More on the Systematics of Hubbert Linearisation

Posted by Euan Mearns on September 12, 2007 - 10:00am in The Oil Drum: Europe
Topic: Supply/Production
Tags: coal reserves, discovered undeveloped, gas reserves, hubbert linearization, production capacity, yet to find [list all tags]

An empirical study of the impact producing at below capacity has on the Qt intercept of a Hubbert Linearisation (HL) shows exact proportionality. If a country produces at 90% of capacity, the Qt intercept is 90% of actual URR (ultimate recoverable reserves) and so forth.

On this basis the following methodology for applying HL is proposed.

$$URR = \frac{HLi}{Cf} + DU + YTF$$

URR = ultimate recoverable reserves
HLi = Hubbert Linearisation intercept
Cf = production capacity factor (actual production / capacity)
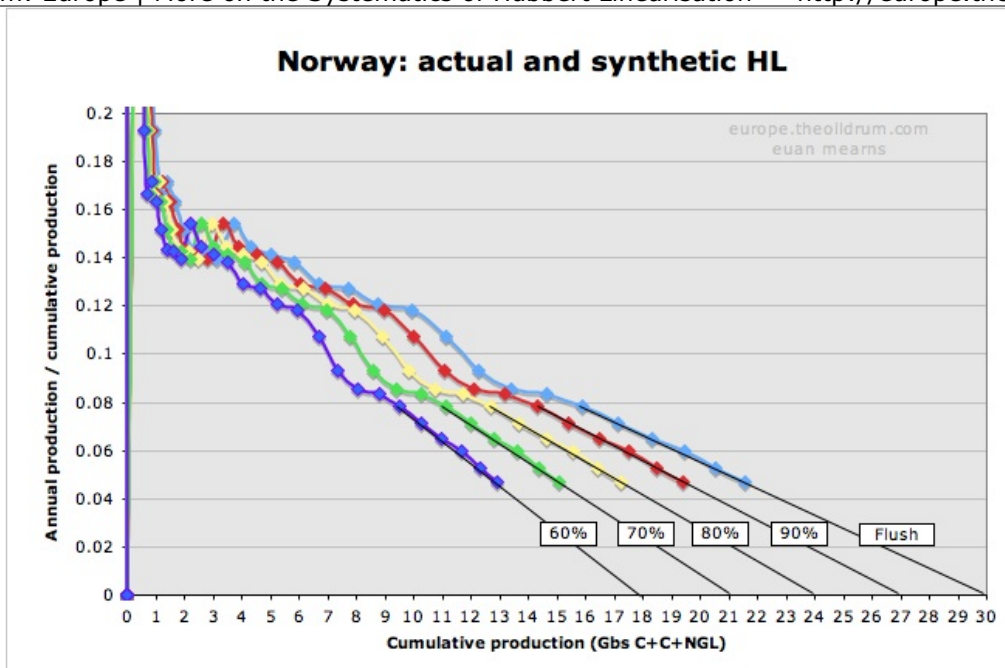DU = discovered undeveloped
YTF = yet to find

Background

This post is aimed at bridging the gap between a face value interpretation of reserves based on the Qt intercept of a well-defined linear decline trend on Hubbert Linearisation and a more progressive interpretation that takes into account political and wider economic interference with resource exploitation.

Empirical approach

The actual crude + condensate + natural gas liquid (C+C+NGL) data for Norway as published in the **BP statistical review of world energy** are used to model the effect of producing at below capacity upon the HL Qt (URR) intercept.

The Norwegian data have been modelled at 100% (flush production), 90%, 80%, 70% and 60% of capacity and the results are shown below.

Norway: actual and synthetic HL

In advance of doing this exercise I was pretty sure that Qt would be reduced with below capacity production, but I was not sure about the nature of the relationship.

The experiment shows exact linear proportionality. If a country is producing at 90% of the built oil production capacity the Qt intercept gives a false low result for URR that is exactly 90% of actual URR and so forth.

Methodology

HL provides information on the **developed resources** in any given country. It says nothing about discovered undeveloped (DU) and yet to find reserves (YTF). In many countries, the size of the discovered undeveloped and yet to find resources are relatively small if the petroleum industry is mature. The majority of discoveries will be on production and most areas will be thoroughly explored. The HL for a mature country producing at capacity may provide an indication of that country's URR.

However, in countries where political interference has guided the resource development strategy, oil fields may not have produced at capacity and the full resource base may not have been produced following a single, commercial development cycle. In these instances the following methodology is proposed.

$$URR = \frac{HLi}{Cf} + DU + YTF$$

URR = ultimate recoverable reserves
HLi = Hubbert Linearisation intercept
Cf = production capacity factor (actual production / capacity)
DU = discovered undeveloped
YTF = yet to find

A correction should be applied for producing at below capacity. And allowance should be made for discovered undeveloped and yet to find reserves. I suggest this approach should always be followed but as already noted, in mature areas Cf will equal 1 and the size of DU and YTF are likely to be small. Hence the first order approach and this modified methodology will yield similar results in mature countries.

In countries that carry large volumes of DU reserves and which have produced for long periods below "capacity" it is very difficult to accurately estimate Cf and the size of DU reserves.

The variables of Cf, DU and YTF should always be taken into account when applying Hubbert Linearisation - be it to oil, gas or coal reserves.