig counts are cross checked with [Baker Hughes international rig count](#).

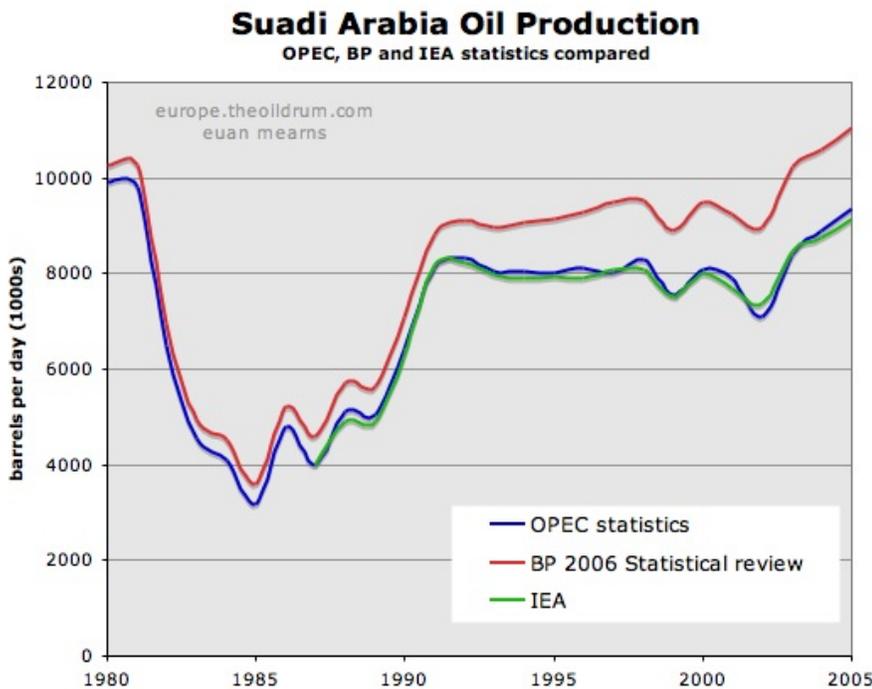


Figure 2 Saudi Arabian oil production. OPEC (Table T38), BP and IEA sources compared. The OPEC data is "Crude oil" and shows excellent agreement with the IEA data which is crude + condensate (C+C). The BP data includes natural gas liquids

(NGL) which explains why this data tracks well above the C+C. Note how the contribution from NGL has grown in importance since 1990. Click to enlarge (applies to all charts).

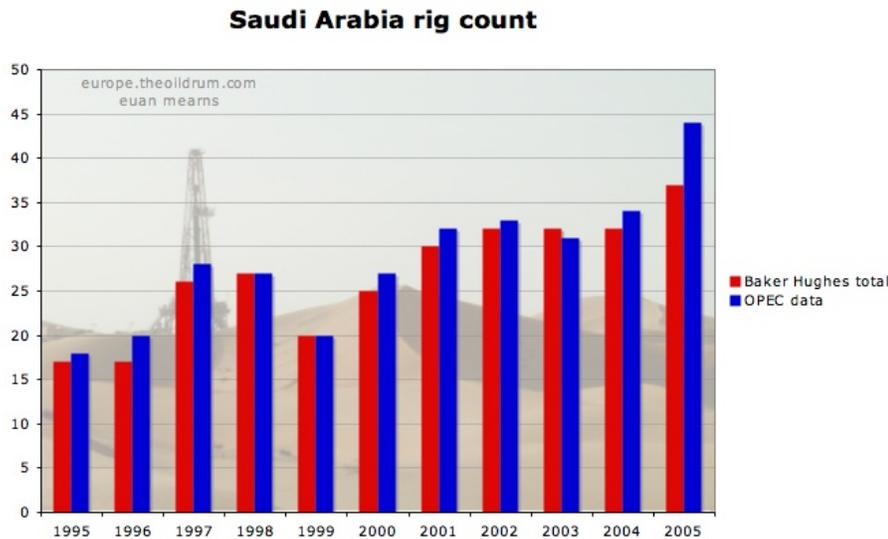


Figure 3 The number of active rigs in Saudi Arabia. OPEC (Table T35) compared with Baker Hughes (oil+gas+miscellaneous). The agreement is generally excellent apart from 2005 where the OPEC count is significantly higher than Baker Hughes. Note how the total rig count has been rising steadily since 1995, suggesting that the Saudis have been winding up their oil and gas activities steadily for the last decade.

In general terms there is excellent agreement between the OPEC data and other sources and I see no reason to doubt the validity of the drilling and well data provided by OPEC.

Producing wells and production

There is a close correspondence between the numbers of producing wells and oil production (Figure 4). But as discussed below, the correlation between these two variables is complex and masks a story of shifting reservoir management strategy, global supply and demand, swing production and geological constraints.

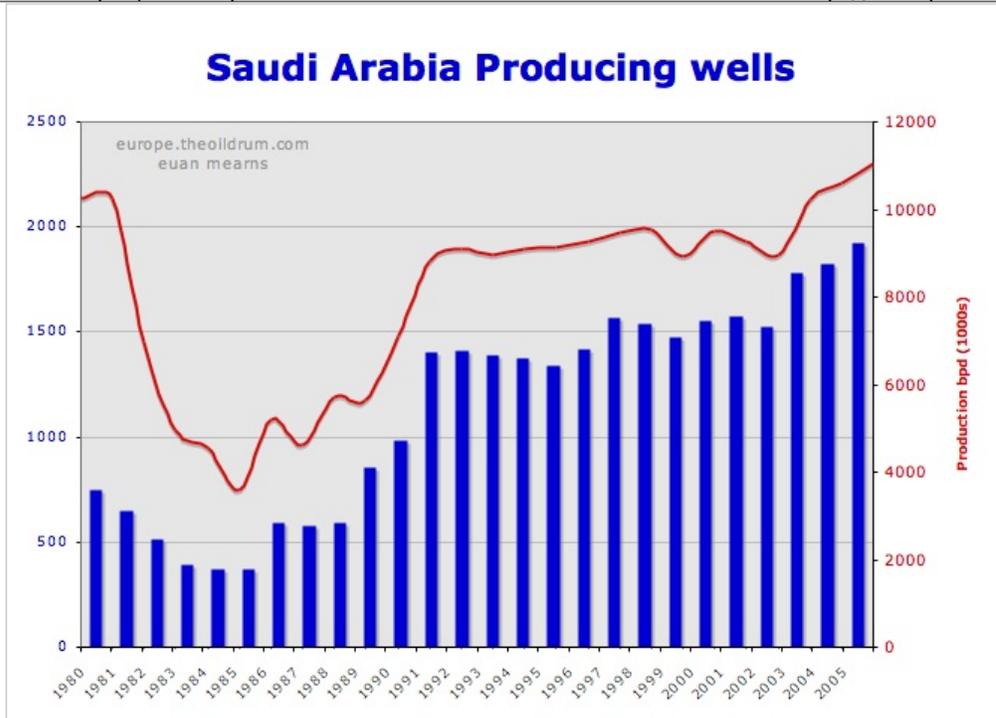


Figure 4 The number of producing wells (left scale) and the average daily oil production (C+C+NGL; right scale).

In broad terms, the number of producing wells was reduced from 1980 to 1985 in order to cut back production and constrain global oil supply at a time production was building in the North Sea, the North Slope (Alaska) and other areas. In this period, new wells were still being drilled and the reduction was achieved by mothballing wells and production capacity. Following the 1985 production low, wells were brought out of retirement and from 1985 to 1991, production was built back towards 10 million bpd.

Note how production dips in 1990 and 2002 correspond with dips in the number of producing wells. **These are voluntary reductions in production brought about by retiring wells that may be brought out of retirement to boost future production as needs dictate.**

In 2003 there was a surge in global demand and the Saudis helped meet that demand by drilling more oil wells that year (Figure 5) and by retiring fewer wells (Figure 6) resulting in significant jump in the number of producing wells (Figure 4).

Drilling history

Figure 5 provides some fascinating insight into the workings of Saudi Aramco. In the period 1980 to 1985 production was cut from 10 to 4 million barrels per day through a program of well retirements discussed above and yet they continued to drill new oil wells at a rate of around 100 per year throughout this period. It was only in 1986 that drilling activity was cut back (oil price crash) and the drilling low point of 1988 is offset by 3 years from the production low point of 1985.

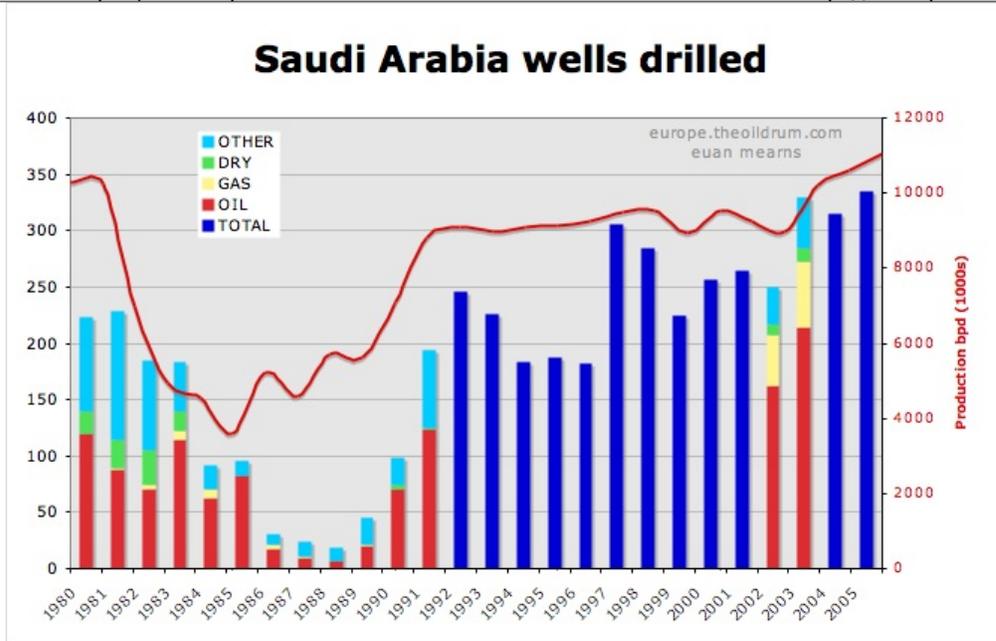


Figure 5 The number of wells drilled (left scale) and the average daily oil production (C+C+NGL; right scale). The breakdown of well by type has not been made available from 1992 to 2001 and since 2004. Wells in the "other" category will include water injection wells and observation wells. Dry wells are presumably unsuccessful exploration wells.

The overall level of drilling activity has been rising since 1991 (GW1) and it is a great pity that we do not have the breakdown by well type for most of this period. By 2002-2003 it can be seen that the number of oil wells being drilled each year had approximately doubled from the pre-1985 era and that there has been a substantial increase in the number of gas wells drilled. The rising number of oil wells drilled combined with more or less flat production in the period 1991 to 2003 is a sure fire sign that the average productivity of new wells is falling. This is perfectly natural, not surprising and does not signal an immediate crisis. The average productivity of new wells will most likely continue to fall. For example the [Khurais](#) development has target production of 1.2 million bpd using 300 wells. This suggests a minimum target well productivity of around 4000 bpd as some of the wells will be water injectors.

Well retirement pattern

What is meant by well retirement?

Saudi Arabia, as the biggest producer in the OPEC swing production cartel, have a long history of raising and lowering production to suit market needs. Part of the mechanism used to achieve this control is to shut down production in perfectly good wells. The other mechanism for lowering production is to choke back producers (lower production). Production may then be raised at will by re-instating retired wells, opening the chokes on restricted wells and drilling new wells. Saudi ability to raise production will be dependent upon the inventory of retired wells available to them at any point in time and to the capacity of production facilities. In his comment [here](#), Kyle suggested that the Saudis may be retiring wells that were producing at 4000 bpd. This would be unheard off in the OECD and in most other OPEC countries. In my post of 7th March I suggested that the Saudis may elect to retire wells with high water cuts or low reservoir pressure. Resting such wells is good reservoir management practice. It must also be noted, however, that some wells that are retired may eventually be abandoned if their productivity is no longer profitable or if they have become obsolete.

Combining the data shown in Figures 4 and 5 enables an estimate to be made of the number of producing wells that are shut down each year.

$$\text{number of retired wells} = \text{number of wells drilled} - \text{YOY change in productive wells}$$

This pattern is shown in Figure 6 and in Figure 7 the cumulative tally of retired wells is stacked on the producing well tally.

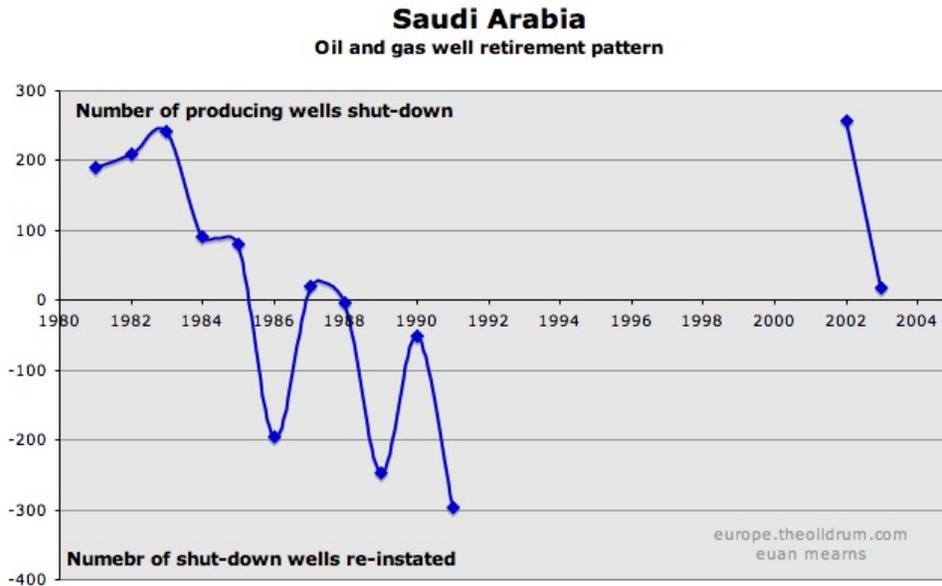


Figure 6 Saudi Arabia well retirement pattern. A positive number equates to the number of wells retired (mothballed) in any given year while a negative number equates to the number of wells brought out of retirement. It is not possible to conduct this exercise for the years where the breakdown of wells drilled by type are not given.

In the period 1980 to 1991 the Saudis essentially went through a cycle of retiring wells and then bringing those wells out of retirement (whilst continuing to drill new wells all the time). The peak cumulative tally was reached in 1985 (the production nadir) when the Saudis had mothballed 814 wells! By 1991, when all production was required during GW1 the tally of mothballed wells had fallen back to just 40.

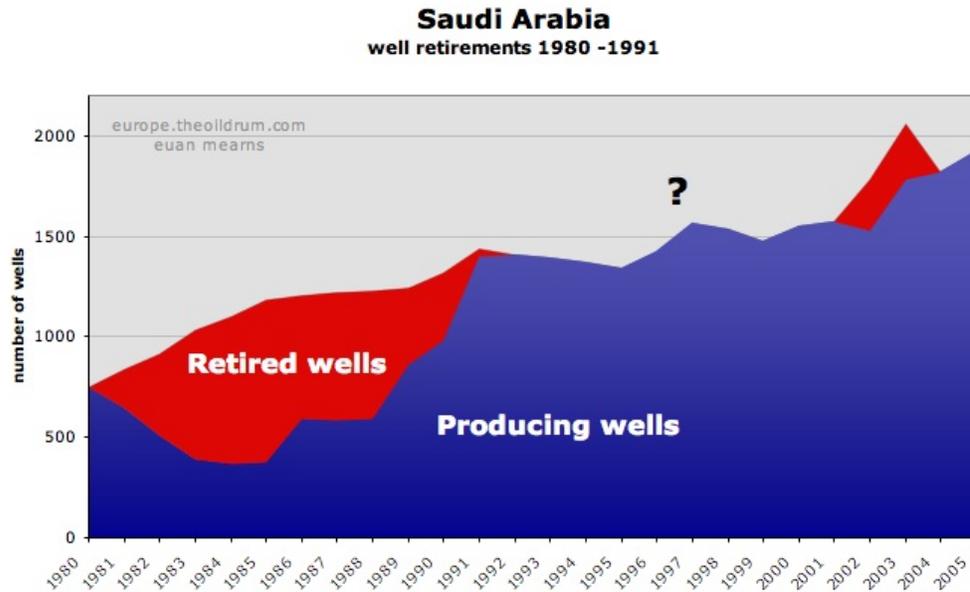


Figure 7 Cumulative wells retired (Figure 6) stacked upon the number of producing wells. In 1980, there may have been a significant inventory of retired wells for which we have no data and these are not shown here. The breakdown of wells by type is not given for most years since 1991. It seems likely that a significant inventory of retired wells may have accumulated in this period. Note that some wells that are shut down may become obsolete. For example, during redevelopments such as Haradh, old vertical wells may be replaced with horizontal wells and these retired vertical wells will most probably become obsolete.

So what might the current tally of mothballed wells in Saudi Arabia be? The paucity of data since 1991 makes this impossible to say. However, in 2002 a staggering 257 wells were mothballed. In 2003, which was the first year of the recent production surge, the Saudis still had capacity to mothball or abandon 18 wells. The production increase that year was achieved by adding 214 new oil wells and not shutting down a large number of older wells to compensate.

The period 2004 to 2005 I imagine may replicate the pattern of 2003, where new production was added by simply drilling wells without retiring older wells. If there was any production shortfall then the Saudis will have had 257 wells rested in 2002 to fall back upon. 2006 saw the commissioning of the Haradh III project, although this only has 32 production wells. [Haradh III](#) was a high profile mega project development but the number of producing wells is not hugely significant compared with the annual drilling program (unless of course a trilateral is counted as 3 wells).

Production history

Saudi Arabian average daily production per year is plotted against the number of producing wells in Figure 8. This provides fascinating insight into Saudi reservoir management practice. From 1981 to 1985 production did nose dive from over 10 to below 4 million bpd through a program of planned well retirement. Then in 1985 Saudi policy was changed in order to maintain market share, production was raised and the oil price collapsed in 1986.

Between 1988 and 1989 production was held constant even though the number of producing wells was raised from 590 to 858. This would seem to signal a new approach to reservoir management with lowered flow rates and production sustained from a larger number of wells. The constant trend of 6000 bpd per well was established in 1989 and it would almost seem that this has been a target well productivity for the Saudis since then.

The great knot of data points at around 9 million bpd represents the "plateau years" of production from 1991 to 2002. Then in 2003, with rising global demand and falling production in the North Sea and other areas, the Saudis were called upon to ramp up production which was achieved with relative ease by simply adding more wells through drilling and reducing the well retirement rate.

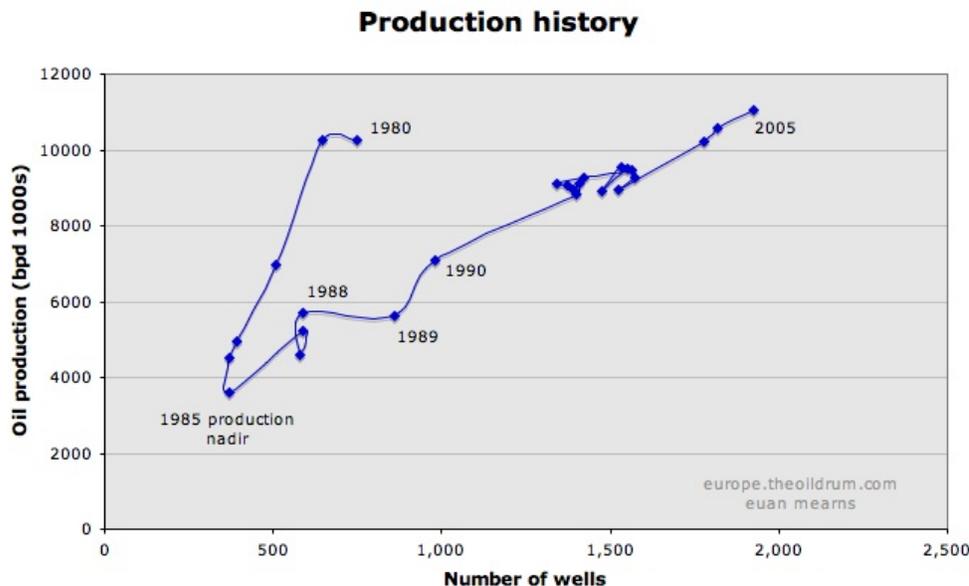


Figure 8 The production history of Saudi Arabia with C+C+NGL plotted on the Y axis versus the total number of producing wells on the X axis. The key features are 1) 1980 - 1985, falling production as a result of voluntary well retirement. 2) 1985 to 1988 increasing production brought about by bringing wells out of retirement and drilling new wells. 3) 1988 to 1989 flat production with large increase in number of producing wells resulting in a drop in average well productivity. 4) The knot of data points at 9 million bpd represents the plateau years of 1991 to 2002. 5) 2003 to 2005 production stretch achieved by increasing the number of producing wells through drilling and reduced retirement rate.

That \$2000 bet

So where does this leave Saudi oil production, peak oil and the end of the world as we know it? Regular readers of The Oil Drum may think I have become a cornucopian. I assure you not at all, I'm simply looking at data and drawing reasonable conclusions.

Saudi ability to sustain and grow production is dependent upon the availability of new good quality mega projects to develop and the cupboard in this respect is beginning to look rather bare. Khurais due on by 2009, some off shore field developments and further development of gas resources (NGL) should provide sufficient resources to sustain production, and perhaps modest growth, for a few years at least. And as Stuart pointed out the Saudis will likely have a huge number of smaller fields to develop, though I very much doubt many of those will be brought on stream by 2008.

Hubbert linearisation suggests that Saudi Arabia is in the vicinity of 50% depletion of their ultimate recoverable developed reserves. Declining Saudi production therefore is probably only a few years away.

In his last post Stuart raised the stakes on his wager to \$2000. So let's have a reminder what that wager was:

I'll bet \$1000 (now \$2000) with the first person who cares to take me up on it that the international oil agencies will never report sustained Saudi production of crude+condensate of 10.7 million barrels or more.

In BP currency of C+C+NGL that equates to around 12.8 million bpd. Figure 9 shows the fundamental difference between my position and Stuart's and also illustrates why I'm not about to take on Stuart's bet. Stuart has called a peak in Saudi production in 2005 and no matter how many wells they now drill, he forecasts that production will continue to slide in a manner similar to that shown. My position is that recent falls in Saudi production reflect voluntary restraint achieved by retiring wells and that production may rise again in the future, **dependent upon global demand picking up**.

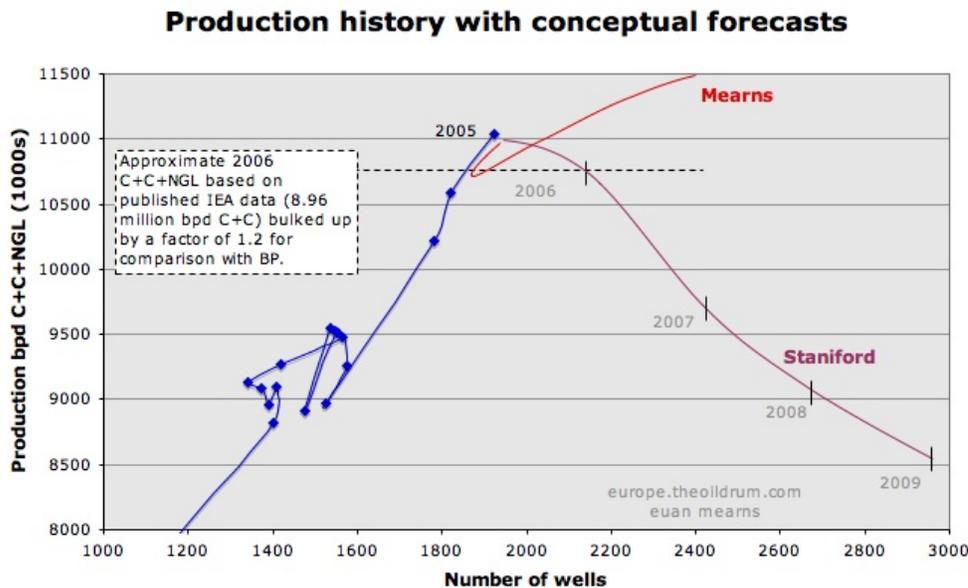


Figure 9 Detail from Figure 8 showing production history from 1991 to 2005 with conceptual forecasts. The plum coloured line is Stuart's more optimistic scenario from his [post of 8th March](#) (green line with ?). I have shown the number of producing wells increasing at a rate of 250 per year (the last year with data was 2003 where over 250 oil and gas wells were drilled) and this results in an average well productivity below 3000 bpd by 2009. This would be a truly phenomenal collapse from 2005 levels of 5700 bpd. The red line illustrates conceptually how I see Saudi production evolving. I cannot place a time line on this as I see Saudi production linked to the global demand supply balance. The key features however are falling production linked to well retiral followed by resumption of growth but at a lowered gradient reflecting anticipated lower well productivity in future (11.5 million barrels per day from 2400 wells equates to 4800 bpd per well).

So what difference does this make for global energy markets? A look at the oil demand forecast for 2007 from the IEA gives some insight.

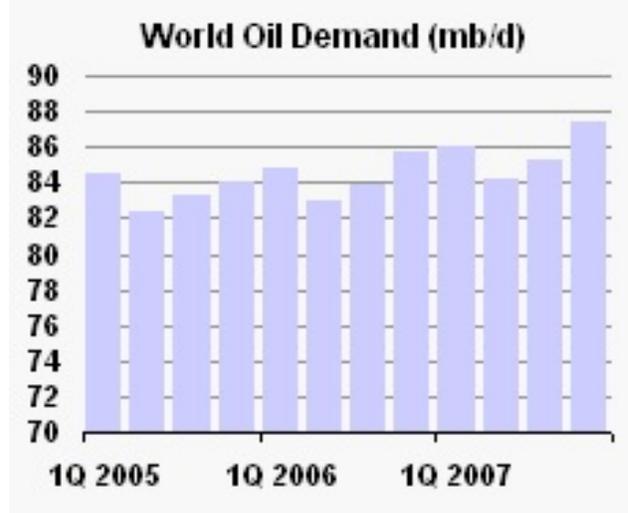


Figure 10 [IEA demand forecast.](#)

The IEA are forecasting demand to rise strongly by around 3 million bpd between the second and fourth quarters. Saudi Arabia would normally be the main country called upon to meet this increased demand. If Saudi production falls instead by around 1 million barrels per day, as modelled by Stuart, then a supply crunch and energy crisis will likely unfold. According to my view, Saudi Arabia, together with other OPEC countries will raise production to meet this demand challenge. We will see another squeeze on reserved capacity, higher prices and demand destruction, essentially repeating the cycle of 2005 / 2006. Every squeeze such as this will bring us one step closer to peak oil which I still see as 2012±3 years.



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