

Forecasting Production from Discovery

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Abstract

Since oil has to be found before it can be produced, production mimics discovery after a time-lapse. The relationship is well illustrated by the example of the US Lower-48, provided backdated *Mean* reserve estimates, as opposed to current *Proved Reserves*, are used. The distinction is important because the term *Proved* is a financial term defined by Stock Exchange rules. We seek the best estimate of what is physically producible, described in technical terms as having a *Mean Probability*.

The first step in forecasting world production is to define what to measure, as there are different categories of oil, including conventional and non-conventional crude oil, synthetic oils, natural gas liquids and processing gains. The second step is to obtain a complete database, with revisions properly backdated to discovery date.

Published data on reserves, as compiled principally by OPEC, the Oil & Gas Journal, World Oil and the BP Statistical Review, are grossly unreliable. Many countries, especially those vying with each other for OPEC quota based on reported reserves, have implausibly failed to revise their estimates for years on end, despite production.

Individual oilfield estimates are confidential in most countries except the United Kingdom, Norway and US federal lands. Such information is available only at great expense from commercial databases from spying (scout) companies, such as IHS or Wood Mackenzie, and is of variable quality. These databases differ greatly between themselves, and there are differing treatments. Some list all discoveries while others report only those worth developing. Unconventional reserves vary largely. The discrepancy between the several scout world present cumulative discoveries is larger than my estimate of undiscovered reserves.

US *Mean* discovery prior to 1990 is contained in a US DoE report giving the oil and gas reserves by year of field discovery, whereas that after 1990 can be found in the MMS field estimates and the US DoE/EIA annual reports. The reserves reported by the Soviet Union were based on the maximum theoretical recovery, and have to be reduced on the basis of field production decline analysis to obtain a *Mean* value.

So-called *Reserve Growth* is another source of confusion. Revisions to *Mean Probability* reserves are statistically neutral, whereas *Proved Reserves* tend to grow over time as they become commercially confirmed for financial purposes. The probability of the US DoE *Proved Reserves* estimates has decreased since 1970 from 75% to 50% now. Negative revisions now exceed positive ones in US offshore areas.

For these reasons, it is a major challenge to select from different technical sources the most reliable input data for study and analysis. I have gathered my own world field inventory of mean values, which differ from other sources, being a synthesis of all.

Once the best available information has been selected, it can be analysed with the help of *Creaming Curves*, which plot cumulative discovery against cumulative *New Field Wildcats*, to estimate the ultimate potential recovery by country and region. Such plots display several hyperbolic cycles.

Future production can be forecast from *Ultimate* values using several bell-curves. In the case of the United States, M.K Hubbert in 1956 showed that, with only one curve, an *Ultimate* of 150 Gb (billion barrels) (his estimate) delivered a peak of production

in 1965, whereas an *Ultimate* of 200 Gb (highest estimate from an enquiry) produced one in 1970, which proved to be correct.

Another simpler approach is correlate smoothed annual discovery and production trends after a time-lag, which may vary from 5 to 40 years depending on circumstances. It gives satisfactory results except where production has been artificially constrained by for example OPEC quota or war. A variant of this approach is to compare cumulative discovery with cumulative production.

Studies based on these methods indicate that the World Ultimate Recovery for crude oil is about 2 Tb (trillion barrels), with a further trillion comprising Extra-Heavy oil, Natural Gas Liquid, Synthetic oil and Refinery Gains.

Forecasting Natural Gas production by these methods is less satisfactory as it is more regional in character and subject to local market constraints. But it is clear that supply is set to fall steeply in North America and later in Europe.

Careful study of existing data can provide a useful indication of future production, but more reporting transparency is needed to refine the analysis. Production forecast will improve only when field reserve data is more reliable, in particular in OPEC countries, but it will only occur when quotas are definitively abandoned.