IEA WEO 2008 - World Oil Forecasts using Wikipedia Megaprojects, Dec 2008

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In this analysis, Samuel Foucher ("Khebab") and I (Tony Eriksen or "ace") present an update of Wikipedia Megaprojects data. We also provide forecasts of future oil production, reflecting the Megaprojects data. The IEA uses megaprojects in its analysis and we reconcile our Megaprojects information to the data they provide in their report.

A wide variety of methods can be used to forecast future oil production. Each will provide different indications. Sam and I each make projections with megaprojects data, using somewhat different methods. Sam's projections are shown in Figure 6. My forecasts are shown in Figures 8, 9, and 10. Despite our differing methods, the indications we produce are all substantially lower than the indications of the IEA.

> Until quality data about production history, reserves and future development plans including capacities are obtained for fields in secretive OPEC countries, forecasts beyond 2012 are highly uncertain, regardless of the source. While quality data remain unavailable, the world's future energy security, in particular liquid fuels supply security, remains an extremely high risk.

This chart shows the IEA WEO 2008 forecast together with Sam's forecast derived from using Megaprojects sanctioned capacities and yet to be sanctioned capacities (including yet to find oil - YTF). By 2020, the IEA's forecast is significantly greater than Sam's forecast.

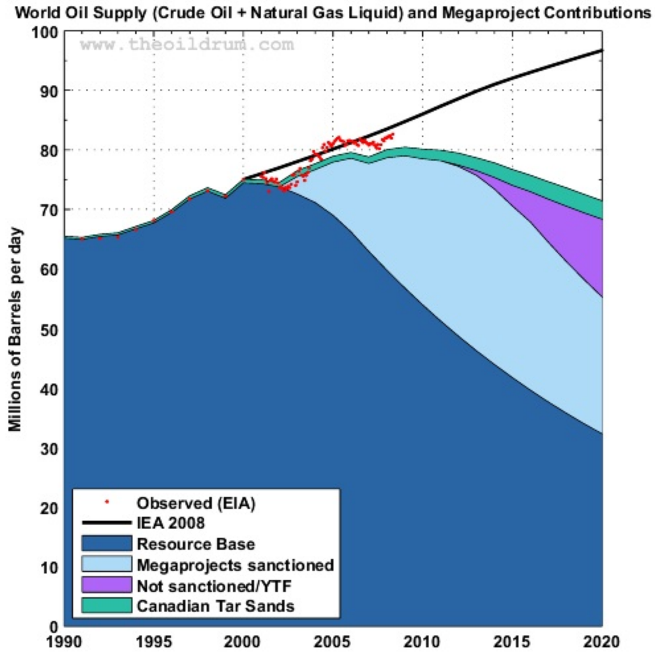

Fig 1 - Possible Future Supply Capacity Scenario for Crude Oil and NGL

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1. Background

This is a special update on the Wikipedia Oil Megaprojects Database, maintained by the Oil Megaprojects task force, to coincide with the release of the IEA WEO 2008.

Wikipedia Megaprojects was developed in late 2007. Data about each project includes country, production capacity, reserves and most importantly, project references. There are difficulties with forecasting production rates using referenced production capacities. The production capacity, provided by references, is usually the capacity of the production platform and associated infrastructure. The future production from a field is often significantly less than the capacity.

A very good example of production additions falling short of capacity additions is Brazil, for which there was almost 1,000 kbd of capacity additions in 2006 and 2007. The average crude and condensate production for the first quarter of 2006, prior to 2006 capacity addition, was 1.69 mbd. The average production for the first eight months of 2008 was 1.80 mbd, an increase of 0.11 mbd. This means that only about 10% of the almost 1,000 kbd of capacity additions became net production additions. Probable causes of this small net increase is that Brazil's existing offshore field decline rates are incredibly high and production, from new fields and expansions, is well below production targets.

Capacity Addition versus Production Addition – Pyrenees Project

An example of forecast production addition being lower than the capacity addition is the Pyrenees project, scheduled for first oil in 2010. The operator, BHP Billiton states that the capacity of the Pyrenees FPSO is 96 kbd which is much higher than the forecast 55 kbd addition, estimated using data supplied by Apache, the other Pyrenees partner.

Apache presented this chart from their October 2008 presentation. The chart shows the forecast production growth by project, net to Apache. The peak production addition from Pyrenees is 7 million barrels of oil equivalent (mboe) in 2010 which is the same as 19 kboed, slightly less than Apache's press release figure of 20 kboed. Apache has a 29% interest in Pyrenees which means the forecast total Pyrenees production is about 65 kboed.

As the forecast oil production addition is needed, an estimate of gas production is needed. Fortunately, BHP Billiton states that gas production capacity is 60 million cubic feet of gas per day which is equal to about 10 kboed. Consequently, the forecast oil production addition is about 55 kbd, the peak in 2010, much less that the FPSO capacity of 96 kbd.

Apache's forecast production from Pyrenees also shows a high decline rate, a common characteristic of many small offshore field developments. In 2010, annual production is forecast to be 55 kbd and in 2014, only 15 kbd. This corresponds to an average annual production decline rate of 28%. The Pyrenees decline rate from 2010 to 2011 is almost the same at 29%.

Since Apache gave a production forecast for Pyrenees, the more accurate 55 kbd oil production addition for Pyrenees is shown in Megaprojects 2010, rather than the higher 96 kbd capacity. Unfortunately, for almost all other Megaprojects supply additions including Brazil's, the higher, less accurate, project capacity additions are shown due to a lack of data on forecast project production additions. If this important issue is not considered then oil production forecasts are likely to be too high using unadjusted Megaprojects annual supply additions data.

Megaprojects data can be used to forecast production using two methods. The first is to add up the capacity additions for each year and apply decline rates, as in the chart above. The second is to forecast production by each megaproject, then aggregate these forecasts to derive a world forecast, discussed later.

The chart below shows how capacity addition profiles have evolved since December 2007. Many of the large capacity reductions from May 2008 to November 2008 are due to excluding projects which have not yet been sanctioned, from countries such as Iraq and Iran. The latest November 2008 profile is also a result of updating from the IEA WEO 2008, oil company reports and project delays due to the current credit crisis and low oil prices.

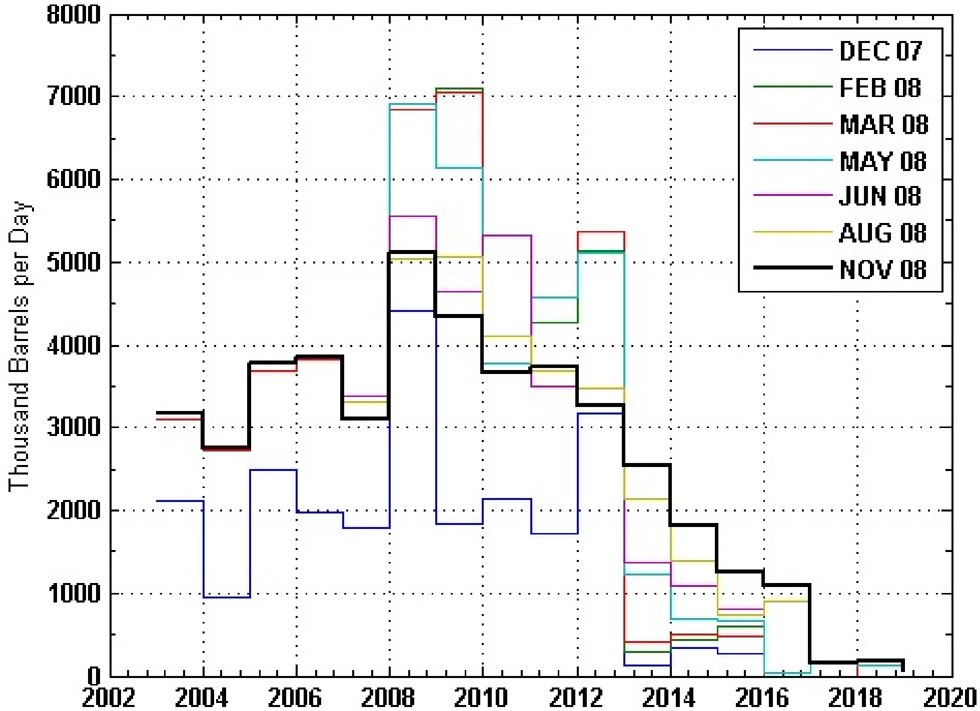

Fig 2 - Previous Megaprojects Annual Capacity Addition Profiles

2. IEA WEO 2008 Project Data

The Wikipedia Megaproject data have been reconciled to the IEA WEO 2008 project data and corresponding revisions have been made to the Wikipedia Megaprojects. Project/field names and data from WEO pages 263, 268-276, 299, 312, 313, and 314 were used for this reconciliation.

The Wiki Oil tables show capacity additions, excluding bio-fuels and including GTL/CTL, of 25.7 mbd from 2008 to 2015, inclusive. These capacity additions, unlikely to all become future production, are based on additions from projects which are likely to start. The project names and associated data contained in the WEO relate to about 16.3 mbd from 2008 to 2015. Consequently, there is about 9.4 mbd of project capacity not referred to in the WEO 2008. It would have been much better if the IEA included a full sanctioned project list, from 2008 to 2015, as an appendix to their WEO.

From 2016 to 2030, the projects the WEO considers are mainly unsanctioned projects. The WEO forecasts that all of these projects will be successful in the timeframe provided. It is doubtful that anyone can forecast individual projects accurately so far in the future. This 2030 forecast is based on hope and the validity of the WEO forecast beyond 2015 needs to be seriously questioned.

There were some differences in project capacities between Megaprojects and the IEA, but fortunately the degree of consistency was good. One of the bigger differences was for Project Kuwait. Megaprojects included only 50 kbd for Project Kuwait, since no formal development plan has been accepted by the Kuwaiti parliament, and the WEO has 450 kbd. Offsetting this difference is the Wiki forecast for Vankor at 420 kbd compared to WEO at 200 kbd. WEO has a BS500 Urugua project at 175 kbd whereas Wiki excludes this project because it was not on Petrobras project schedule from their June 2008 presentation. In contrast, Wiki has a greater project capacity for Petrobras' large Tupi discovery (300 kbd), as compared to only 100 kbd from the WEO. The WEO has a 120 kbd Burgan expansion but Wiki excludes this because no internet reference could be located. WEO has two oil sands projects of 180 kbd (Northern Lights and Muskeg River ph 2); Wiki excludes these because of indefinite delays.

3. Sanctioned Capacity Additions from MegaProjects and Yet to be Sanctioned Projects

The updated Megaprojects world supply additions are shown below. A decline in annual project capacity additions from 2008 and on is evident. In addition to the Megaprojects supply additions, the chart also includes a future capacity estimate of a total of 15 mbd for yet to be sanctioned projects, including yet to find oil. This unsanctioned/YTF capacity is expected to start in 2012 and increase to 2020.

Yet to be sanctioned capacity of 10 mbd includes capacity from discovered fields mainly located in the countries of Iraq, Brazil, USA (deepwater Gulf of Mexico), Saudi Arabia, Canada (oil sands) and Russia. In addition, there is another 5 mbd of yet to be sanctioned capacity from fields yet to be found (YTF), which is consistent with Figure 11.5 of the IEA WEO 2008. These yet to be sanctioned projects can be expected to help slow the decline of oil production in the future.

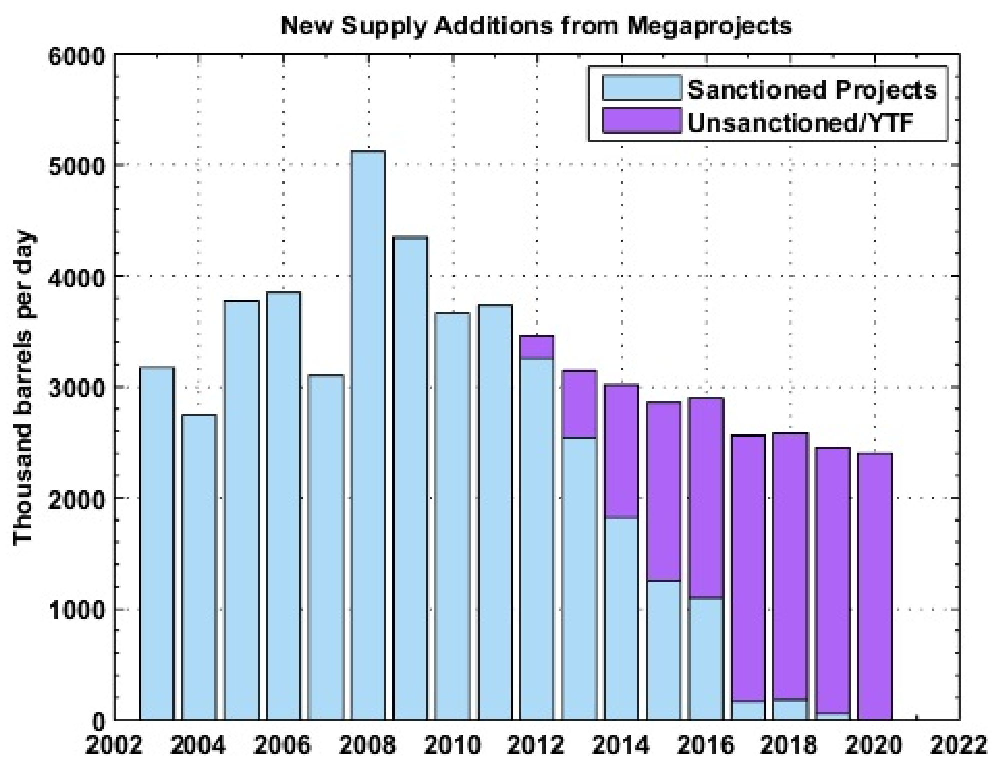

Fig 3 - Megaprojects Annual Capacity Additions and Yet to be Sanctioned/YTF Additions

The chart below shows the project contributions ranked by size. From 2008 to 2011, note the large capacity additions from projects under 100 kbd. Many of the larger projects, greater than 250 kbd capacity, are from Saudi Arabia. In 2008, there are two large NGL projects, about 300 kbd each, due to start. In addition, two other large projects are Khursaniyah, split into 300 kbd for 2008 and 200 kbd in 2009, and Shaybah, 250 kbd in 2009.

The problem of capacity additions being greater than production additions for projects was previously discussed for Brazil. This problem also applies to Saudi Arabia, as data about field reserves and production are state secrets. In the chart below, Saudi Aramco claims that Khurais will add capacity of 1,200 kbd, split into 600 kbd for 2008 and another 600 kbd for 2009. As the data quality about Khurais is poor, there is a high degree of uncertainty about Khurais true capacity additions. Instead of adding 1,200 kbd, it might add only 800 kbd.

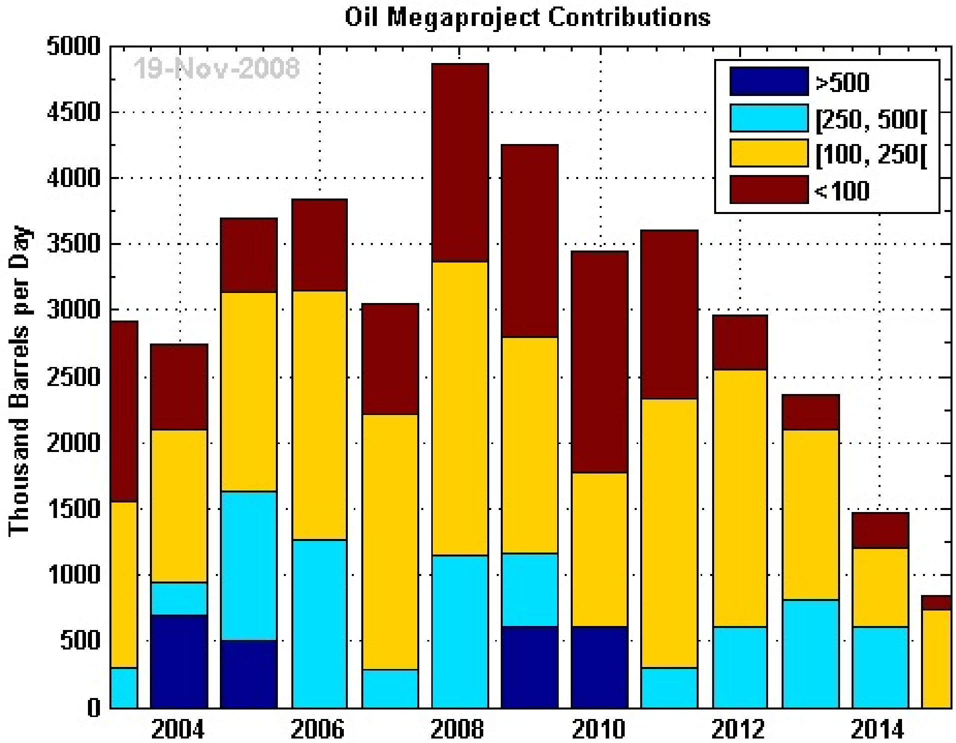

Fig 4 - Megaprojects Annual Capacity Additions by Contribution

Wikipedia Megaprojects also includes other useful charts about sanctioned capacity additions. This chart shows the estimated percentage of new supply additions from 2003 to 2020, by country. The top three contributing countries are Saudi Arabia, Brazil, Angola, Canada and Iran. An additional chart splits the annual capacity additions into the categories of crude oil/lease condensate, NGL and unconventional. Starting in 2008, capacity additions from NGL and unconventional oil gain importance. This third chart shows the annual capacity additions split between OPEC and Non-OPEC. Finally, this fourth chart shows the capacity additions from each year since 2002.

4. Production Forecast, using Annual Supply Additions

Below is a scenario for future supply growth based on the Megaproject database and a 5% decline rate for the resource base. The last monthly numbers from the EIA seem to confirm an increase in supply of about 1 mbpd, shown by the Net New Capacity additions below. 2008 should see a small supply growth from 2007. However, 2009 appears very small and given that field production additions are usually below the corresponding field capacity additions, it is highly likely the net new production addition for 2009 will be negative.

Negative additions are forecast for 2010 and 2011. Biofuels are not included in these forecasts.

Increases from biofuels production should partially offset these negative additions. 2012 and beyond show further negative additions which should be partially offset by yet to sanctioned/YTF capacity additions. Nevertheless, when all these sources of capacity additions are aggregated, the total liquids production is likely to remain on peak plateau, perhaps for another two years, discussed later and shown by Fig 9.

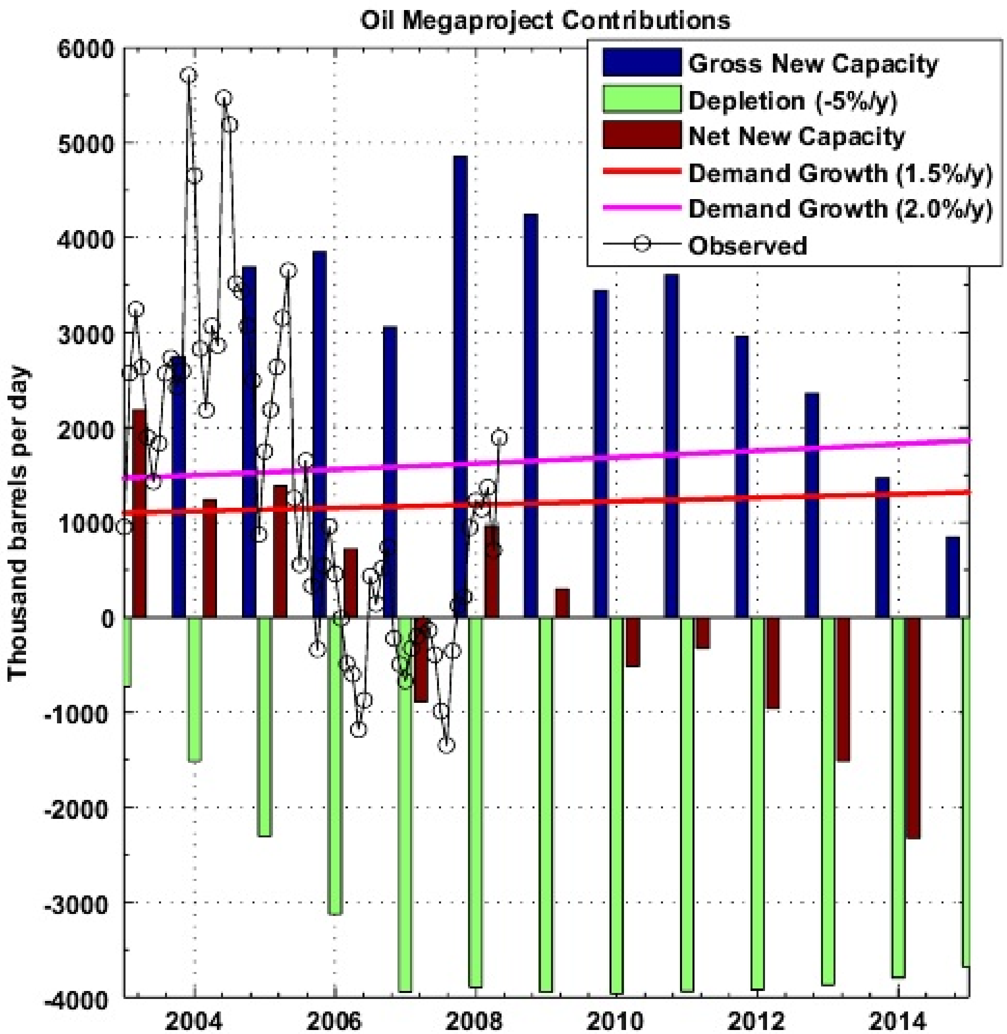

Fig 5 - Gross and Net New Annual Capacity Additions

The decline rates applied to the existing resource base and annual supply additions give the forecast in the chart below. A 5% decline rate for the existing resource base is assumed partly because this decline rate was already used by the IEA in its Medium Term Oil Market Report, July 2008. This decline rate of 5% is higher than the 4.5% decline rate used by CERA. However, considering that past forecasts of both the IEA and especially CERA have been extremely optimistic, a higher 5% decline rate is thought to be more realistic. This decline rate is higher than the least squares fit of 4.35% from the IEA WEO 2008 as discussed in the Oil Drum's recent story on The 2008 IEA WEO - Production Decline Rates. Note also that the assumption of one decline rate applying to the resource base for all years is very simplistic. Ideally, separate decline rates should be applied to each country and to each year. Note also that the assumed decline rate of 5% for the resource base is much lower than the IEA WEO's natural, or underlying, decline rate of 9% for post peak fields, from page 43 of the IEA WEO 2008 Executive Summary.

A peak plateau of just over 80 mbd is forecast for 2007 to 2011. Unfortunately, this forecast is about 25 mbd below that of the IEA in 2020. The IEA forecast is optimistic and expects that the supply should be able to increase sufficiently to meet demand, if there is sufficient investment.

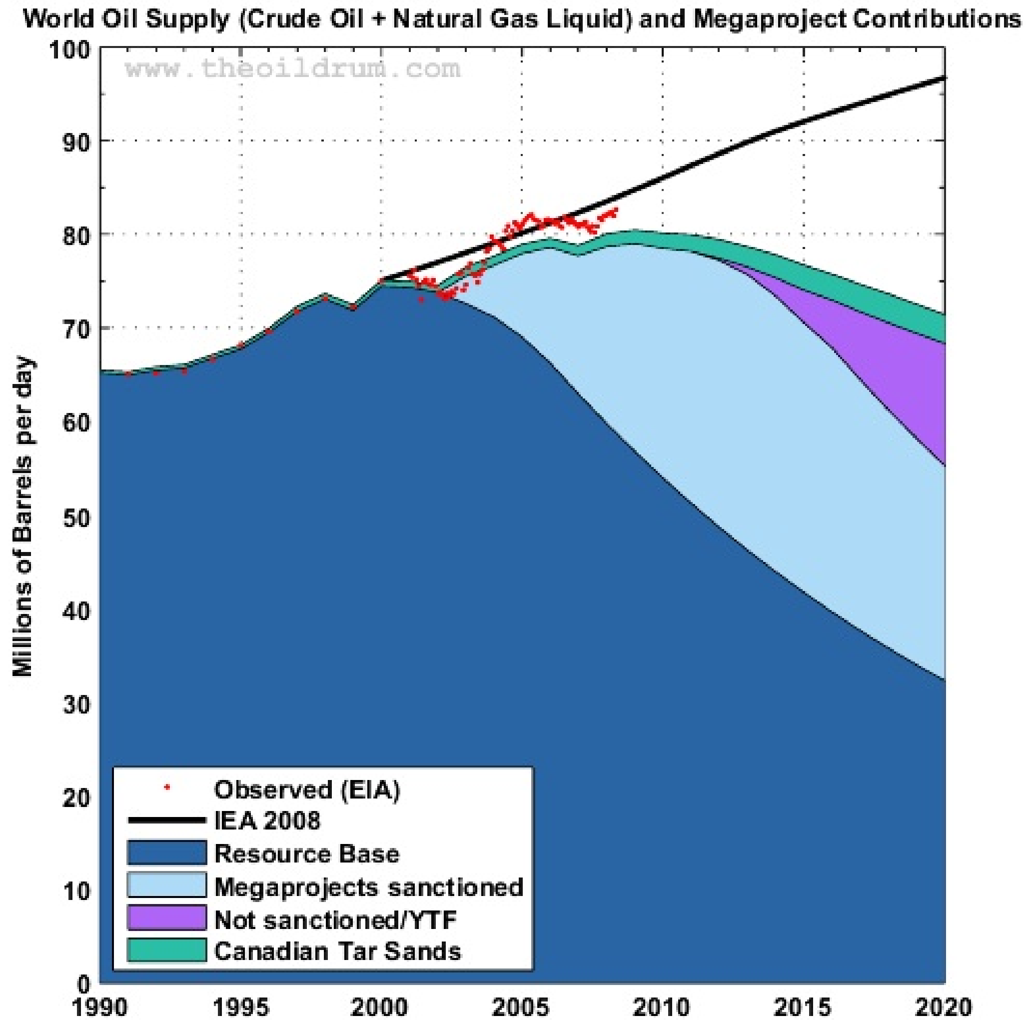

Fig 6 - Possible Future Supply Capacity Scenario for Crude Oil and NGL

An important feature of the chart above is that the forecast from 2004 using Megaprojects has been about 1 mbd below the actual production from the EIA and the IEA. This difference is to be expected as Megaprojects project data does not include data about every capacity addition in the world. Megaprojects focuses mainly on project capacity additions, from new fields, workovers and enhanced oil recovery programs, greater than 20 kbd.

The most likely explanation for most of the 1 mbd difference between actual production data and the Megaprojects forecast are production capacity increases from maintenance programs. These programs are excluded from Megaprojects and can be significant. It is commonplace to do annual maintenance on fields, for example in the North Sea and Middle East. Saudi Arabia has a Maintain Production Potential (MPP) Program. This program is not considered as a separate project to add capacity, but if this program were not done, then production declines from some of Saudi Arabia's fields would have occurred.

One of the risks of these types of MPP programs is that keeping production rates higher may cause overproduction from the reservoirs due to higher extraction rates. If the extraction rates are too high and recovery factors are not increased, then future production decline could become high as it becomes equal to the high extraction rate. Colin Campbell summarises this effect, except that he uses the term "depletion rate" instead of "extraction rate".

> *Depletion Rate* is defined as annual production as a percentage of the amount Yet-to-Produce at the end of the preceding year. It tends to increase in a country until the midpoint of depletion, when it stabilises and equates to the *Decline Rate*, the percentage change in production from one year to the next. The reason is that in practice it is mainly controlled by the large early fields, which are already in decline, giving a composite *Depletion Rate*, which effectively masks the impact of any late stage small discoveries.

The supply addition forecast from Canadian tar sands does not assume any depletion nor does it ramp up over time. Nonetheless, we get a reasonable forecast as shown on Figure 6.b below.

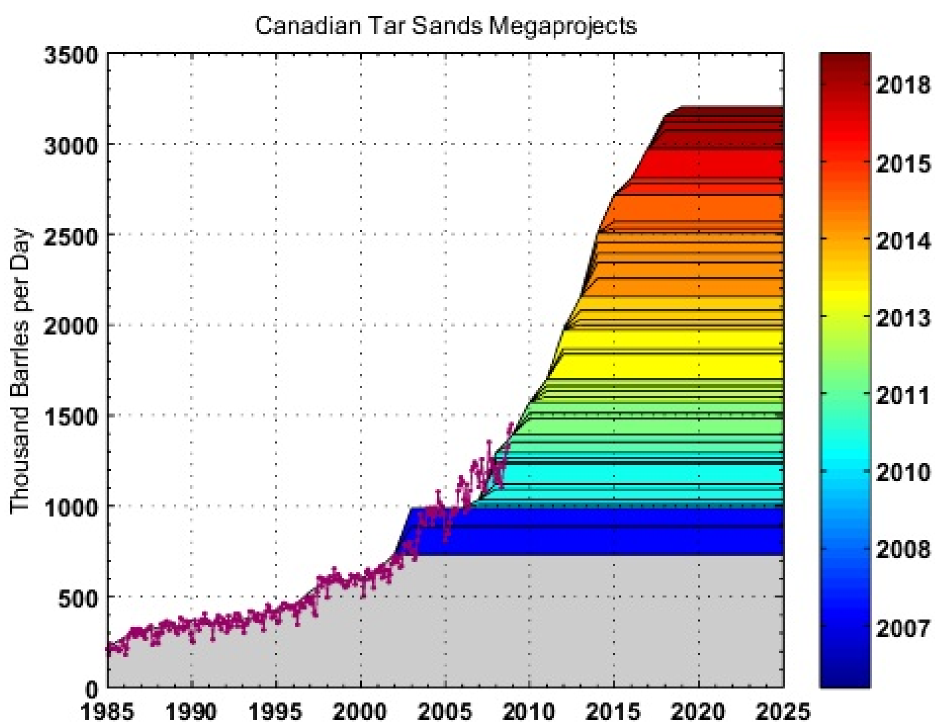

Fig 6.b - Supply Additions from the Canadian Tar Sand megaproject.

5. Production Forecasts, using Megaproject Supply Additions

The Megaprojects capacity additions can also be used to forecast oil production, based on a bottom up project basis rather than using an annual capacity basis as above. In the case of the project being a new field start-up, the field production profile takes the generic form shown in the chart below. There is a ramp up to a peak plateau, followed by sustained production, and next a production rate decline until the field is abandoned. For a small offshore field, the ramp up time can be quick in months with a very short plateau. Larger onshore fields can have peak plateau production periods lasting decades.

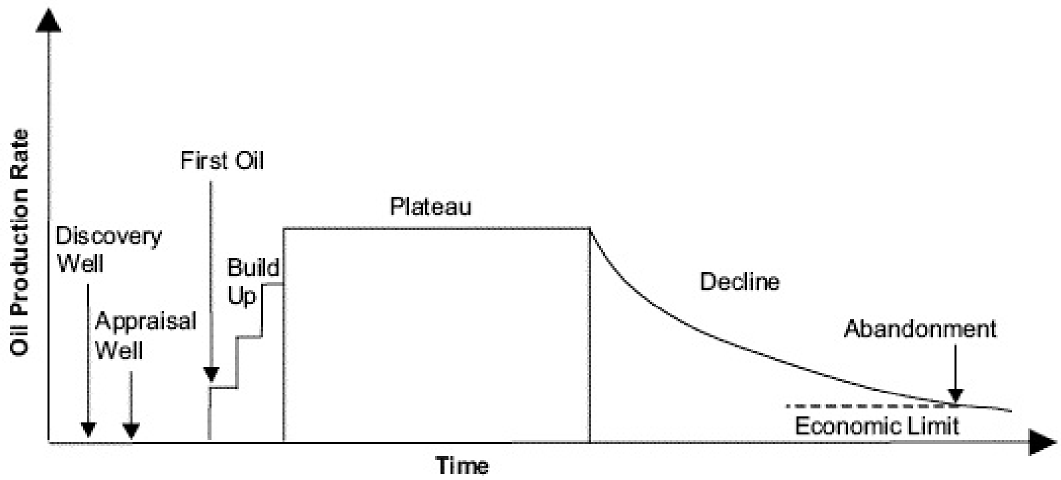

Fig 7 - Generic Field Production Profile

The 2009 Megaprojects data table has about 50 projects, a combination of new start-ups and expansions, each of which will have its own forecast production profile. The forecast production of projects from this year and all the other years are aggregated to produce a world oil forecast. If only the crude, condensate and oil sands projects are selected from Megaprojects then the crude, condensate and oil sands forecast to Dec 2012 can be calculated, and is as shown below.

The peak production month has probably occurred in the past, on July 2008, at 74.94 mbd. The production decline rate, an output of the forecasting model, is about 3%/year, starting within the next year.

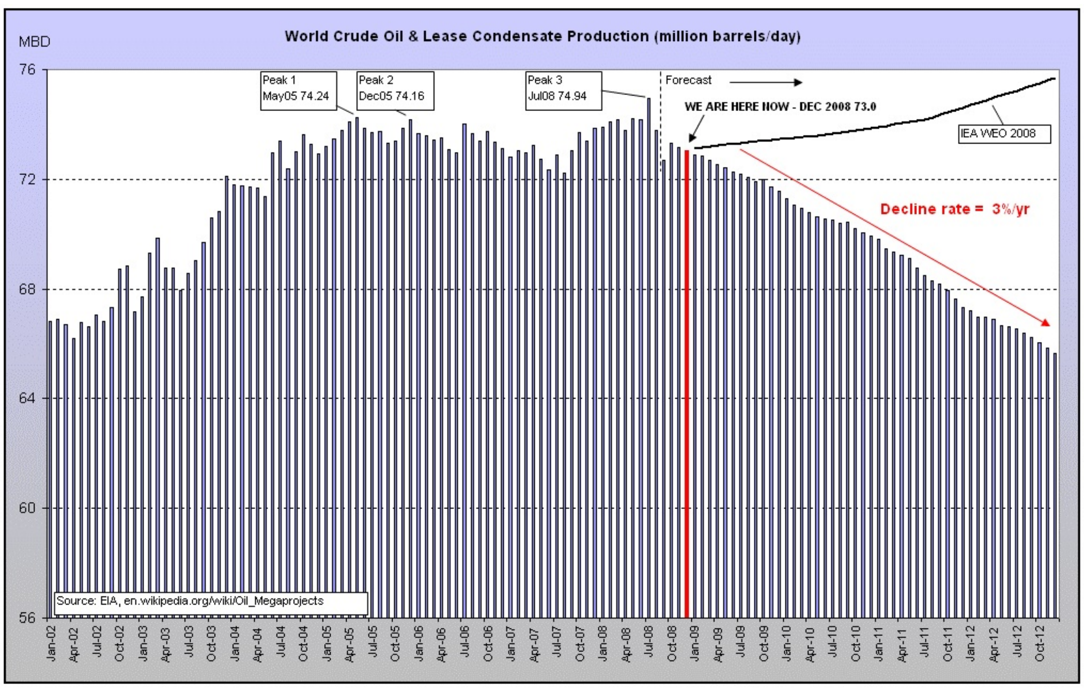

Fig 8 - Crude Oil and Lease Condensate Production to 2012 (bottom up forecast) - click to enlarge

The same procedure for crude oil and lease condensate projects can be repeated for the other project data from Megaprojects which includes data for capacity additions from natural gas liquids (NGL), gas to liquids (GTL) and coal to liquids (CTL). If bio-fuels production data and processing gains are included, then forecast total liquids can be estimated, shown in the chart below.

The peak month of July 2008 for total liquids is 87.9 mbd. This is the same as the peak month for crude oil and lease condensate. The peak year for total liquids is forecast to be 2008 at 86.7 mbd, including bio-fuels. Colin Campbell has also forecast the peak year for total liquids to be 2008 at 85.3 mbd, which is lower because bio-fuels are excluded.

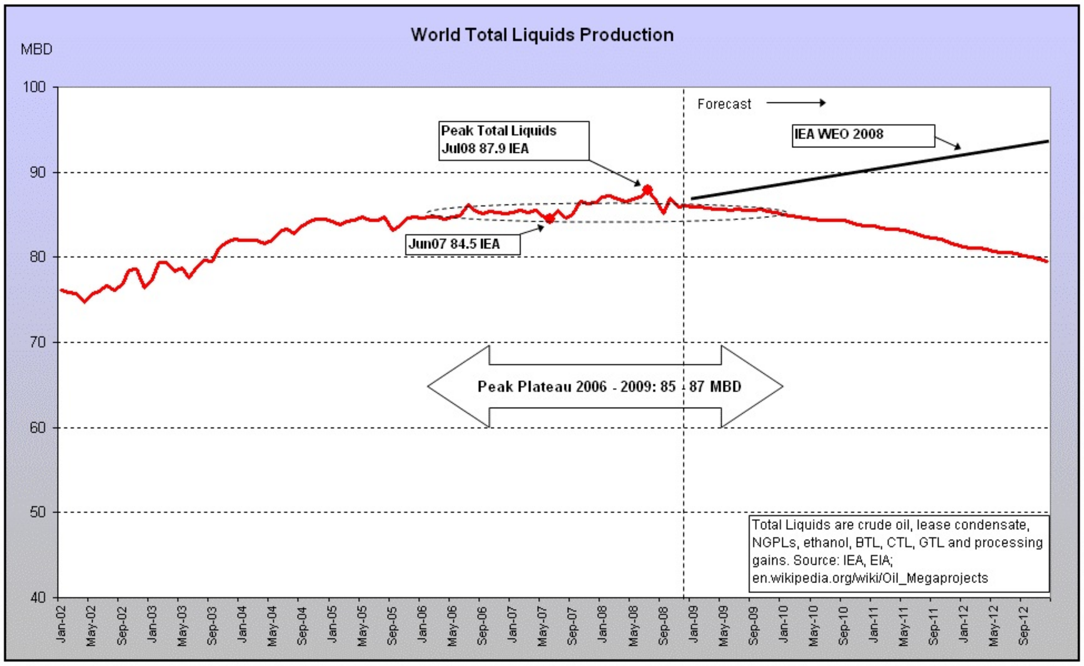

Fig 9 - Total Liquids Supply to 2012 (bottom up forecast) - click to enlarge

The total world supply additions of crude and condensate (C&C), including the yet to be sanctioned capacities, are unlikely to be sufficient to produce a rebound in the C&C production. Consequently the C&C production is forecast to continue declining beyond December 2012, possibly to the end of this century as shown below. The forecast to 2012 is from the chart above and from 2013 to 2100 is an exponential fit to the ultimate recoverable reserves (URR). The URR is a bottom up aggregation of the URRs of all of the oil producing countries.

In Figure 10, there are two forecast scenarios shown. The first, represented by a URR of 1.92 trillion barrels is shown by the red line. This scenario, up to 2020, is consistent with the sanctioned and yet to be sanctioned capacities. The second, represents a URR of 2.20 trillion barrels which is the amount estimated by Colin Campbell, from his ASPO monthly newsletter. This second scenario is possible, but less likely. Colin Campbell may use a slightly more optimistic URR but his forecast predicts peak total liquids in 2008, excluding bio-fuels, which is consistent with the forecast below.

The dark blue line shows the production profile for OPEC countries of Saudi Arabia, Kuwait and the UAE. It's an interesting coincidence that the world C&C production 74 mbd plateau occurs during the same years, 2005 to 2008, as the OPEC Core 14 mbd plateau. If further project delays occur, as a result of low oil prices and funding constraints due to the current credit crisis, then forecast C&C production could fall below the red line, after 2012.

The IEA WEO 2008 report is a start in the right direction, as it has begun its bottom up field analysis. However, for the bottom up field analysis to have meaning, third party audited data on many of the OPEC fields must be acquired. For example, in the IEA WEO 2005, an estimate of oil initially in place for the world's largest field, Ghawar in Saudi Arabia, was 300 billion barrels (Gb). In the IEA WEO 2008 it decreased down to 250 Gb. Other analysts estimate OIIP of 200 Gb. Recovery factors can only be guessed as Saudi Arabia keeps reservoir data as a state secret.

Until quality data are obtained from fields in secretive OPEC countries, forecasts beyond 2012 are highly uncertain. The forecast range in Figure 10 for 2030 is between 37 and 44 mbd, including oil sands. The IEA WEO 2008 crude and condensate forecast for 2030, from Figure 11.1 and Figure 11.12, is about 83 mbd, including oil sands. This massive forecasting difference of potentially more than 40 mbd is an extremely high risk to future energy security and will only be resolved through acquiring quality data on all of the world's fields.

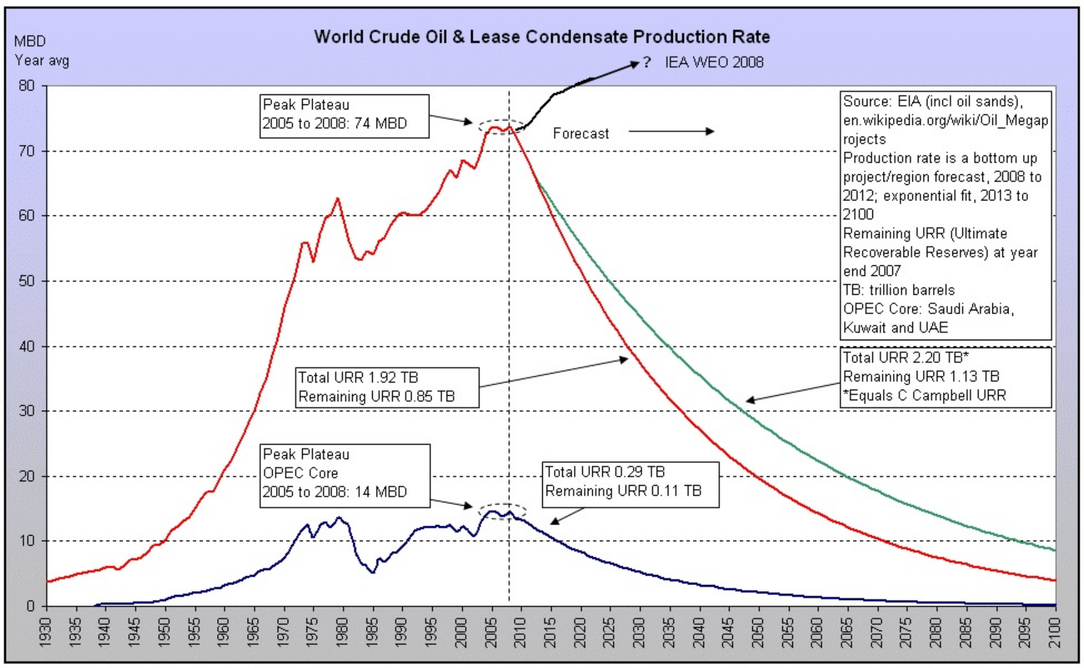

Fig 10 - Crude Oil and Lease Condensate Production to 2100 - click to enlarge

6. Comparison of the IEA WEO Forecasting Method to the Two Forecasting Methods using Megaprojects Data

The IEA WEO forecasting method assumes very low decline rates and very high remaining resources which can be changed into increased production if there is enough investment. The IEA's forecast assumes that there are almost 2.5 trillion barrels remaining conventional oil and NGLs. In reality, this number is probably closer to 1.4 trillion, an overstatement of about 1.1 trillion as discussed in the Oil Drum's recent story on The 2008 IEA WEO - Oil Reserves and Resources. Since 2000, the IEA has consistently produced optimistic supply forecasts which easily meet demand. The IEA's forecasting method leads to an overoptimistic supply forecast.

The last year that the IEA gave somewhat realistic forecasts was in their IEA WEO 1998. In this report, page 100, Fig 7.7, the IEA's forecast for 2030 was about 55 mbd, using ultimate conventional oil reserves of 2.3 trillion barrels. This number is 20 mbd less than the forecast in the IEA WEO 2008 and deserves a full explanation from the IEA.

In stark contrast to the WEO forecasting method, the two forecasting methods discussed here are based on robust project data from Megaprojects. Nevertheless, even these two methods have differences.

The first forecast method, using annual supply additions, shown in Fig 6, indicates a crude oil, lease condensate and NGL production rate of about 71 mbd in 2020. The second forecast method, using project supply additions, shown in Fig 10, indicates 56 mbd for crude oil and lease condensate in 2020, using the higher URR of 2.2 trillion barrels. A reasonable forecast for NGLs in 2020 is that from Sadad Al Husseini, at about 8 mbd, which is also similar to the number used to generate Fig 9. This gives a total of 64 mbd crude oil, lease condensate and NGL for 2020.

The first forecast method indicates 71 mbd crude oil, lease condensate and NGL in 2020, while the second gives 64 mbd, a significant difference of 7 mbd. How can two methods both using the same Megaprojects data give different forecasts? The first forecast in Fig 6 assumes that 100% of the total annual capacity addition from the Megaprojects data becomes a production addition in that year. In reality, projects can be delayed or cancelled which has a negative impact on production additions. However, the main reason for the different forecasts is that the first method uses decline rates for global annual capacity. The second method uses decline rates for individual fields which are aggregated to give country forecasts, which are in turn aggregated to give a global forecast.

A good example to illustrate the difference is Brazil. The first method would take Brazil's capacity additions and sum them together with capacity additions from other countries to get a global capacity addition. Next a single global decline rate would be applied to the capacity additions. Megaprojects shows Brazil's capacity additions of 1.53 mbd from 2004 to 2007. The production for Brazil for 2003 was an average of 1.50 mbd (EIA). The year to date average to August 2008 was 1.80 mbd. Brazil's net production additions since 2003 was 0.27 mbd based on a capacity addition of 1.53 mbd. This means that the capacity additions are not becoming production additions.

The second forecast method uses decline rates specific to Brazil, which in deepwater can be as high as 20%. In addition, almost all of Brazil's capacity additions are the nameplate capacities of the FPSOs, not the production capacities of the underlying fields. For example, a 100 kbd FPSO might be connected to a field but perhaps only 50 kbd, on an annual average, might be produced through the FPSO. Individual country forecasts can take these factors into account, which cannot be done by a forecast using global data. Colin Campbell also does country forecasts first, before doing a global forecast. His forecast for Brazil takes into account the nature of Brazil's fields and is currently showing a peak production plateau of just over 2 mbd, despite all of Brazil's claimed capacity additions.

Another example of Megaprojects capacity additions being possibly overstated is Mexico. The first forecasting method would include Mexico's capacity additions of 483 kbd, from Megaprojects 2008 and 2009, in the global annual capacity additions for those years. However, some of these Mexican project supply additions are heavy oil, requiring huge numbers of production wells, and are expected to take over ten years to ramp up to peak production. In contrast, the second method would forecast Mexico's production taking into account the long ramp up period, giving less production additions for 2008 and 2009 than the first method.

Forecasting global oil production is difficult. A project by project basis can be used to produce country forecasts. The second method aggregates these country forecasts to produce a global forecast. Jean Laherrere and Colin Campbell have been doing global forecasts for several years but using mainly a logistic curve fitted to ultimate recoverable reserves for the world. This method ignores the reality of projects needed to produce oil. Laherrere has acknowledged the importance of projects in his latest world forecast as he states that this is why, for the short term, it is better to rely on the study of already planned large oil developments = megaprojects. Megaprojects data can be used to forecast until 2012, with some accuracy. Afterwards, a mathematical production rate fit to remaining recoverable reserves can be performed to give a long term forecast, as in Fig 10.

7. Summary

The Wikipedia Megaprojects database contains extensive information about past and future projects to 2020, including many useful summary charts. The projects listed are mainly those that have been sanctioned.

Consequently, estimates are made for capacity additions from yet to be sanctioned projects and additions from yet to find oil. When all of these sources of capacity additions are aggregated then production forecasts can be made.

Both forecasting methods use Megaprojects data, annual supply additions and project supply additions, and show significantly lower forecasts than those from the IEA WEO 2008.

The IEA forecast for crude oil and natural gas liquids is just over 95 mbd in 2020, about 25 mbd greater than the 70 mbd forecast by the annual supply addition method shown in Fig 6. The forecasts, using the project capacity addition method, show lower results for the reasons discussed in Section 6. Fig 9 shows total liquids forecast below the IEA forecast. The crude oil, lease condensate and tar sands forecast in Fig 10 shows a huge gap of at least 40 mbd between the IEA forecast and the forecast assuming the higher remaining URR.

Until quality data are obtained from fields in secretive OPEC countries, forecasts beyond 2012 are highly uncertain. The IEA WEO 2008 does not have quality data on the critical OPEC countries. The huge forecasting differences between the IEA WEO 2008 and the results from the two methods discussed here represents an extremely high risk to future energy security and will only be resolved through acquiring quality data about production and reserves on all of the world's fields.

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