The Oil Drum: Europe
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North Sea Petroleum Reserves

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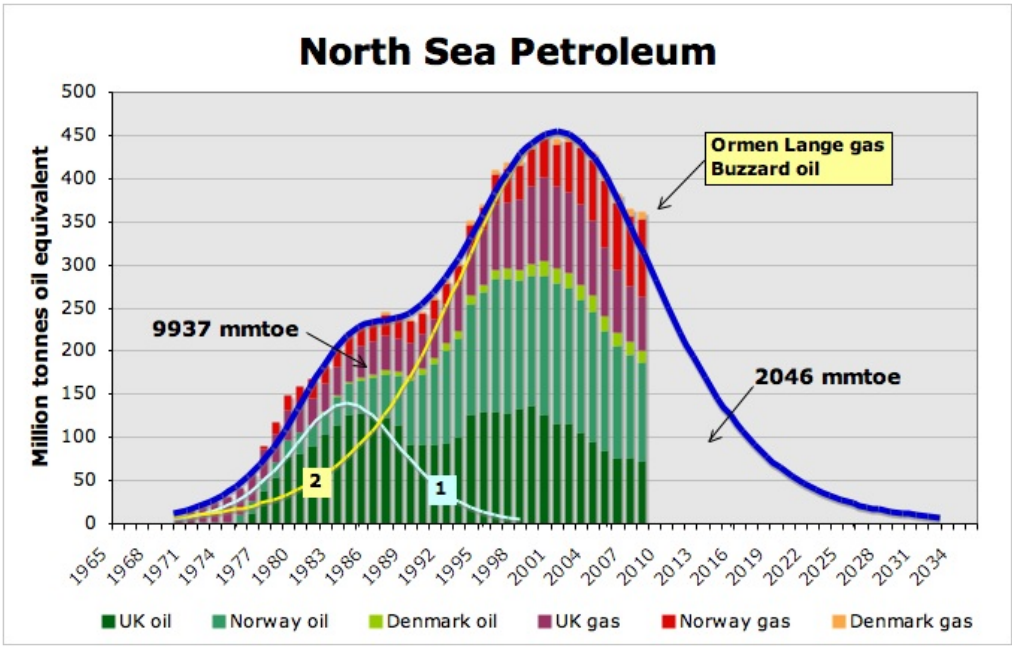


North Sea petroleum (oil+natural gas) production from 1970 to 2008 can be modeled to fit two Hubbert cycles. The first cycle represents surge production from the giant UK oil fields, **Forties, Brent, Piper and Ninian.** Actual cumulative production was 9937 million tonnes oil equivalent (mmtoe) 1970-2008 whilst the area beneath the two Hubbert curves is 9665 mmtoe - a difference of 2.7%.

To what extent the second Hubbert cycle will describe the decline in oil and gas production is highly pertinent but also uncertain. There are signs that the decline trajectory has already been influenced by a third cycle of giant field development with the Buzzard oil field and Ormen Lange gas field both coming on stream in 2007. The impact of this third cycle is shown below the fold.

In a February 2000 paper, **The Hubbert Curve: its strengths and weaknesses**, Jean Laherrere advises that the Hubbert curve works best where:

- There are a large number of fields
- Where exploration follows a natural pattern unimpeded by political events or significant economic factors
- Data from a single petroleum province can be amalgamated across international boundaries

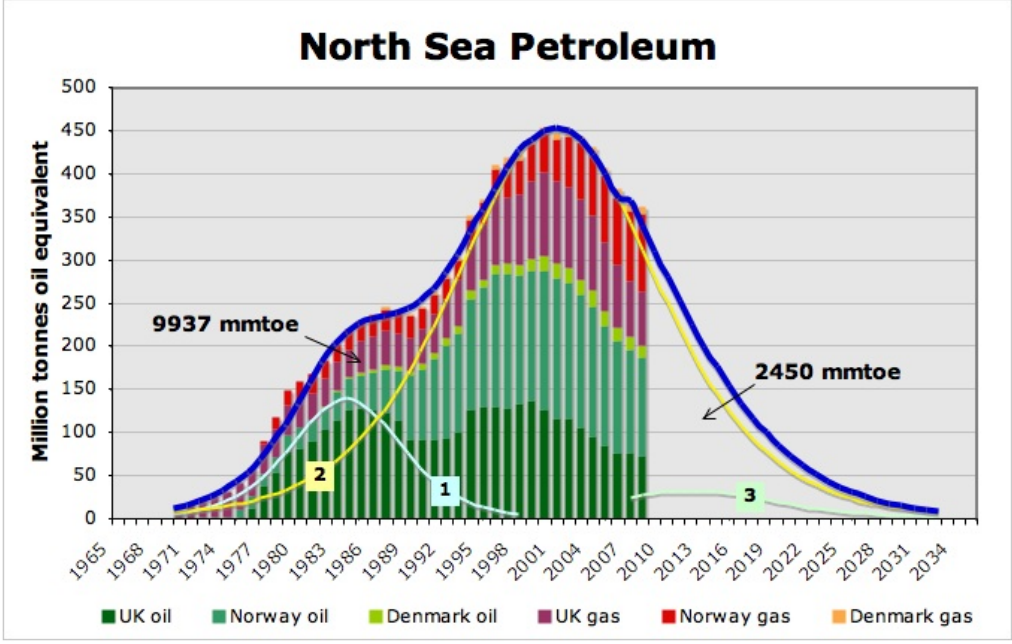
Not many data sets meet these criteria, including those for the North Sea and it is clear from the production data that they do not follow a single Hubbert curve. The overall structure is heavily

influenced by the double top in UK oil production brought about by the oil price collapse of 1986, that delayed on-going field development plans, and the Piper Alpha oil rig explosion of 1988.

The BP statistical review allows data to be combined from the four countries with significant North Sea oil and gas production - UK, Norway, Denmark and The Netherlands - but combining these data masks the fact that some production comes form outside of the North Sea. The UK has significant production on the Atlantic margin and in the Irish Sea, while Norway has significant production from the Haltenbanken area off mid-Norway. Strictly speaking these are separate petroleum basins.

Dutch production from the giant Groningen gas field is excluded from this analysis for two reasons, 1) it comprises an earlier discovery cycle to the rest of the North Sea and 2) production is capped by the Dutch government, hence it is not exempt from political influence.

Notwithstanding these known limitations, I wanted to see if production data could be fitted to two Hubbert curves in order to see what remaining reserves and future decline might look like. The chart up top is produced by trial and error on a spread sheet, where 4 variables may be changed: 1) start and end date, 2) peak date, 3) peak flow, and 4) gradient [notes 1, 2 & 3]. The chart up top shows what I consider to be a good fit, with the noted exception that 2007 and 2008 data are deviating from the expected decline. Knowing that two giant fields, belonging to a late discovery cycle for the province had just come on stream, it seemed pertinent to model these as a third cycle.



The dark blue curve equals the sum of the three Hubbert cycles. 1) is best viewed as surge production from the Forties, Brent, Piper and Ninian Fields when they came on stream in the early 1980s, 2) represents the main discovery and field development cycle of the North Sea, 3) represents a late discovery cycle, Ormen Lange in 1997 and Buzzard in 2001. Both fields came on stream in 2007.

Ormen Lange is reported to have reserves (gas and condensate) of 381 mmtoe and **Buzzard** 75 tonnes oil. Peak production at Ormen Lange is constrained by the capacity of the **Langeled pipeline** (25.5 bcm / annum, translating to 23 mmtoe / annum) and peak production at Buzzard is assumed to be 180,000 bpd, translating to 9 mmtoe / annum. Cycle 3 reflects all of these parameters but is modeled asymmetrical since production peaks will be reached early on in both fields. The chart above shows the impact of this cycle 3 model upon the eventual decline and

reserves.

The remaining oil and gas reserves following this analysis are 2450 mmtoe. This is somewhat lower than official reserves for the three countries that amount to 4575 mmtoe, according to BP 2009. [note 4] Over 2 billion tonnes of oil difference is quite a substantial amount. One fly in the ointment is that the giant Troll gas field in Norway has production capped by the capacity of the platform and pipeline. This is in effect a political cap, and this gigantic resource will distort the decline phase of the Hubbert curve, extending it further to the right. I have not had time to look into adjusting the analysis for this.

One feature of the logistic curve is that decline accelerates with time. The blue line has a decline rate of 9% in 2010, accelerating to 15% in 2020 and 17% in 2030. In contrast, the decline on an exponential curve is constant. The decline rate in oil fields in known to **increase with time from phase 1, to phase 2 and 3.** But rates of 15 to 17% are well above the average current decline rate for the North Sea. So what is going on here?

I need to stress that I do not consider this analysis to be a forecast. It is an exercise to see how combining Hubbert logistic curve derivatives would fit the existing production data. One scenario that may bring about an acceleration in decline is field decommissioning. High oil prices in 2002 to 2008 have delayed decommissioning of many platforms; it remains to be seen if this is reversed in the lower oil price environment. One further consideration: the word on the street here in Aberdeen is that the major drilling contractors are very short of work. This will result in accelerated decline in the years ahead.

Notes

1. Long term readers of The Oil Drum will know that math is not my strong point. This appears not to be a genetic disorder since my younger son Duncan (age 16) excels at Maths. I gave him Laherrere's paper and asked if he could prepare the Hubbert equations and spread sheet for me to use.

2. There are a number of excellent mathematicians who contribute to The Oil Drum: Sam Foucher, Luis de Sousa, Jean Laherrere and Webhubbletelescope to name but a few. If there is a better way to do this then constructive criticism would be most welcome.

3. Sam Foucher modeled global oil production using a series of **7 loglets** in September 2006, which is still the best multi-curve analysis of production data that I know of. I'd be interested to know how this model is standing up to the rigors of time.

4. To convert billion cubic meters gas to mmtoe, the conversion factors recommended by BP have been used - 1 BCM = 0.9 mmtoe.