The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

Predicting Future Supply from Undiscovered Oil

Posted by Sam Foucher on November 26, 2008 - 10:05am
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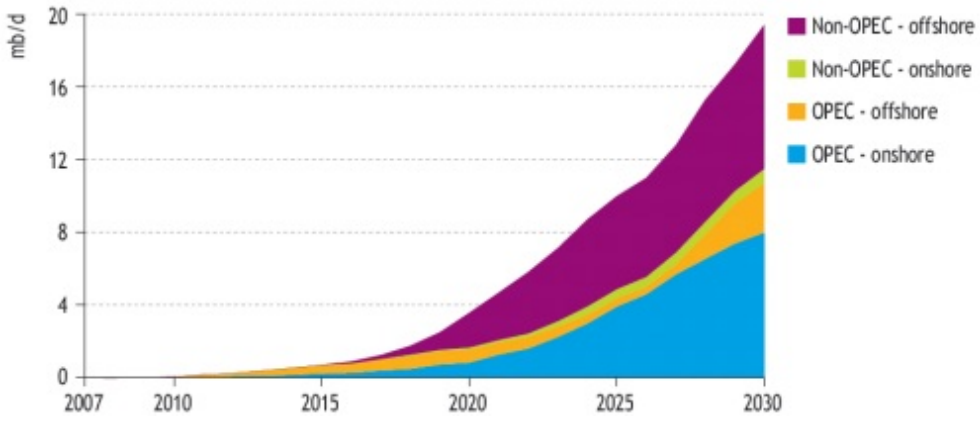
> *"Now what is the message there? The message is that there are known "knowns." There are things we know that we know. There are known unknowns. That is to say there are things that we now know we don't know. But there are also unknown unknowns. There are things we don't know we don't know. So when we do the best we can and we pull all this information together, and we then say well that's basically what we see as the situation, that is really only the known knowns and the known unknowns. And each year, we discover a few more of those unknown unknowns."*
>
> **— Donald Rumsfeld**

The shock model, originally proposed by WebHubbleTelescope, is an attempt to link discovery data, reserves and production (see this post and this post for more details). Put simply, it is based on the observation that the oil production cycle results in a time shift and dispersion of the original discovered resources. In other words, there is a delay between first discovery and a mature oil production as well as a transformation of the original discovery curve imposed by the available production infrastructure. In its last report, the IEA is proposing the following forecast for supply for yet-to-be-found (YTF) oil fields:

Figure 11.9 • World crude oil production of yet-to-be-found oilfields in OPEC and non-OPEC countries by location in the Reference Scenario



Unfortunately, they offer few details on how this result was obtained except that they are forecasting 114 Giga-Barrels of new discoveries between 2008 and 2030 that once developed will bring around 44 Gb of new supply until 2030. I propose to see if this result could be derived from the shock model.

Optimistic Scenario

Between 1995 and 2005, nearly 110 Gb of conventional oil and NGL have been discovered (see Rembrandt's story for details). A reasonable, but optimistic, scenario is to assume that this pattern of discovery will remain the same for the next 22 years. An easy way to reproduce the observed variability in annual discoveries is to choose randomly a sample among the previous ten years for each of the next 22 years (this method is called bootstrapping in statistics). This approximation is optimistic for two reasons: one would normally expect discoveries to decline over time, and this model does not reproduce this result. Also, the mean of this distribution is 10.7, while the historical mean during the 1995 to 2005 period was only 10.0.

The shock model will then smooth out, shift and spread over time the original discovered volume. This transfer function simulates the effect of the necessary extraction infrastucture that has to be planned and built transforming the original discovery strike. An important parameter in this model is the average time delay for each phase (planning, building and maturation). We assumed 3 years for planning and building and 2 years for maturation. With these assumptions, it takes an average of 8 years between first discovery well and the time oil production is mature and reaches a production plateau. In addition, it is very likely that this average time shift will get larger in the future because of the increasing remotness and technical difficulties of new projects as well as the recent hostile investment environment.

Once the developed discovery volumes are simulated, production can be derived by assuming a fixed extraction rate. Here, I used the extraction rate value (0.0466) derived by Andrew Pickering from an anlaysis of the relationship between proven reserves and production.

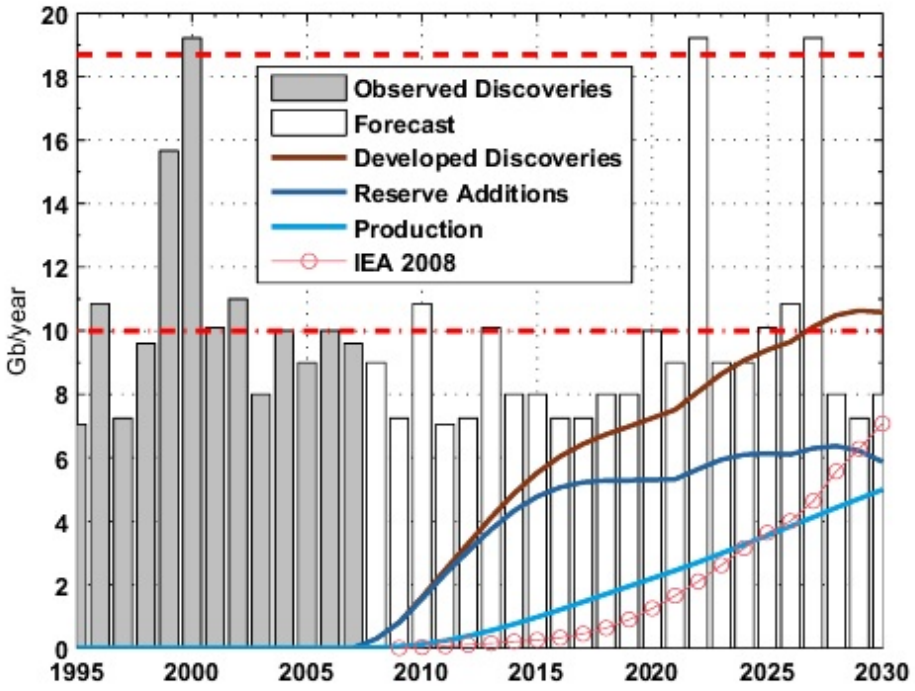


Figure 1. Optimistic scenario with a constant discovery rate of 10.7 Gb. Discovery data from the ASPO.

Discovery data is quite noisy, so we repeat the same procedure several times and take the average (Monte-Carlo procedure):

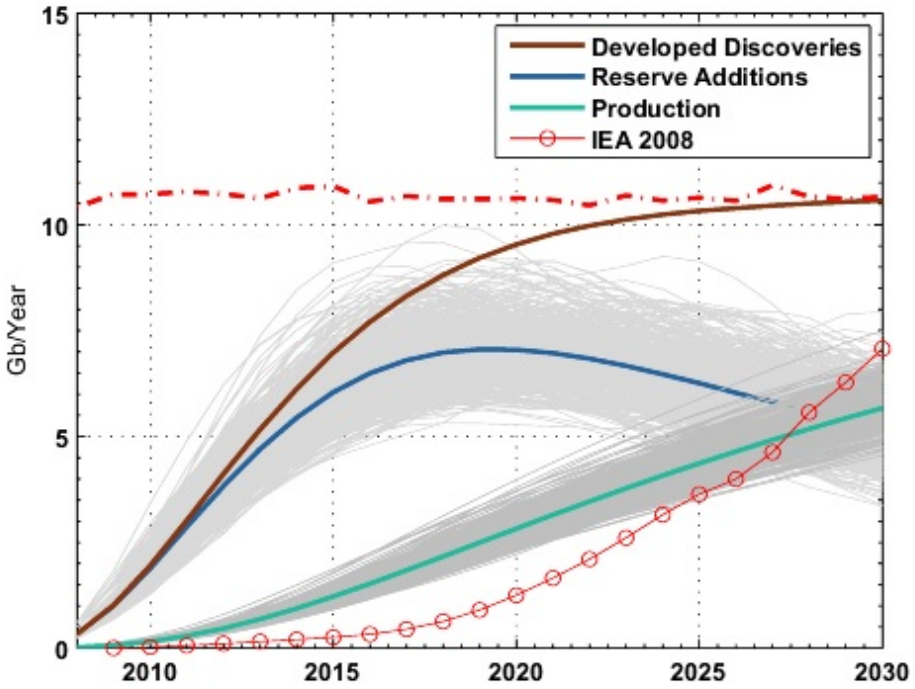


Figure 2. Results of the Monte-Carlo estimation (500 runs), the dotted red line is the average annual discovery volume (10.7 Gb/year). The extraction rate is K=0.0466. Data for this figure in ascii format here.

We can see that under the optimistic scenario, we can reproduce total extraction over the period close to what the IEA is proposing. The difference may be that their extraction rate is higher and dependent on the producing region.

A More Realistic Scenario

When we look at the pattern of oil discoveries over the previous century, it is obvious that we are in the tail of the discovery curve:

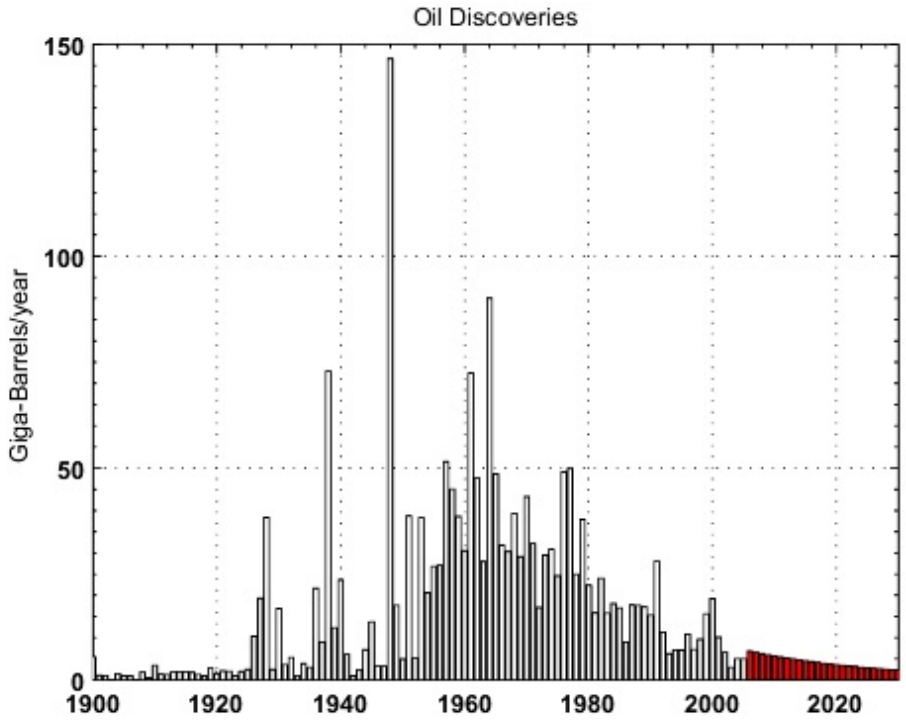


Figure 3. Backdated oil discoveries (conventional crude oil and NGL) according to the ASPO.

Therefore, it seems logical to impose the same decline pattern to future discoveries resulting in much lower flow rates.

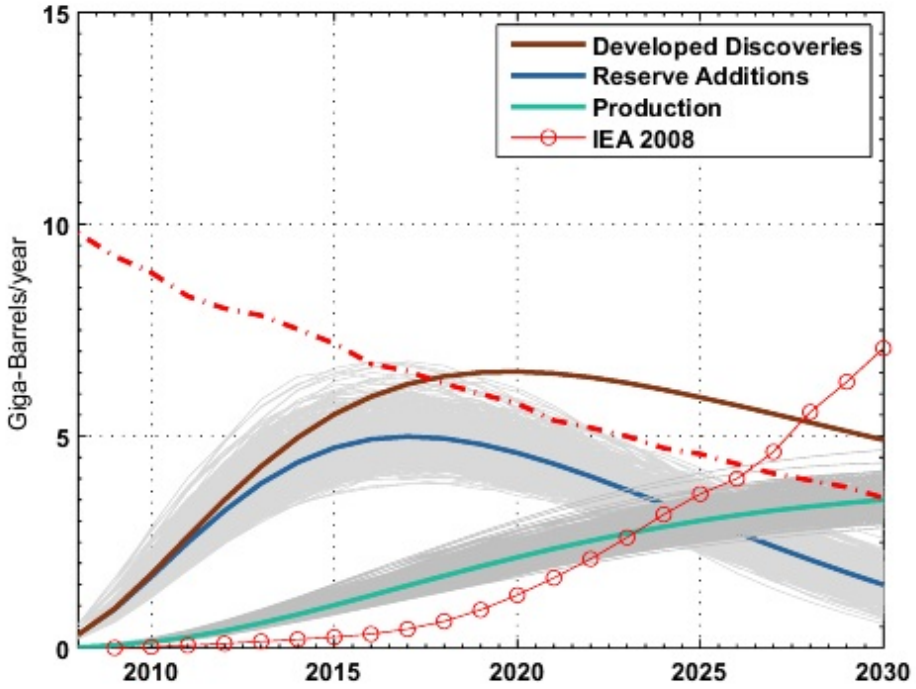


Figure 4. Results of the Monte-Carlo estimation (500 runs), the dotted red line is the average annual discovery volume. The extraction rate is K=0.0466. Between 2008 and 2030, a total volume of 144 Gb is discovered, 113 Gb is developed and 44 Gb is produced. Data for this figure in ascii format here.

What are the Extraction Rates?

For most countries, the average extraction rate based on published proven reserves is around 0.05. The extraction rate is the rate at which oil is extracted from reserves. Deepwater fields with highly productive horizontal wells can reach 0.09 and giant fields are around 0.02, based on published reserves (which may be overstated). At the world level, it is unlikely that the extraction rate will go beyond 0.05. Assuming that the IEA forecast is true, what could be the extraction rate values behind this forecast? based on the two discovery scenarios described above, we can retrieve the corresponding extraction rate profiles.

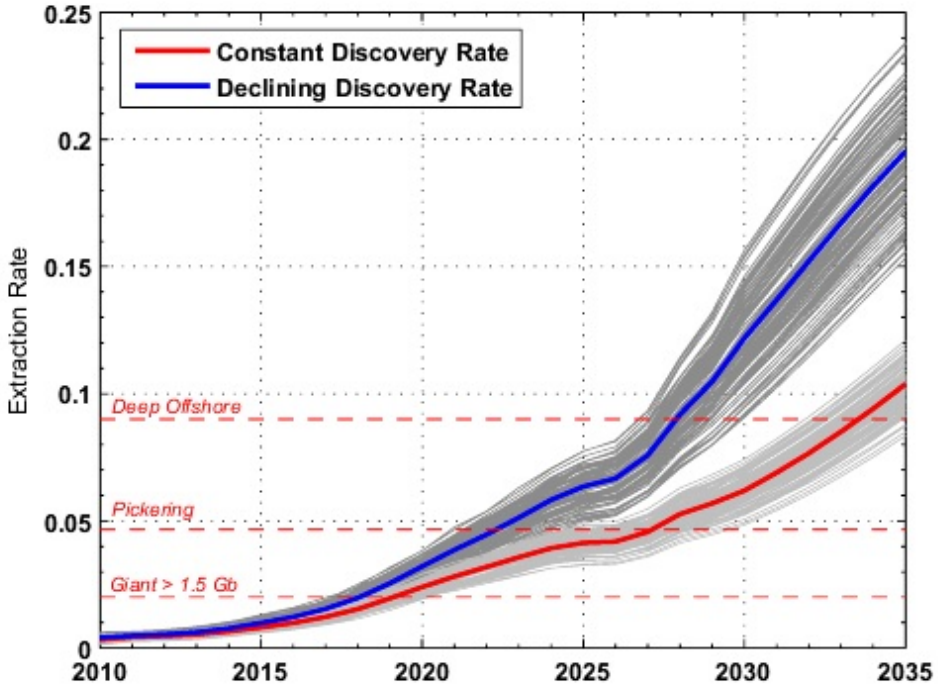


Figure 5. Estimated extraction rate profiles derived from the IEA forecast. The dotted lines are showing typical extraction rates.

Looking at the range of extraction rate values under the discovery decline scenario, it is unlikely that this steep production curve can be achieved.

Potential Impact of Project Delays

In the above simulations, we assumed an average of 8 years between oil discovery and a mature production. The production levels are strongly dependent on this average time, a small average time will result on a fast addition of new reserves and high flow rates can be achieved. On the contrary, large values will constrain production levels. Figure 6 below, is showing the impact of the average build time on the projected 2030 production level. Under the constant discovery rate scenario, the IEA forecast seems to be consistent with short build time around 3 years. When discoveries are declining, the flow rates are already constrained by declining reserve additions so fluctuations in the build time have a lesser impact.

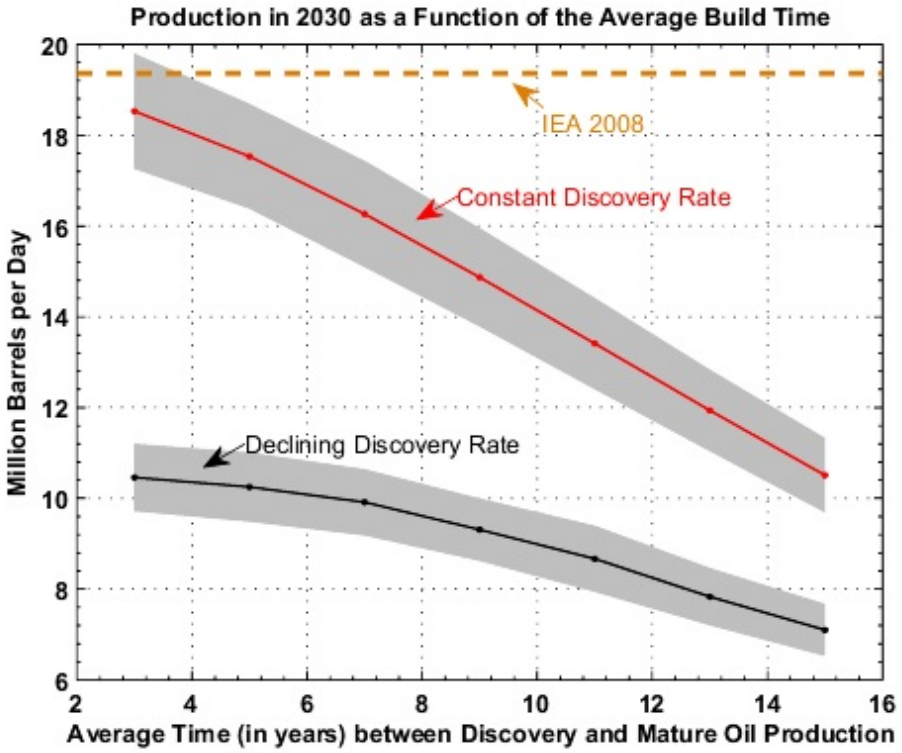


Figure 6. Impact of the average build time value (in years) on the 2030 production level. The gray areas are the 2 standard deviation bands (75% of probability).

In Summary

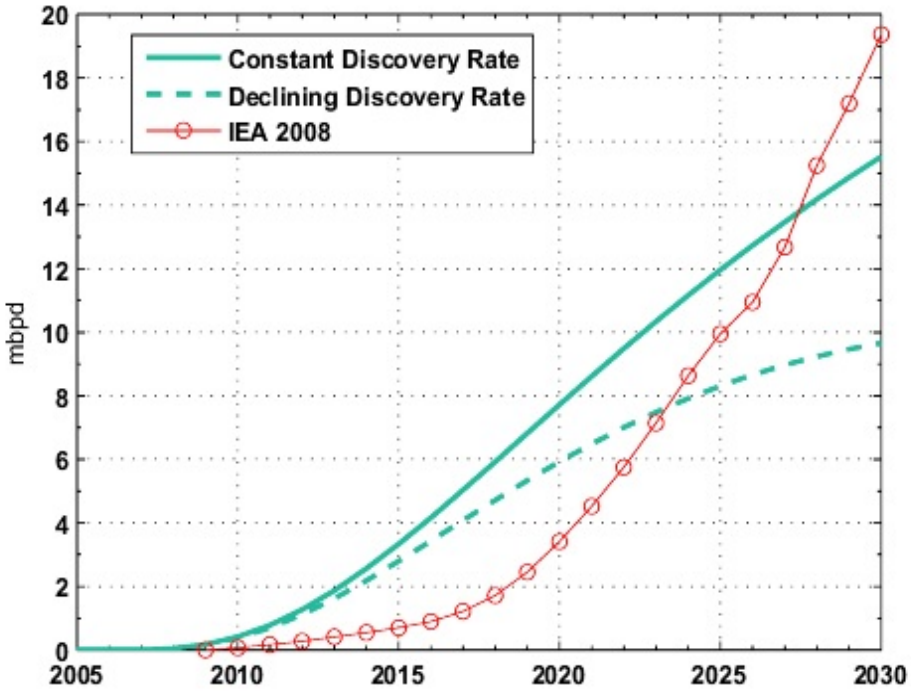


Figure 7. IEA forecast for developed YTF along with our two scenarios.

A few thoughts:

1. The IEA report is all about expected production by year, with it being important to their

story that production not decline before 2030. The IEO WEO 2008 forecast production for 2030 is 19.4 barrels a day. With the realistic estimate, the expected production in 2030 is only about 9.6 million barrels a day, and with the optimistic estimate it is about 15.5 barrels a day.

2. The IEA provides few details about what is behind this forecast.
3. A total of 114 Gb given by the IEA for YTF does not make a lot of sense, it suggests a 5 Gb/year discovery rate. The developed amount will even be lower than that around 90 Gb. It is very likely that 114 Gb refers to the total developed YTF for 2008-2030.
4. The steepness of the IEA forecast requires high extraction rates (Figure 5) unless it is based on at least a steady rate of new discoveries around 10-11 Gb per year.
5. The declining discovery rate scenario (Figure 4) does not support production going beyond 10 mbpd in 2030.
6. The combination of the current financial meltdown, collapsing oil prices, technical challenges of new projects is pointing toward higher time lags for the different oil development cycles. This will contribute to further lowering the amount of developed new discoveries.