World Oil Production & Peaking Outlook

Peak Oil Netherlands Foundation

Rembrandt H.E.M. Koppelaar

Contact@peakoil.nl ; http://www.peakoil.nl

STICHTING PEAKOIL-NEDERLAND

Peak Oil Netherlands Foundation (PONL) was founded in May 2005 by a group of citizens who are concerned about the effects of a premature peak in oil and other fossil fuels production. The main aims of PONL are to carry out research and to raise awareness with respect to the depletion of non-renewable energy sources. PONL currently relies on volunteers for its activities. To safeguard its independency, PONL does not accept donations from companies involved in the development of either fossil fuels or alternative sources.

The author of this report, Rembrandt Koppelaar, would like to thank the editors of this report, the other people in the Peak Oil Netherlands Foundation for their work, peakoil.com & the oildrum community, C. Campbell for raising the peakoil issue since the early days, R. Heinberg for providing the first Peak Oil book the author did read, J. Laherrère for his splendid papers, M. Simmons for raising awareness regarding peakoil to new heights and writing his book, M. Lynch for his fresh insights regarding peakoil, C. Skrebowksi and CERA for making their oil project reports and last but certainly not least his family from whom he has learned a considerable amount .

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Executive Summary

It is widely known that oil, like other fossil fuels, is a finite resource. The question when oil will be depleted has been asked since the oil age began. What is less known, however, is that before oil is exhausted, it will reach a production peak. This peak can be described as the highest production level in the history of oil after which a structural decline will commence. It is important to determine the period in which this peaking will occur, in order to implement appropriate mitigating measurements. Predicting the exact timing of the peak is a difficult task however, due to a lack of reliable data.

There are large uncertainties regarding reserve data. In the 1980's OPEC stated an increase of approximately 300 billion barrels in their reserves within a few years. During this time no significant discoveries were made. It is still unclear what the true amount of reserves in OPEC countries are. The bigger problem is that there is no worldwide accepted method to account for oil reserves in place, various regions account their reserves in a different way. On top of that, oil companies, whether national or commercial, generally have a financial or political incentive to overstate the amount of oil reserves they possess.

Because of the uncertainty regarding the amount of worldwide reserves, oil production & peaking projections differ widely. We probably will never know the true amount of worldwide reserves. Therefore, it is recommended that the discussion of world oil peaking is not primarily based on oil reserves but shifts to five different areas.

1. The net decline rate for the entire world. The total amount of production declining per year from fields already past their peak.

2. The amount of production that will come from new discoveries still to be made.

3. The amount of production that can come from known reserves not yet in production

4. The amount of production that can come from implementing new technologies and insights

5. The amount of production that can come from unconventional oil

This report contains an estimate of these five factors influencing oil production. By approaching the peaking issue in two parts. First of all, by creating a detailed oil production outlook between 2005 and 2010 using oil projects announced by oil companies and estimating a decline rate for individual oil producing countries. Secondly by extrapolating on the data from this production outlook and using well-documented trends in oil production.

The central conclusion made from our research is that the production of world liquids (all oil and oil equivalent resources) will approximately peak around 2012. Liquids production is expected to form a "plateau" for approximately 6 years starting around 2010. This peak could arrive earlier if our estimate for world decline rates proves to be too low. It also could arrive later, around 2017, if oil companies succeed in improving the recovery rate of oil due to technological improvements.

This conclusion is largely based on:

- A conservative decline rate for the world in comparison to estimates made by the International Energy Agency.
- A continuation of the decline in oil discoveries since 1964. More oil has been consumed than discovered since 1986; currently twice as much oil is consumed than discovered
- Nearly every oil field ever discovered will be in production after 2010
- Moderate production increases from reserve growth (an increase in the recovery rate)

- A projection for unconventional oil production based on official data from oil producers.

Since future predictions are always quite uncertain, this world oil production & peaking outlook is not guaranteed to be accurate. However, this should not be seen as a reason to not take the peak oil issue seriously.

Current government policies in the Netherlands and elsewhere are based on the assumption of a continued access to relatively inexpensive fossil fuels. If this assumption turns out not to be true anymore, then society will face serious difficulties, as practically no precautions have been taken to anticipate such a situation. Of the various oil production outlooks, most government agencies seem to take into account only the optimistic ones, without a proper understanding of the shortcomings and implicit assumptions under which these forecasts were made (as is explained in chapter 2). By refusing to take pessimistic projections (like ASPO, PFC Energy, Douglas Westwood) into account, even as potential scenarios, policy makers make huge, ill-supported and potentially dangerous assumptions.

For an important subject as future energy supplies, one would expect the involved agencies to carefully examine the merits of each relevant forecast. The fact that the optimistic scenarios of, for instance, the IEA are cheerfully and uncritically accepted resembles in our view a serious lack of critical thinking among various well-established agencies.

Other important conclusions of this report include:

It is expected that Non-OPEC liquids production will peak and plateau around 2008.

The maximum average production growth in the period 2005-2010 rests at approximately 1.5%, a far lower level then the years 2003 (3.51%) and 2004 (4.16%). This means oil production growth levels like those in 2003 and 2004 will not be able to continue.

Because of little to zero spare capacity on the market, any oil disruption due to political, economical or natural events will have a profound effect on oil prices. A global oil shock owing to rising oil prices is likely in the period 2005-2010. At the very least, the current tightness in the international oil market will persevere. After 2010, continued price increases will become a structural problem.

Glossary of Terms

GB, giga barrel or 1000 million barrels or one billion barrels

Mb/d, million barrels per day

b/d, barrels per day, also noted in industry terms as bbl/d which refers to blue barrels per day. A term originating from the early days of the American oil industry were they used to work with barrels in a blue color.

boe/d, barrels of oil equivalents per day

EROI/EROEI, energy return on energy invested. The extraction, transport and processing of any fuel produced uses energy. EROI indicates the net energy balance for the process of producing a fuel/energy. Summarized by M. K. Hubbert as:

"*There is a different and more fundamental cost that is independent of the monetary price. That is the energy cost of exploration and production. So long as oil is used as a source of energy, when the energy cost of recovering a barrel of oil becomes greater than the energy content of the oil, production will cease no matter what the monetary price may be*"

API gravity, American Petroleum institute gravity, a term that indicates the heaviness and quality of oil. A higher gravity number indicates lighter oil and therefore a better quality.

EUR or **URR**, estimated ultimate oil recovery/ ultimately recoverable resources, Those quantities of petroleum which are estimated, on a given date, to be potentially recoverable, plus those quantities which already have been produced at that time.

Orimulsion, extra heavy oil from the Orinoco belt in Venezuela

Proved reserves, reserves of petroleum in place that can be estimated with a reasonable certainty by analysis of geological and engineering data. They must be commercially recoverable at current oil prices from known reservoirs, with current operating methods and current government regulations. Proved reserves are categorized as developed or undeveloped.

Probable reserves, reserves of petroleum in place that are less likely to be recoverable concluded from analysis of geological and engineering data. In this context, when probabilistic methods are used, there should be at least a 50% probability that the quantities actually recovered will equal or exceed the sum of estimated proved plus probable reserves.

Possible reserves, unproved reserves that are less likely to be recoverable than probable reserves concluded from analysis of geological and engineering data. In this context, when probabilistic methods are used, there should be at least a 10% probability that the quantities actually recovered will equal or exceed the sum of estimated proved plus probable plus possible reserves.

Monte Carlo Simulation, a type of stochastic mathematical simulation, which randomly samples variables. These variables can be used as distributions to simulate for example recoverable petroleum volumes.

Oil initially in place, the quantity of petroleum that is estimated, on a given date, to be contained in known accumulations, plus the quantities already produced there from.

Liquids, oil and oil equivalent resources, this includes light, medium and heavy oil, Natural Gas Liquids (NGL), tar sands or oil sands, oil shale, deepwater oil and polar oil.

Oil projects, projects that add oil production either by bringing new fields into production or by increasing production due to the implementation of technology.

Depletion, the decline in oil reserves in a given year due to production.

Depletion rate, the rate at which reserves are declining in a given year

Decline, the decrease in production in a given year

Type I decline, the decline of production in an oil field that comes from wells in the field. This decline can be offset by bringing new wells on-stream or by increasing production from other existing wells in the field.

Type II decline, the decline of production in an oil field that cannot be offset by placing new wells or by increasing production from other existing wells in the field. This decline has to be offset with a production increase in another field or region**.**

Type III decline, the decline of production in an entire country. This decline has to be offset with a production increase in another country.

Recovery rate, the amount of oil that can be extracted out of the ground at current oil prices from known reservoirs, with current operating methods, as a percentage of the total amount of oil present in the field.

1) Introduction – peaking of world oil production

Oil plays a central role in our society. We use it for a variety of purposes including fueling our automobiles and producing our plastics and food. The amount of oil we consume increases every year while oil in the ground remains finite. This makes it inevitable that one-day world oil production will reach its peak. We can describe this moment as the highest production volume of oil in the history of mankind. After this, oil production will start its structural decline.

Because industrial society is extremely dependent on oil at this moment, the peak will have a tremendous impact; it has the potential to change society as we know it. Therefore, it is tremendously important to anticipate life in the post-peak era. In order to lay out a specific plan of action, be it in conservation or in an energy transition to alternative sources, it is important to have at least a rough idea of when the peak will take place. Unfortunately, projections of the peaking date differ widely:

Source of Projection	**Projected date**	**Source of Projection**	**Projected date**
Individual Experts		**Governments**	
A. Bakthiari	2006-2007	Dutch Government (IEA HI copy)	After 2030
M. Simmons	2007-2009	French Government	2020-2030
C. Skrebowski	2007-2010		
K. Deffeyes	2005-2009	**Analyst firms**	
J. Laherrère	2010-2020	IHS Energy*	2011-2020
P. Odell	2060	Douglas Westwood	2010-2020
B. Pickens	2005-2007	Energy Files	2010-2020
M. Lynch	After 2030	PFC Energy	2014-2025
C. Campbell	2010		
S. Al-Husseini	2015	**Energy advisory organisations**	
J. Gilbert	2010	World Energy Council	After 2020
T. Petrie	Before 2010	Energy Research Center Netherlands	2010-2035
		CERA	After 2020
Oil Companies		ASPO	2010
CNOOC	2005-2010	IEA deferred investment scenario	Around 2020
Total	2020-2025	IEA high resource case	After 2030
Shell	After 2025		
BP	We cannot know	**Other Organizations**	
Exxon-Mobil	After 2030	Volvo	2010-2015
		Ford	2005-2010

*Table 1 – World oil peaking estimates as of October 2005, * prediction means that the demand of oil will probably not be met.*

The reason for differences in peaking date estimates are partly due to a lack of data; no universal accounting system for oil reserves is in place. In particular, the oil reserve data from OPEC Middle East are uncertain. In these countries the world's largest reserves are located according to official data sources.

The reserves claimed by OPEC Middle-East however, are doubtful. Between 1985 and 1989 worldwide reserves increased with 43% or 304 billion barrels. A total of 65 billion barrels were discovered and total production was 95 billion barrels. The increase of 304 billion thus means a total reserve addition of 330 billion barrels. Non-OPEC reserves stayed stable during the period 1970-1995. It can be concluded from these facts that official OPEC reserves increased with nearly 300 billion barrels while no significant discoveries were made to back up these revisions. Since that time, reserves have hardly changed while countries in the

OPEC regions still produce oil each year. One would expect a drawdown of reserves due to production but this was never reported. Official OPEC reserves are therefore unreliable.[1]

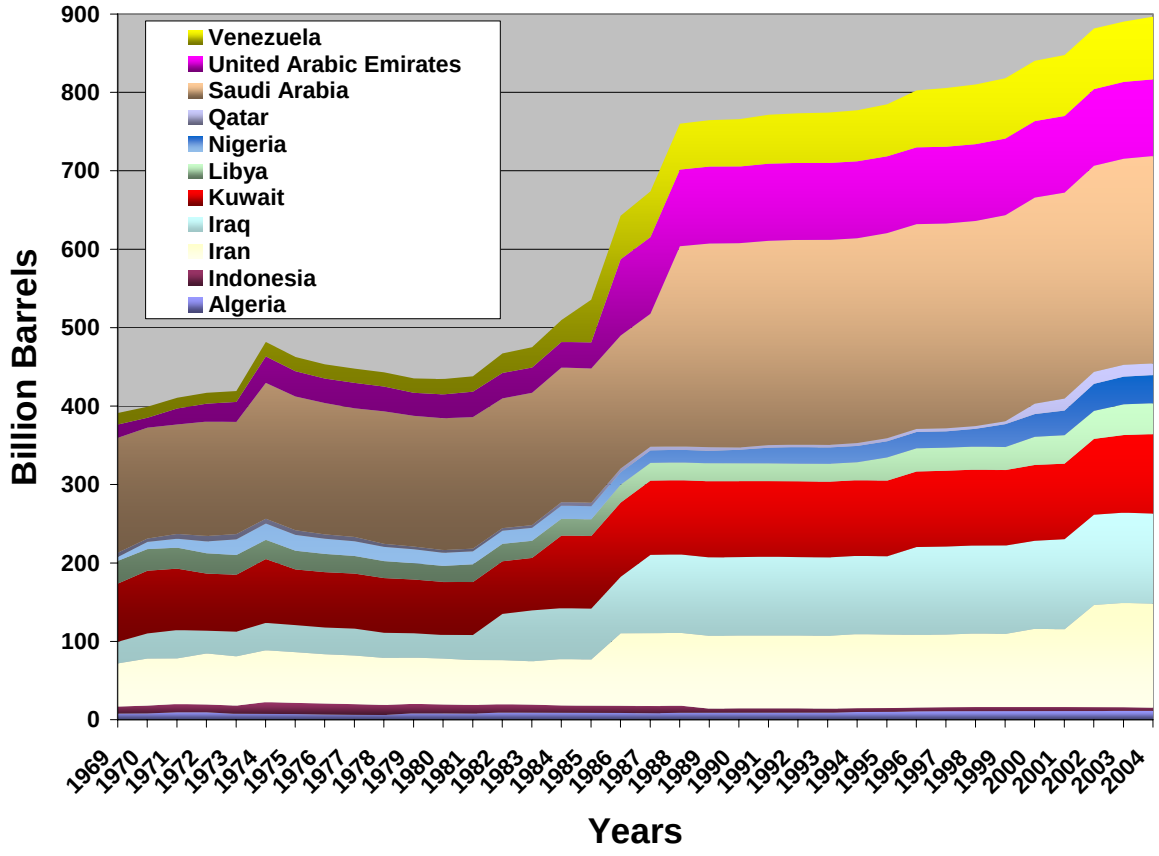


Figure 1 – Oil reserves in OPEC countries from 1969 to 2004, data taken from the OPEC Annual Statistical Bulletin 2004.

These revisions are still happening. Recently, in 2001/2002 a big revision took place in Iran. Oil reserves went from 100 billion barrels to 130 billion barrels. This was mainly due to the discovery of the Kashagan oil field (10 billion barrels of recoverable reserves) and Yadaravan oil field (3 billion barrels of recoverable reserves and 17 billion barrels of oil initially in place). The oil minister of Iran, Bijan Namdar Zanganeh, said that:

"*The new figure of 132 billion barrels of proven reserves, a jump of 17 billion barrels from before, came from discoveries in the Kushk and Hosseinieh oilfields - now classed as one single field and renamed Yadavaran - in the southwestern province of Khuzestan. … exploitable oil at Yadavaran stood at over 3 billion barrels*"[2]

Without any international difficulties, the 17 billion barrels of total reserves were added as recoverable reserves, instead of the 3 billion barrels that are recoverable. This was even stated by the oil minister of Iran himself. This recent incident stresses the fact that the amount of reserves in OPEC countries are to say the least, doubtful. OPEC members probably do not state the true amount of recoverable reserves but give a number which includes oil that will never be recovered. Therefore, in order to know exactly when oil production will peak, transparency in oil reserve data is necessary for all individual oil producing countries.

[1] International Energy Agency, *World Energy Outlook 1998*, 1999
[2] The daily start - http://www.dailystar.com.lb/article.asp?edition_id=10&categ_id=3&article_id=5893

In addition, peak oil models should be more transparent in their methods and assumptions. Only a few models explain how the estimate for the peak year was derived. Many of the peak projections near 2030 and beyond assume that OPEC Middle-East will be able to double oil production. Given the uncertainty concerning the reserves in the Middle East, such an assumption is speculative. If this assumption is wrong, world oil production will peak far earlier than currently expected. In that case, society will face severe difficulties, as there is currently no anticipation for this event. A global fuel crisis would change countless aspects of life we nowadays take for granted.

The goal of this report is to create a detailed view on oil production and provide the most plausible five-year range in which oil production might peak. The report summarizes different methodologies and assumptions on oil production and incorporates these different arguments into one model. The basis for this model is an extended oil project model and a decline rate assessment based on publicly available information. From this basis an analysis was made to extrapolate future oil production beyond 2010. In addition to the project model, well-documented trends in oil production were used in order to estimate the most likely peaking scenario. In the “turbulent world” scenario geopolitical instability and oil disruptions were incorporated in contrast with the other scenarios. Within this report, the abbreviation of PONL is used to refer to the Peak Oil Netherlands Foundation

2) The four peak oil estimation methodologies

There are four main methodologies to estimate the peaking date:

1. The Hubbert analysis
2. The USGS statistical analysis
3. The economical market based approach
4. The oil projects and decline methodology

All methods have their own strengths and weaknesses. There are two points however, that no method has taken into account. Michael Lynch addresses the first point in his paper about the flaws in the Hubbert methodology:

"*No countries have 'unrestrained extraction' --- everywhere a host of regulations … affect the level of exploration and production.*"[3]

This means that no estimate has been made in previous models on the effects of social, political, economical and natural factors regarding future oil production. Oil projects are often delayed due to the costs involved or difficulties in reaching an agreement. A variety of factors can disrupt oil production (unrest, wars, deliberate cutting of oil production, workers strikes, hurricanes and a material/personnel shortage).

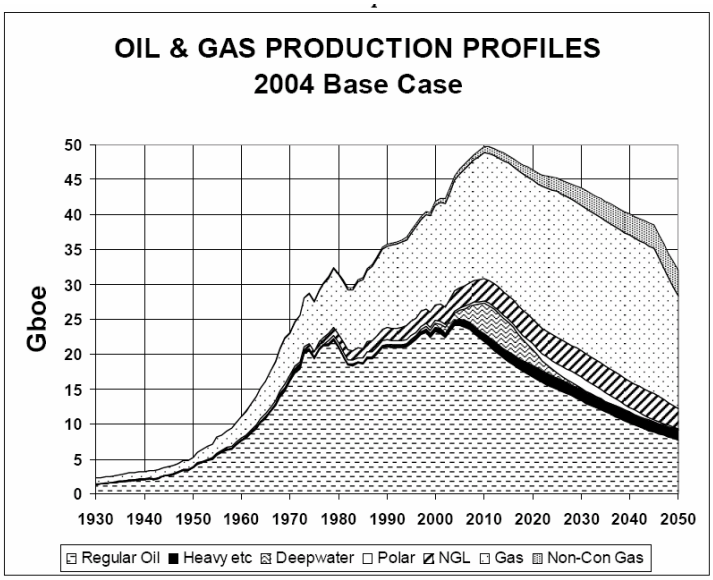
The second point is that the difference in quality between oil grades and oil-equivalents has not been taken into account. NGL, tar sands, Orimulsion and Heavy Oil are very different than oil with an API gravity above 32. There is a great difference in the EROI for these types of liquids, which affects future demand. An increasing share of the world oil market consists of unconventional and heavier grades of oil. There is doubt as to the amount of refining capacity available in the future, able to process this amount of heavier oil.

The Hubbert Methodology

The first methodology to be discussed is that of the late Marion King Hubbert, a well known petroleum geophysicist who worked for Shell. He estimated in 1956 that American oil production would peak between 1966 and 1971. It turned out that his prediction was correct and American oil production indeed peaked in 1970. His method relied on the estimated total amount of oil that will ever be extracted (I.E. Estimated Ultimate Recovery) for a given country or the entire world. In the present the EUR estimates vary between 1850 and 4000 billion barrels worldwide. This amount is estimated for either individual countries that are added together or directly for the whole world. It is then entered into a formula that is used to calculate the peak date and gives a bell-shaped curve called the "Hubbert" curve.

Today Hubbert's method is mainly used by geologists from ASPO[4] and by geologist K. Deffeyes[5] who was a colleague and good friend of Hubbert. The fallacy of this method is that it relies on the Estimated Ultimate Recovery (EUR) of oil as a central number to estimate the peaking date. The EUR however, is not a static variable but a dynamic one, which changes over time due to technological, economical and geological factors. As such it is very difficult to come to a decent estimate. The way Hubbert modelers try to account for these effects is either by means of an extrapolation from past cumulative production to estimate the EUR or by calculating personal estimates on future technological, economical, and geological factors.

[3] Michael C. Lynch, *the new pessimism about petroleum resources*, Global petroleum seer 2003
[4] Association for the study of Peak Oil & Gas – http://www.peakoil.net
[5] K. Deffeyes - http://www.princeton.edu/hubbert/



The best known Hubbert analysis has been made by Colin Campbell who is the initiator of ASPO (Association for the Study of Peak Oil and Gas). He is an experienced exploration geologist who at the end of his career was the Executive Vice-President of Fina in Norway. He has written five books on oil depletion, as well as numerous scientific publications. His latest prediction assumes oil production will peak around 2010. He does this based on an optimistic assessment for the world decline rate, a continuation of the declining trend in discoveries since 1964. And a pessimistic outlook for unconventional types of oil. The problem with his forecast is a lack of general underlying data regarding the assumptions he makes, necessary to evaluate his prediction.

Figure 2 – ASPO prediction as of November 2005.[6]

The IEA prediction based on the USGS statistical methodology

The second methodology is a reserve based assessment from the International Energy Agency. This assessment is released in the form of the World Energy Outlook every year. Mainly based on the reserve assessment made by the USGS (United States Geological Survey) in 2000 called "the world petroleum estimate". The world energy outlook is in its turn used by policy makers, governments and a variety of organizations in order to base policies on. Instead of carefully assessing the value of IEA figures they are directly taken for granted because it has the official seal of OECD energy consuming nations.

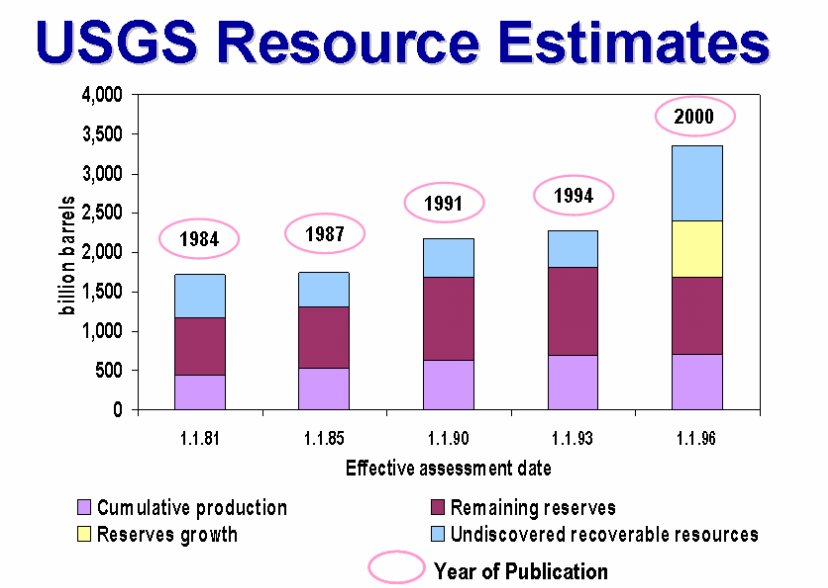
In their reference scenario the IEA predicts a peak after 2030. This is based on a very pessimistic decline assessment, a break with the declining trend of discoveries since 1964 which results in a very optimistic discovery assessment, an increase in production due to an increase in the recovery rate that is quite optimistic and a moderate outlook for so called unconventional oil.

	MENA	Rest of world	Total
Undiscovered	313	570	883
Reserves growth	109	199	308
Remaining reserves	784	322	1 106
Cumulative production	334	714	1 048
Total ultimately recoverable resources	1 541	1 804	3 345
Remaining ultimately recoverable resources	**1 206**	**1 090**	**2 297**

Figure 3 – IEA assessment for remaining ultimately recoverable resources. MENA refers to Middle-East and Africa.[7]

The framework for the IEA prediction is the USGS reserve assessment which is based on the Monte Carlo Simulation method. To come up with an outlook for oil production the estimates (5%, 10%, 15%, 20%... …95%) are added and divided to provide a "mean" number for future potential discovery and reserve additions. Adding the mean estimate with the remaining reserves gives a figure for EUR. The potential discovery and reserve addition numbers from the USGS are almost directly copied by the EIA to predict future oil production.

[6] ASPO - http://www.peakoil.net/Newsletter/NL59/newsletter59_200511.pdf
[7] IEA, *World Energy Outlook 2005*, 2005



It is interesting to note that the method used by the USGS was introduced in the year 2000. By introducing this new method the potential world reserves had suddenly risen with approximately 1200 billion barrels. Coming from a huge increase in the estimate for undiscovered reserves but also from the newly introduced estimate called reserves growth. Shown in figure 4 to the left.

Figure 4 – USGS assessments for remaining ultimately recoverable resources.[8]

The main shortcoming of this method lies in the manner in which future potential discovery and reserve additions for the whole world are calculated. Future reserve growth was calculated by using the reserve growth observed in the Lower 48 U.S., then extrapolated to the whole world. Because the geology, economy and access to technology for each oil producing region is different, there is great doubt as to whether this approach is correct.

An additional problem with this method is that the "mean" estimate does not correlate with observed discovery trends and reserve additions. Since 1964 the amount of oil discoveries has been declining to a point where, since the year 1986, more oil has globally been consumed then found. The USGS estimate of 95% correlates with this trend while the "mean" estimate suggest that this trend is radically broken, to put it simply, far more oil will be found between now and 2030 then the trend suggests according to the USGS and therefore, also the IEA.

"*Between 1995 and 2002 in total only 107 GB were discovered and 110 GB were added by reassessing existing fields.*[9] *According to the USGS projections ("mean") however, in this period 219 GB should have been found and 170 GB should have been added due to reassessments, whereas the amounts to be expected with a probability of 95% did materialize.*"[10]

There is no indication that the USGS estimates, apart from the 95% probability values, have anything to do with reality.

The economical/market based methodology

The third method to be discussed comes from the field of economics and puts the main emphasis on technological and cost/price functions to predict future oil production. It does not have a firm basis in any organization but is used by individuals instead. Well-known proponents of this theory are Michael Lynch and

[8] IEA, *World Energy Investment Outlook 2003*, 2003
[9] Data taken from the IHS energy database
[10] L-B-Systemtechnik, *The countdown for the Peak of Oil Production has begun*, 12 October 2004

Peter Odell. In the Netherlands this way of thinking is currently also the view of the CPB (an independent body that calculates the economical effects of governmental policy and gives advice to the Dutch government). There is no widely accepted economical model; proponents usually rely on economical arguments instead of a scientific method.

The economical view is that as prices increase more effort will be made by the oil industry to explore as well as to exploit already discovered resources and to develop new technology.

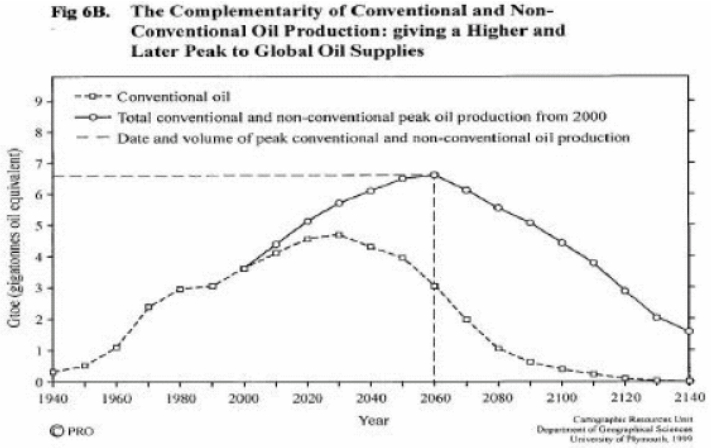
The main idea is stated as follows by M. Lynch:

"*Price (or revenue) leads to exploration expenditures and thus drilling, which cause discoveries, discoveries are developed into capacity which is produced*"[11]

Resources can then be added to reserves and this process continues for a long period given the huge resource base of unconventional oil. Soon after this renewed investment the price of oil will fall again and the market balances itself. The idea that there is enough oil ready to produce in the future is based on three arguments:

- The oil reserve base is large enough to sustain production for a long period
- The recovery rate from world oil fields has increased from 22% in 1980 to 35% in 2004[12]
- We are still replacing annual production with new discoveries and reserve growth

The strength and weakness of this method is that it relies on a dynamic variable for EUR. A dynamic treatment is quite logical given past trends but most proponents tend to overstate the dynamics of the EUR and assume that if we invest enough, new production will appear without great difficulty.



There are several fallacies to this approach. First of all, it is not taken into account that many regions are not accessible to outside investors; especially OPEC Middle-East is restricted. Secondly, there is no realistic assessment on the impact of new technology over time. The recovery rate from oil fields has increased worldwide, in what manner does this turn into new production? Which part of the increased recovery rate merely extends the life of a field and which part leads to actual increases in yearly production necessary to offset declines in other regions?

Figure 5 – Peak oil projection made by Peter Odell showing peak oil in 2060..[13]

Moreover, the argument that reserves will increase considerably over time based on historic data is doubtful. OPEC Middle-East reported major reserve increases in the 1980's, in the order of 300 GB. These reserves were reported while no significant oil discoveries occurred, total OPEC Middle-East reserves grew with 62%. No independent verification has been made on the certainty of these reserves. One of the reasons often stated is that the amount of oil an OPEC nation can pump, the quota; is reliant on the amount of reserves an OPEC country has. Therefore, each increase in reserves leads to allowed production increases and extra revenue. This issue makes the reported "proven" reserves from the OPEC Middle-East region very suspicious. Are

[11] M. C. Lynch, *Forecasting oil supply: theory and practice*, The quarterly review of economics and finance, 2002
[12] L. Maugeri, Oil: *never cry wolf – why the petroleum age is far from over*, Policy forum science and industry
[13] P. Odell, *Why Hydrocarbon energies will rule the 21st century's global economy*, 2004

current OPEC Middle-East reserves "proven" reserves or are they probable/possible reserves reported as proven by the countries themselves? Because of this uncertainty it is difficult to assess the current state of proven world oil reserves.

In addition proponents of this view do not provide sufficient data on were the considerable amount of reserve growth is actually going to come from. Is reserve growth mainly influenced by for instance, new technologies, recovery techniques (EOR) or improvement of reservoir understanding?[14]

Finally, this methodology is also based on the view that unconventional resources can be exploited in the same manner as conventional oil. As stated by P. Odell:

"*Ultimate non-conventional oil resources (tar-sands, shales etc.) are eventually likely to exceed those of conventional oil.*"[15]

This is a careless assessment since it relies heavily on assumptions rather than facts. According to a scientific study,[16] the maximum oil/tar sands production level is 5 Mb/d due to limiting factors (like natural gas and logistic restrictions). Production of Heavy oil or orimulsion produced in Venezuela has only just begun; the time to increase production up to the expected maximum limit of 6 Mb/d is very long. Analyst organizations claim that no significant production will come from this region in the near and medium term future.[17] And whether shale oil production is viable at a large scale has yet to be seen. We do not know if exploitation will be energetically and financially possible in the future. Shell is working on such a project in the U.S. with an extremely long timeframe. A no/go decision has yet to be made.

The oil projects and decline methodology

The fourth method has recently gained considerable attention with the release of two projections. One made by The Oil Depletion Analysis Center (ODAC),[18] the other one made by the Cambridge Energy Research Associates (CERA).[19] It is based on a list of all known oil projects announced by oil companies for the coming years, an assessment of the decline rate for either separate regions or the whole world and an estimate of future discoveries. Combining these elements gives a fairly reliable outlook for the nearby future. Because of the short timeframe it can only be used to assess with a high level of certainty how world oil production will look like within five years from the moment the study is made.

Strangely enough, the estimates from ODAC and CERA differ greatly. ODAC estimates a peak before 2010 while CERA thinks world oil production will peak after 2020. The reason is that they are only similiar in a broad sense. ODAC includes oil projects from 50.000 b/d or above while CERA includes oil projects from 75.000 b/d or above.

The main problem with the CERA study is that the decline in production is almost certainly underestimated, especially for production from current fields in the North Sea given official decline data from oil companies. Further comparison between the studies from ODAC, CERA and PONL can be found in appendix B.

In general the fallacies of this approach are twofold. First of all, the question is whether all oil projects are indeed included and whether they are actually coming on-stream according to the timetable as given by the oil companies. The second question is whether or not the decline assessment is correct for given regions or if this assessment is perhaps over- or underestimated.

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[14] D. Klingma & M. Mulder, *De huidige olieprijs is een slechte indicator voor de toekoms*t, ESB december 2004
[15] P. Odell, *The global energy outlook for the 21st century*, may 2003
[16] B. Söderbergh Uppsala University Sweden, *Canada's oil sands resources and its future impact on global oil supply*
[17] International Energy Agency, *World Energy Outlook 2004*, 2004
[18] Oil Depletion Analysis Centre – http://www.odac-info.org
[19] Cambridge Energy Research Associates - http://www.cera.com/home/

3) Method

The oil production outlook of this report consists out of two parts. The first part is based on an extended oil project and decline forecast concerning the period 2005-2010. The second part consists of an extrapolation of the first part wherein trends observed in oil production have been incorporated in order to determine the most probable future oil outlook. This method was chosen because it relies on relatively few assumptions and avoids using grossly unreliable data (like the officially reported Middle East oil reserves). As a base quarterly production figures from 1996 to 2004 were taken from the Oil, Gas, Coal and Electricity Quarterly Statistics,[20] published by the International Energy Agency (IEA).

Project information was taken from press releases, oil company websites, analyst websites and various other Internet sources including, the Energy Information Administration (EIA),[21] The Oil Depletion Analysis Center,[22] and Alexander's gas and oil Connections.[23] These figures are quite reliable since oil projects are well documented because of the huge costs, leading times and multiple parties involved. The oil project list can be found in Appendix D.

Decline rates are either estimated using historic numbers or with data from various Internet sources. This data is less certain for some countries and oil fields. The most significant example is the Ghawar field in Saudi-Arabia, the biggest oil field in the world with an estimated production of 5mb/d. The knowledge provided by Saudi Aramco about the reserves and production life is inadequate to predict the future life of this field. Therefore, analysts have no clue whatsoever as to the peaking date of this field. They can only assess the lifespan of the fields from its discovery date, 1948, and various snippets of data from technological papers. The only thorough analysis on Saudi Arabia's oil production to date has been done by Matthew Simmons.[24] In order to know whether his devastating conclusion, namely that Saudi Arabia is about to peak in oil production is correct, an independent oil field analysis in Saudi Arabia would be necessary.

The supply forecast for the period 2005-2010

In order to estimate the most probable oil production rate for the coming five years, three things were determined:

- The decline rate for individual oil producing countries
- New production from scheduled oil projects
- New production from new discoveries/potential projects

The decline rate was estimated in two ways. Firstly, for countries that have been in decline for at least four years the average production decline after the peak was calculated. This production decline percentage was thereafter extrapolated. The problem with this method is that adding new projects to an extrapolated historic decline rate gives too optimistic an outlook. This is because the decline from the entire country (type III decline) is extrapolated. The decline rate is actually steeper than assumed by using this method. A better approach would be to see what projects came on-stream in the period that was used to estimate the decline and deduct the additional production from new projects in that period, then calculate the average production decline. In this way decline in fields and regions in the country (Type II decline) is calculated. However, it is questionable if this changes the outcome significantly, because once an oil producing country has peaked, it is logical that fewer oil projects will be added. This is due to the decreasing amount of discoveries starting at least 5 years before the peak.

[20] IEA, *Oil, Gas, Coal and Electricity Quarterly Statistics* - http://puck.sourceoecd.org/
[21] Energy Intelligence Agency, Country analysis briefs - http://www.eia.doe.gov/emeu/cabs/contents.html
[22] ODAC Megaprojects - http://www.odac-info.org/bulletin/documents/MegaProjRelease16-11-04.pdf
[23] Alexander's gas and oil connections - http://www.gasandoil.com
[24] M. Simmons, *Twilight in the desert, the coming Saudi oil shock and the world economy*, June 2005

The second way of estimating the decline rate was by taking decline rate estimates for existing production from a wide variety of sources such as newspapers and official bulletins/journals from oil analysts and institutes. In the case that no reliable source could be found a conservative estimate was made. To this decline base new projects were added from the project list in Appendix D. In exceptional cases an estimate for possible new production due to potential projects and discoveries was added.

The following is an example on an oil production assessment as per this report (Indonesia):

The country's oil production has peaked. From 1998 to 2004 the country's average decline was 4.71% per year. From 2001 to 2004 the country's average decline was 6.19% per year. A decline rate of 6.19% has been added over 2004 oil production. 2004 NGL production of 175.000 b/d was assumed to remain stable.

Indonesia	2003	2004	End 2005	End 2006	End 2007	End 2008	End 2009
Total production	1200	1143	1125	1235	1184	1136	1090
Declining fields	1025	968	910	855	804	756	710
New production			40	165		35	
Stable production	175	175	175	175	175	175	175

Table 2 – Oil production outlook example.

To include some realism to this outlook a second scenario called "turbulent world" was made which predicts oil disruptions from social, political, economical and natural causes and a refining capacity assessment. This was based on oil disruptions and project delays in the years 2000-2005 which were quantified and extrapolated.

The extrapolated oil production outlook (2010 and beyond)

To reach to an estimate for oil production beyond 2010, the type of project, the type of oil and the date of field discovery were analyzed for oil projects in the period 2005-2010.

A probable decline rate for the existing reserves was made based on the decline rate observed in the period 2005-2010 and data taken from various sources referenced in Appendix C.

Opposite to this decline rate, estimates for four streams of new production were added:

- Production from new discoveries
- Production coming on-stream from known reserves which are not yet in production
- Additional production through reserve growth (an increase in the recovery rate)
- Production from unconventional oil

From the basic scenario outlined above two alternate scenarios were made: one to determine the effects of social, political, economical and natural disruptions and a refining capacity assessment called "Disruption & Delay" and another one to determine the effects of more technological improvements called "Technological". The Disruption and Delay scenario was based on the disruption scenario from the demand forecast for the period 2005-2010. It was assumed that the effects given in the disruption scenario would become more frequent, especially when the peak in world oil production has passed. This is based on a combination of the observed behavioral effects in society due to an oil shortage and the likeliness that no mitigation efforts are going to be made. Once the peak occurs and a decade has passed it was incorporated that the disruptions and delays will diminish based on a probable new balance in the economy and behaviour of people.

The “Technological” scenario was based on a bigger increase of recovery rates and a longer production increase from technology after the peak in world oil production had occurred. Furthermore, a steeper decline rate was added in the technological scenario.

Assumptions

Firstly, restrictions due to material, pipeline, shipping or manpower were not incorporated. An exception to this is the “turbulent world” scenario, which was made to assess the effects of these restrictions.

Secondly, it was assumed that there are no refining restrictions to bring the new oil supply to the market. While it is obvious that there is a refining shortage at the moment there is not enough data available to quantify the effects of this shortage. One cause is the probable peak in Light Sweet crude oil in non-OPEC producing countries;[25] therefore medium and heavy variants of oil are becoming a growing share of the oil market. An exception to this is the “turbulent world” scenario, which was made to assess the effects of future refining restrictions.

[25] OPEC Monthly Oil Market - http://www.opec.org/home/Monthly%20Oil%20Market%20Reports/2005/MR082005.htm

4) World production outlook “Ideal World” 2005-2010

General data used in this outlook can be found in Appendix A. Detailed data on individual countries including references can be found in Appendix C. Detailed project data can be found in Appendix D. A comparison between the studies made by CERA, ODAC and PONL can be found in Appendix B.

OPEC

Total gross OPEC liquids production is expected to increase with approximately 7.4 mb/d per day between 2005 and 2010. Large gross production increases are coming from Iran (1 mb/d), Nigeria (1.2 mb/d) and Saudi Arabia (2.4 mb/d). Due to declining oil fields in Iran, Libya, Saudi Arabia, Dubai, Venezuela and Indonesia, net OPEC liquids production is expected to increase with 4.2 mb/d between 2005 and 2010.

This outlook does not support the analysis that concludes that a peak in Saudi Arabian oil production will cause a peak in world oil production. Based on the amount of projects still coming on stream, and given observed gross decline rates of between 5% and 12%, it can be concluded that if Saudi Arabia peaks with steep decline rates the world would face an oil shock instead of an oil peak. A Saudi oil peak does imply though that world oil production will peak far earlier than now in general is assumed.

Production in thousand barrels per day	**2004**	**1st qtr 2005**	**End 2005**	**End 2006**	**End 2007**	**End 2008**	**End 2009**
OPEC							
Algeria	1930	2067	2018	2056	2144	2232	2421
Indonesia	1158	1144	1140	1250	1199	1151	1105
Iran	4149	4161	4242	4338	4438	4494	4460
Kuwait	2171	2222	2151	2130	2160	2190	2221
Libya	1614	1693	1718	1718	1688	1759	1830
Nigeria	2513	2551	2700	3122	3139	3316	3564
Qatar	1020	1027	1012	1005	997	990	1122
Saudi Arabia	10135	10358	10679	10693	11087	11537	11454
United Arabic Emirates	2748	2783	2784	3121	3218	3235	3213
Venezuela	2924	3083	2837	2809	2879	3052	3179
Iraq	2010	1812	1889	1927	1966	2005	2045
Neutral Zone	597	597	597	597	597	597	597
Total OPEC	**32969**	**33498**	**33767**	**34767**	**35512**	**36560**	**37212**

Table 3 – Projected OPEC production from 2004 to 2010.

Non-OPEC

Total gross Non-OPEC liquids production is expected to increase with approximately 11 mb/d per day between 2005 and 2010. Large gross liquids production increases are coming from Azerbaijan (0.77 mb/d), Kazakhstan (0.85 mb/d mb/d), Russia (1.5 mb/d) Canada (1.1 mb/d), Brazil, (1.6 mb/d) and Angola (1.3 mb/d). Due to declining oil fields in the North Sea, USA, Canada, Mexico, Oman, Syria, Yemen, Egypt, Australia, China, Malaysia, Russia and various other countries, non-OPEC liquids production is expected to increase with a net amount of 2.9 mb/d between 2005 and 2010.

It is expected that Non-OPEC liquids production will peak and plateau around 2008.

Countries that probably are going to peak between 2005 and 2010 are China (2006), Malaysia (2007), India (2008), Denmark (2005), Brunei (2007) and Peru (2nd peak in 2008).

Production in thousand barrels per day	**2004**	**1st qtr 2005**	**End 2005**	**End 2006**	**End 2007**	**End 2008**	**End 2009**
Former Soviet Union							
Azerbaijan	309	345	402	522	777	877	1077
Kazakhstan	1209	1275	1259	1409	1559	1759	2059
Russia	9227	9343	9393	9461	9377	9622	9694
Uzbekistan	82	71	80	79	77	76	74
Other FSU	390	375	390	390	390	390	390
FSU Total	**11217**	**11409**	**11524**	**11860**	**12180**	**12723**	**13294**

Table 4 – Projected FSU production from 2004 to 2010.

Production in thousand barrels per day	**2004**	**1st qtr 2005**	**End 2005**	**End 2006**	**End 2007**	**End 2008**	**End 2009**
Non-OPEC Non-FSU							
USA	7828	7664	7533	7745	7700	7467	7246
Canada	3005	3089	3236	3391	3578	3686	3773
Mexico	3789	3825	3663	3428	3316	3324	3218
Argentina	842	796	774	753	733	713	694
Brazil	1801	1796	2258	2349	2855	3126	3169
Columbia	541	528	505	483	461	441	422
Ecuador	418	526	521	516	510	505	500
Peru	91	84	80	75	72	68	64
Trin & Tobago	135	123	223	223	223	223	223
Other S & Central America	229	257	279	279	279	279	279
Denmark	389	393	381	341	315	296	271
United Kingdom	2059	2004	1767	1518	1355	1313	1158
Norway	3188	3075	2996	2902	2779	2619	2556
Italy	110	120	104	99	144	141	138
Romania	114	109	111	108	105	102	99
Other Europe	379	370	370	370	370	370	370
Oman	780	758	723	695	671	626	584
Syria	450	433	459	440	421	403	386
Yemen	402	369	395	389	378	364	349

Other middle east	278	280	278	278	278	278	278
Angola	988	1123	1238	1518	1974	2364	2455
Cameroon	63	60	59	55	51	48	45
Congo Brazzaville	230	225	295	286	277	268	260
Egypt	708	702	682	658	675	652	631
Gabon	235	230	220	205	192	180	168
Tunisia	66	66	66	65	65	66	65
Other Africa	1351	1391	1561	1741	1841	1841	1841
Australia	538	504	541	648	610	576	546
Brunei	216	210	214	242	240	239	237
China	3485	3629	3598	3543	3474	3351	3287
India	799	803	790	782	824	846	838
Malaysia	857	841	827	847	944	917	891
Papua New Guinea	45	31	42	39	36	33	31
Vietnam	405	357	405	405	405	405	405
Other Asia-Pacific	427	440	410	515	555	555	555
Non-OPEC Non-FSU Total	**37250**	**37077**	**37602**	**37932**	**38708**	**38684**	**38031**

Table 5 – Projected Non-OPEC Non-FSU production from 2004 to 2010.

Total World

Production Thousand bbl/day	Years	2004	End 2004*	End 2005	End 2006	End 2007	End 2008	End 2009
Region								
OPEC		32969		33767	34767	35512	36560	37212
Non OPEC		48467		49127	49793	50888	51407	51325
Processing Gains		1834		1865	1897	1929	1962	1995
World Total		**83270**	**84214**	**84759**	**86456**	**88329**	**89929**	**90532**
1% Production growth			84214	85054	85905	86764	87631	88508
2% Production growth			84214	85896	87614	89366	91154	92977

*Table 6 – World oil production outlook 2005-2010, scenario "Ideal world". * The number for end 2004 is an estimate.*

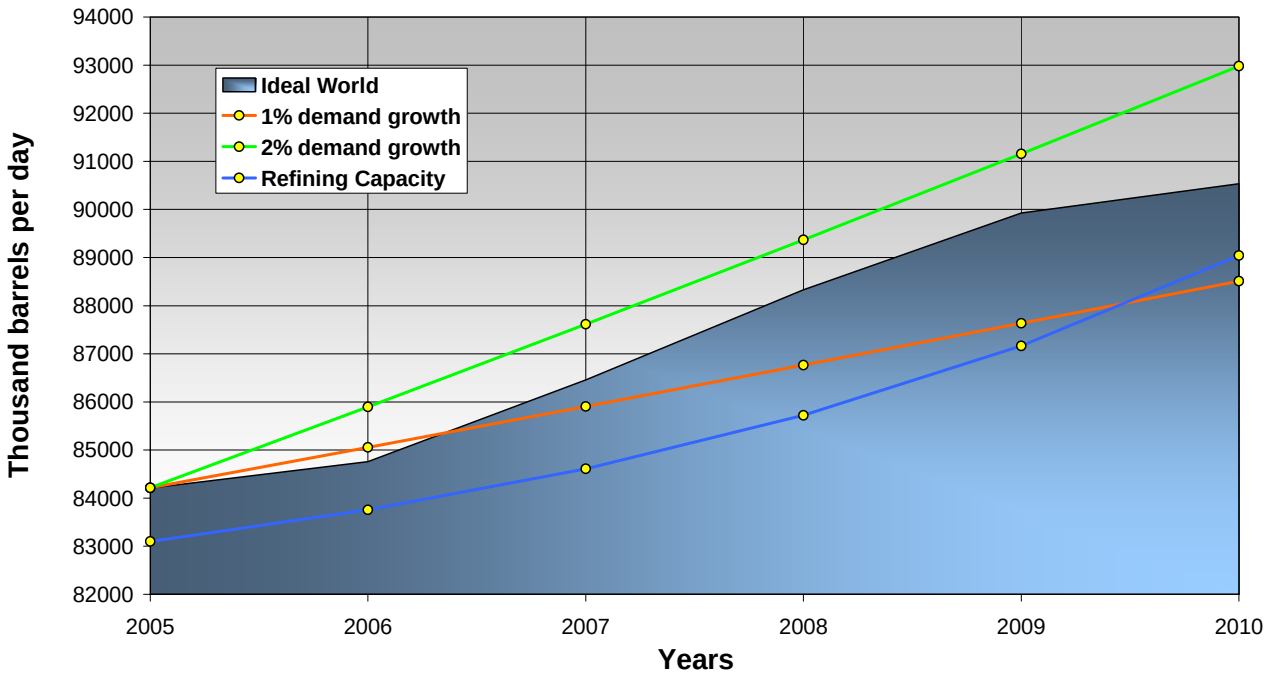


Figure 6 – World liquids production outlook "Ideal World" 2005-2010.

5) World production outlook "Turbulent world" 2005-2010

In real life, things often do not proceed as smoothly as was originally planned, and the international energy market is no exception. In order to increase the level of realism, a second scenario has been made which implements oil disruptions from social, political, economical and natural causes, as well as a refining capacity assessment. This "turbulent world" scenario was based on oil disruptions observed in the period 2000-2005, a refining capacity problem and a notion of other coming problems that have been quantified and extrapolated.

The industry is coping with an aging workforce, an offshore drilling rig shortage, a lack of investment, and substantial project delays:

"*The average age of the industry workforce in Europe and the U.S. is 49 and half the workforce will retire in the next five to 10 years, according to most analysts and oil industry groups.*"[26]

"*The US will need 850 more drilling rigs in the next 5 years. … That represents a 50% increase over today's rig fleet and equates to a 7 % compounded annual growth rate. Rig crews and labour will likely be the biggest limiting factor to activity levels."*[27]

"*Energy companies are under investing in new oil and gas production capacity by up to 20 per cent according to the International Energy Agency, the developed world's energy monitor*."[28]

"*The industry is truly dreadful at project management, or at least at predicting the timing of project start-ups. The amount of production growth that has been lost to projects being delayed over the past few years is stunning, over 2 mb/d, 2.3 per cent of expected global production in 2007.*"[29]

"*What we are hearing is that contractors are very, very stretched as is the availability of rigs and equipment.* [Saudi-Arabia] *may wind up being two to three years behind schedule.*"[30]

In 2004 and 2005 several disruptions and project delays were observed including:

A Norwegian oil industry strike, Hurricane Ivan, Emily and Dennis, Civil unrest in Nigeria, Bombay platform fire, Venezuelan oil production drop, Gas condensate leak Draugen field Norway, Thunder horse project delay (Hurricane effect), Sakhalin II delay (costs).

A small amount of disruption examples:

- The Venezuelan oil strike from end 2002 until the beginning of 2003. Resulting in a production loss of 2 million barrels per day for 2-3 months
- A 3-6 month delay in the startup of Thunderhorse due to Hurricane Dennis. Thunderhorse is BP's newest oil rig with a production capacity of 250.000 barrels per day
- The destruction of a drilling platform in the UK part of the North Sea due to the Piper Alpha fire in 1988
- Hurricane Ivan taking 30 Mb/d of cumulative oil production offline in 2004
- A Norwegian Oil Strike resulting in a 375.000 b/d production loss for 7 days in 2004
- The destruction of a drilling platform due to a fire in the Bombay High field, taking 84.300 barrels of cumulative production off-stream in 2005

[26] Financial Times, August 31, 2005
[27] Oil and Gas Journal
[28] Financial Times, May 2005
[29] Financial Times, *Project delays 'drive up price' of oil*, September 2005
[30] MSNBC - http://msnbc.msn.com/id/9979057/

Several reports have been published about the refinery problem. One of the more important ones is the emerging oil refining capacity crunch[31], which concludes that:

"*Based on the forecast demands through 2010, an additional 8 million barrels per day of global refinery capacity is needed to maintain the same narrow surplus capacity as 2004.*"

"*The overall refining capacity crunch looks like it will be difficult to reverse given the long lead times necessary for construction. Continued high utilizations, increased investment focused on sulfur management, and continued just-in-time inventory planning likely mean high refining margins are here to stay.*"

"*If nothing is done, the best that could happen is that consumers will have to pay a much higher price to live in a cleaner world and yet continue to maintain their lifestyles. The worst that could happen is a world of higher prices, supply shortages, and slower global economic growth.*"

A Bloomberg energy report[32] concluded that:

"*At least nine new plants are being planned by OPEC members in their own countries, increasing global refining capacity by 2.2 million barrels of oil a day, or 2.7 percent, by 2011. World crude oil prices have doubled in the last two years, even as the producer group increased output by 12 percent.*"

"*No new refineries have been built in the U.S. in 29 years, the world's largest market for motor fuels, while the expansion of existing facilities there has failed to keep pace with rising demand. Europe's last new refinery was in 1989.*"

"*China Petroleum & Chemical Corp., Asia's largest oil processor, is building a refinery in Indonesia with a capacity of 200,000 barrels a day, while China's biggest oil company, China National Petroleum Corp. will build a 120,000 barrel-a-day refinery in Algeria turning natural gas condensates into butane, jet fuel and gasoil.*"

"*A U.S. refinery venture owned by Saudi Aramco and Shell is studying a plan to double the size of its 275,000 barrel-a-day plant in Port Arthur, Texas, an expansion that would be the biggest in the U.S. in at least 25 years. The last refinery built in the U.S. was Marathon Oil Corp.'s Garyville, Louisiana, plant, which opened in 1976.*"

A notion of all the factors above has been taken into account to determine the more realistic "turbulent world" scenario. The following possible disruptions and delays were projected:

- A lower overall production rate due to project delays and worker and material restrictions.
- The effects of Hurricane Katrina & Rita on oil production in 2005
- Two major hurricane disruptions in the Gulf of Mexico in 2006 & 2009
- The already tight Nigerian situation exploding in 2007
- A major oil industry strike in 2008 similar to the Venezuelan one in 2002/2003
- Various big project delays in 2009
- A lower Canadian oil/tar sands production due to energy, material and workforce restrictions

According to BP, refining capacity increased annually with an average of 657.000 barrels in the last four years. Currently 2.8 mb/d of refining capacity is scheduled globally according to the Bloomberg survey. In addition, plans for new refineries were recently announced by countries such as Egypt. Since it takes several years to build new refineries, the refining capacity shortage is estimated to last until at least 2010.

[31] ICF Consulting, *The emerging oil refinery capacity crunch, a global clean products outlook*, summer 2005
[32] Bloomberg 19 september - http://www.bloomberg.com/apps/news?pid=10000102&sid=aLfutyiuqIJQ&refer=uk

On top of the 2.8 mb/d refining capacity scheduled for completion in 2011 according to the Bloomberg survey an additional 5.5 mb/d was incorporated in the refinery assessment. This additional increase was based on recent developments such as the announcement of a 450.000 b/d refinery planned in Alberta[33]. It is expected that a total of approximately 8.4 mb/d of refining capacity will be built between 2005-2011. Since the larger part of scheduled refinery plans have only recently been made, driven by the economical situation, it is expected that incremental refining capacity will be small in the next few years.

	End 2005	End 2006	End 2007	End 2008	End 2009
Ideal World	84759	86456	88329	89929	90532
Turbulent World	84127	85404	86580	87811	88421
Refining Capacity	83757	84611	85721	87615	89041

Table 7 – Refining capacity, ideal world and turbulent world average production figures per year in thousand barrels per day

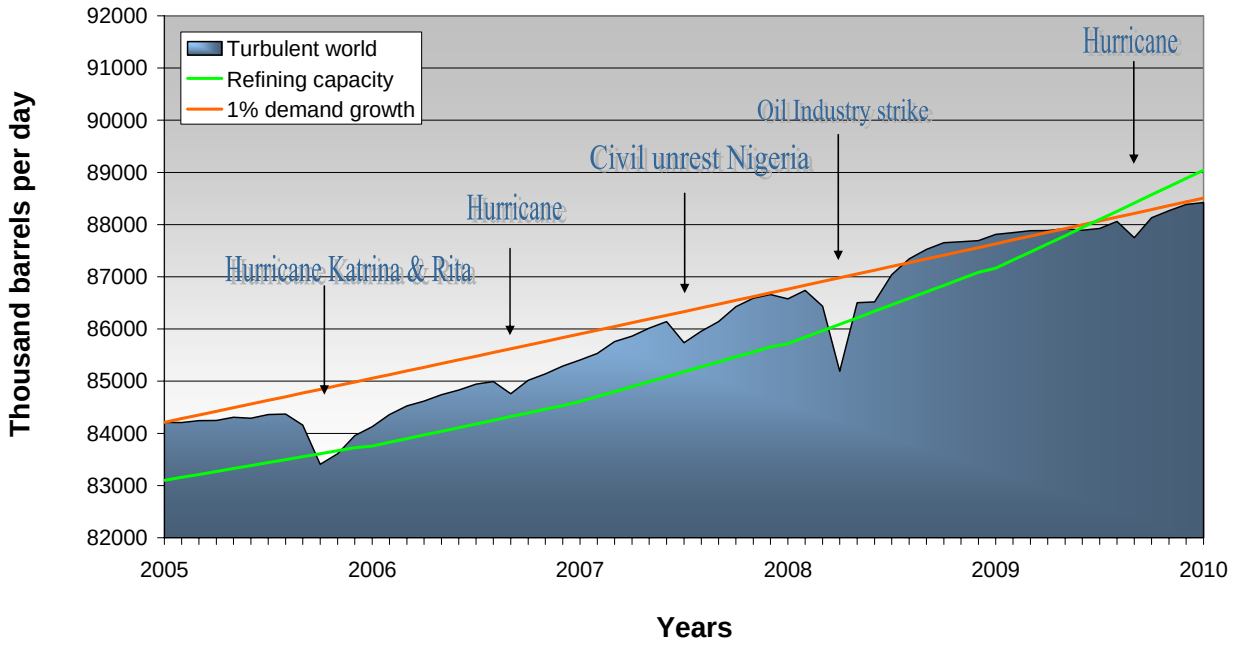


Figure 7 – World liquids production outlook "Turbulent world" 2005-2010.

[33] National Post 13 October - http://www.peakoil.com/fortopic13463-0-asc-75.html

6) Oil project analysis

To be able to assess an outlook for the period after 2010, the projects scheduled for the period 2005-2010 were analyzed. The type and discovery date of 100 oil projects were determined. The type was classified between Enhanced Oil Recovery projects (EOR), non-EOR projects and unconventional oil projects. Non-EOR projects were divided between discovery dates before 1980, between 1980-1989, between 1990-1999 and between 2000-2004.

This analysis showed that:

- 23% of the projects were EOR projects
- 12% of the projects were discovered before 1980
- 7% of the projects were discovered between 1980 and 1989
- 29% of the projects were discovered between 1990 and 1999
- 18% of the projects were discovered between 2000 and 2004
- 11% of the projects were unconventional projects

This is in line with an analysis from IHS energy, which concludes that:

"*New discoveries from 1993 to 2002 added only 137 billion barrels of oil, … of the liquid reserves added during the past 10 years, 75 percent came from discoveries made prior to 1992, and only 25 percent of reserves added came from new discoveries made since then*!"[34]

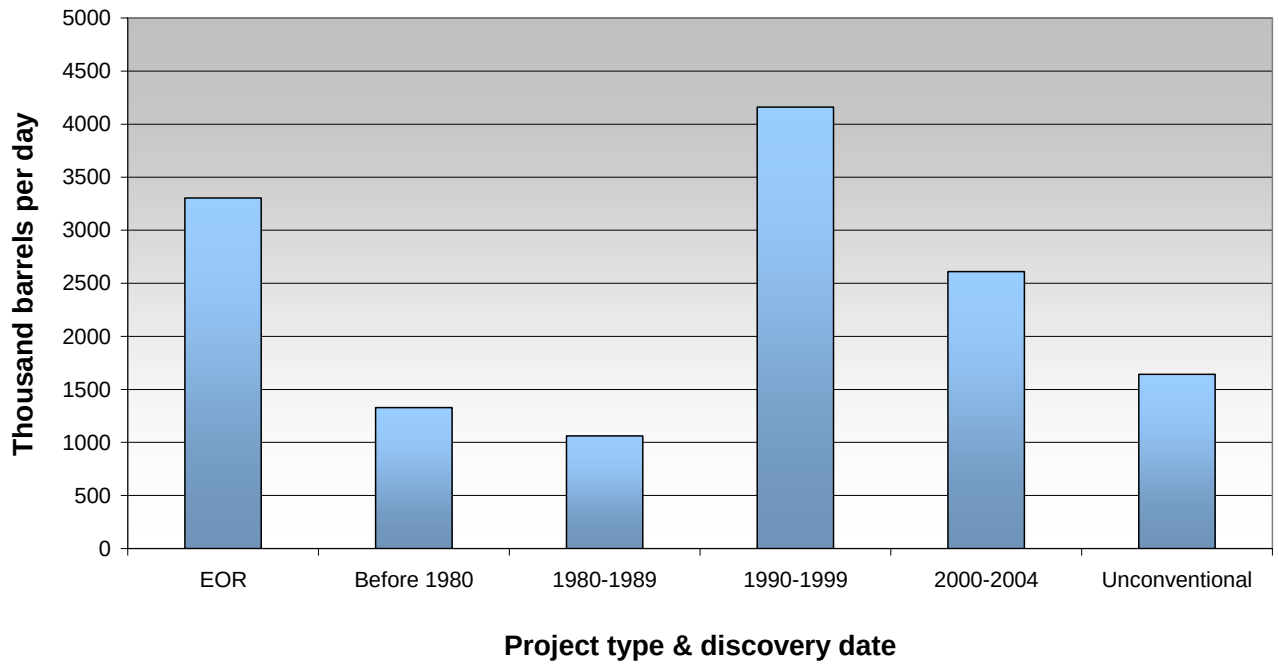


Figure 8 – Analysis of 100 oil projects by type, discovery date and production rate.

[34] IHS Energy - http://www.ihsenergy.com/company/pressroom/articles/files/01-04-worldwatch.pdf

7) Peak Oil Netherlands oil production & peaking outlook

To estimate future oil production five factors were taken into account:

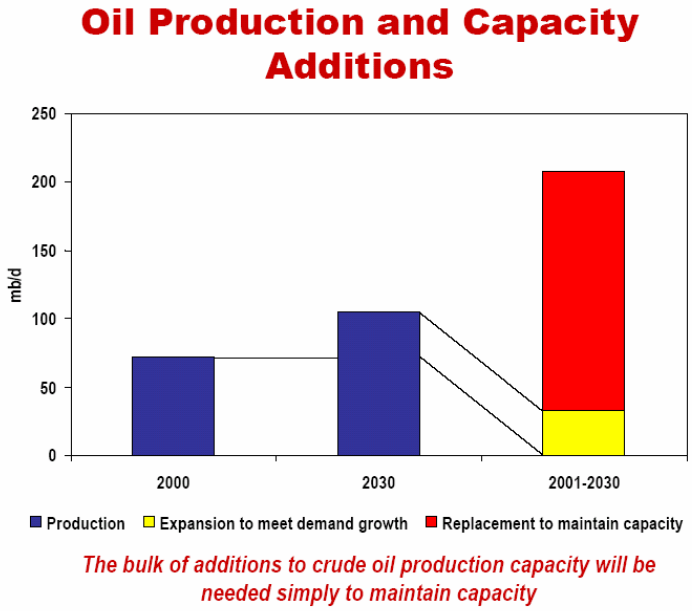
- The net decline rate for the entire world
- Production from new discoveries
- Production coming on-stream from known reserves which are not yet in production
- Additional production through improvements in technology (an increase in the recovery rate)
- Production from unconventional oil

All these issues are first addressed separately in this outlook before they are merged into an overall production prediction.

Decline rates

The lack of knowledge regarding world oil decline rates is causing great uncertainty as to the amount of new production necessary to offset declining regions. In this part we talk about decline rates as defined by Chris Skrebowksi[35], in three types, namely I, II and III. An explanation of these decline types has been added in the glossary of terms. Firstly, the vision of some experts who are referring to the total decline (type I + II + III).

According to the International Energy Agency the decline rate is very high. Approximately 6 mb/d of new production has to be added every year between 2005 and 2030 to offset decline and an additional 1.3 mb/d to meet demand. If this estimate turns out to be true, oil production will likely peak within the coming years given new production announced by oil companies.



"*Decline rates assumed in our analysis vary over time and range from 5% per year to 11% per year. Rates of decline are generally lowest in regions with the best production prospects and the highest R/P ratios, such as the Middle East, where they range from 4% to 6%. Decline rates are highest in mature OECD producing areas. By 2030, most oil production worldwide will come from capacity that is yet to be built.*"[36]

This decline rate presented by the IEA is almost the same as the estimate from Schlumberger, an oil service company. They think that "*an overall decline figure of 8% is not an unreasonable assumption.*"[37]

Figure 9 – IEA estimate for existing production decline and required new production.[38]

[35] Global Public Media - http://www.globalpublicmedia.com/news/539
[36] IEA, *World Energy Outlook 2004*, 2004
[37] Schlumberger - http://newsroom.slb.com/press/inside/article.cfm?ArticleID=213&
[38] IEA, World Energy Investment Outlook 2003, 2003

According to Exxon-Mobil nearly 4 mb/d of new production has to be added every year between now and 2030 to offset decline and meet demand. Existing oil production is declining with approximately 4% to 6% per year. The chart to the right also includes natural gas production.

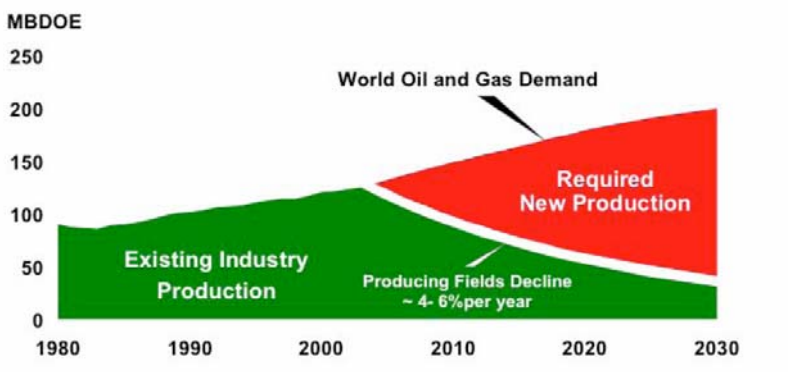
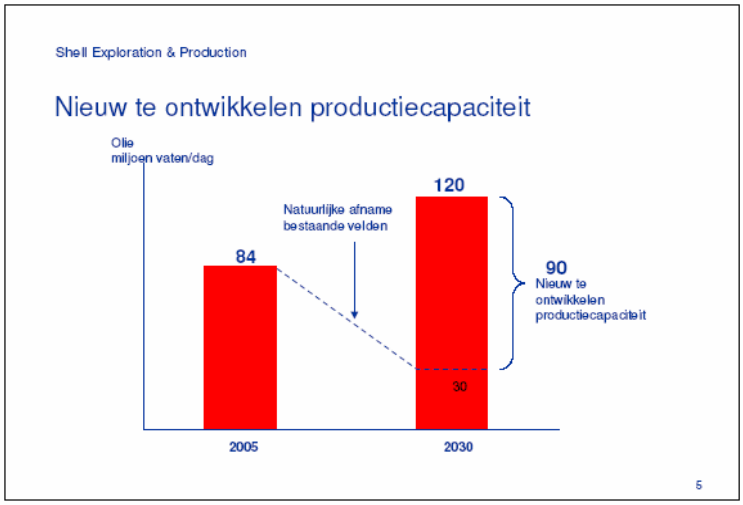


Figure 10 – Exxon-Mobil's estimate for existing production decline and required new production.[39]



According to Shell, existing production capacity is going to decline from 84 mb/d now to 30 mb/d in 2030. Approximately 3.5 mb/d of new production has to be added every year between now and 2030 to offset decline and meet demand.

Figure 11 – Shell estimate for existing production decline and required new production.[40]

We can conclude from the estimates of oil companies mentioned above that currently type I + II + III decline is running somewhere between 4% and 8% worldwide. In this report the world gross decline rate in the period 2005-2010 was estimated at an average of 2.5%. Since this decline refers to type II and III it appears to be a probable estimate when compared to the 4% - 8% decline estimate for type I + II + III decline. But it could very well be too low.

	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009
Decline (Mb/d)	2.4	2.4	2.3	2.2	2.1

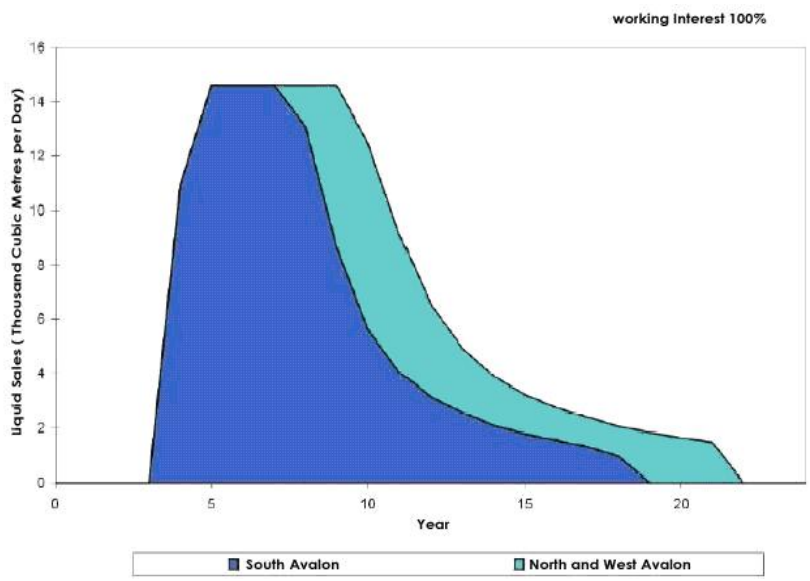
Table 8 – Decline rates in the period 2005 – 2010 in million barrels per day.

[39] Exxon-Mobil, *A report on energy trends, greenhouse gas emissions and alternative energy*, February 2004
[40] H. van der Meer Shell International Exploration & Production B.V, *The end of the (cheap) oil era?*, april 2005

Factors influencing decline rate are numerous, the biggest conflicting factors on a global scale are:

- When a region declines the absolute decline base also decreases. Thus the overall decline rate when compared to total world production also decreases.
- As time passes more fields will start declining and the decline rate when compared to total world production increases.

A decline rate estimate was made for the period beyond 2010 in which it was assumed that as time progresses more countries will pass their peak. Therefore it was assumed that at a certain point nearly all of the world's conventional oil production would be declining. A maximum decline of 6% was incorporated based on Shell and Exxon-Mobil estimates. This decline might appear very high. If we look closer to offshore fields, past examples of declining fields and technological forecasts however, 6% could even be too low.



The significant production life of the average offshore field is around 10-15 years after which a sharp decline begins. A rather short life when compared to onshore fields. This trend is evident from the UK North Sea were oil production declined with 15% from June 2004 to June 2005. A specific example of an offshore field is the White rose field coming on-stream in 2005 in Canada shown in figure 12 to the left. Nearly all scheduled oil projects nowadays are offshore/deepwater projects like White rose. Therefore a considerable part of the production coming on-stream between 2005-2010 will probably have peaked after 2020.

Figure 12 – Production life of the white rose field offshore Canada.[41]

Very sharp decline rates are also observed at fields where production is increased due to new technologies. Some illustrious examples are the Yibal field in Oman, the Cantarell field in Mexico and the Duri and Minas fields in Indonesia.

Another example is the Urdaneta field analyzed by Shell shown in figure 13 to the right. Shell predicts a massive 15% decline rate at the final life of the field despite the aggressive implementation of new technology.

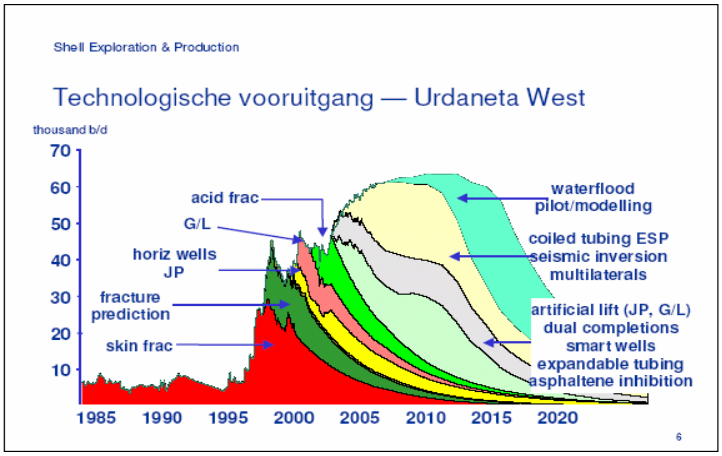


Figure 13 – Technological progress in the Urdaneta field according to Shell.[42]

[41] Offshore Technology - http://www.offshore-technology.com/projects/white_rose/white_rose5.html

In this report a decline starting point of 2.2 mb/d in 2010 was taken. Based on that point a conservative estimate was made, assuming an annual increase in the absolute decline base of 3%. This brings the decline to 2.26 mb/d in 2011, 2.33 mb/d in 2012, 2.4 mb/d in 2013 and so forth. It was than assumed that this decline base continues to increase until it reaches an average decline of 6% per year.

In the technological scenario it was assumed that the increase in decline goes on until an average decline rate of 8% per year has been reached.

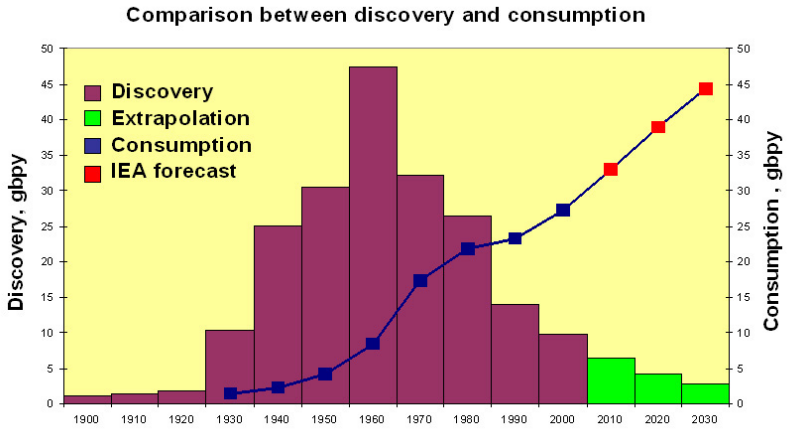
[42] H. van der Meer Shell International Exploration & Production B.V, *The end of the (cheap) oil era?*, april 2005

The amount of production from future discoveries

The outlook for future discoveries is undeniable. In 1964 world oil discoveries peaked in volume. Between 1981-1990 the amount of fields discovered also peaked.[43] And since 1986 more oil has been produced or consumed than found.[44] In 2004, the amount of oil consumed worldwide was 4 times higher the amount globally found. The amount of total liquids consumed was 2.3 times higher than the amount globally found. This declining discovery trend increased in the period 2000-2004:

- 17.9 billion barrels of liquids were discovered in 2000
- 10.4 billion barrels of liquids were discovered in 2001
- 10.9 billion barrels of liquids were discovered in 2002
- 7.7 billion barrels of liquids were discovered in 2003
- 7.6 billion barrels of liquids were discovered in 2004

The probability of the continuation of this trend is underlined by the size of discoveries. In total an amount of 12.465 oil fields have been found until 2003. Of this total around 50% of all oil ever discovered lies in 53 Super fields.[43] Approximately 47% of current world oil production comes from 116 big oil fields that are starting to become truly old. A considerable part of these oil fields were discovered more then 30 years ago. We are finding less and less of such big fields, mostly minute fields with a small amount of oil are being found.[45]



ASPO estimates that future discoveries will keep following the declining discovery trend observed since 1964. They have made an extrapolation from a logarithmic fit to the data between 1970 and 2000. Their conclusion based on this extrapolation is that 134 Billion barrels of oil will be found in the next 30 years.[46]

Figure 14 – ASPO estimate for future discoveries.

The IEA estimates that between now and 2030 a total of 838 billion barrels of reserves will be discovered, of which 313 billion barrels in the Middle-East. This is based on the optimistic USGS assessment from the year 2000. The idea is that little exploration has taken place after 1980 because there was little financial incentive to do so. Since the oil price has risen after 2000 the financial incentive to explore should have increased. This has resulted in an increase in the number of wells with 7.5% in 2004.[47] So far the forecasts made by the USGS do not appear to have any basis in reality as shown in figure 15 on the next page. According to this study approximately 30 billion barrels of liquids (NGL and oil in this case) should have been found each year since 1996. Between 1996 and 2002 only 15 billion barrels of liquids have been found each year on average and this amount has decreased recently.

[43] IHS Energy, *Global exploration trends and outlook*, May 2005
[44] IHS Energy, *Global oil supply issues: recent trends and future possibilities*, March 2005
[45] Matthew R. Simmons, *Twilight in the Desert: The coming Saudi Oil Shock and the world economy*, 27 May 2005
[46] ASPO, *How much crude oil is there to discover in the future?*, April 2005
[47] IEA, *World energy outlook 2005*, 2005

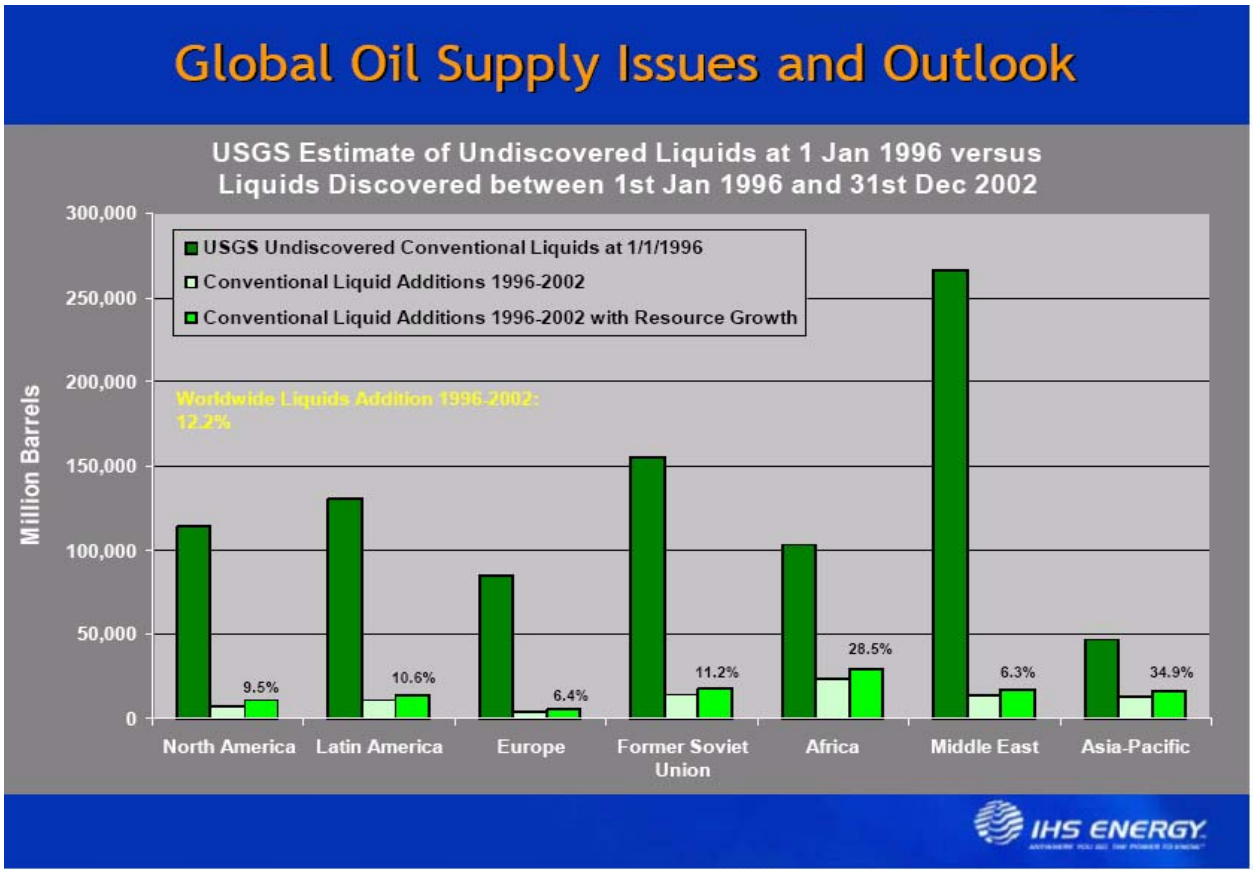


Figure 15 – IHS energy comparison between USGS study, total resources discovered and reserve growth between 1996 and 2002.[48]

But perhaps exploration activity will increase, causing more discoveries. If we look at the past, between 1994 and 2003 the amount of exploration wells stayed stable worldwide. At the same time the oil price increased with 100%. [49] Exploration activity did start to increase in 2004, however, in four regions, Africa, Australasia, the Far-east and the Middle-East as shown in figure 16 to the right. Unfortunately, this activity did not yield a significant increase in discoveries when comparing 2004 to 2003. Preliminary analysis points out that in 2005 probably between 6 and 10 billion barrels of oil will be found. The claim that increased exploration activity yields more and larger discoveries has therefore, not yet been proven by reality.

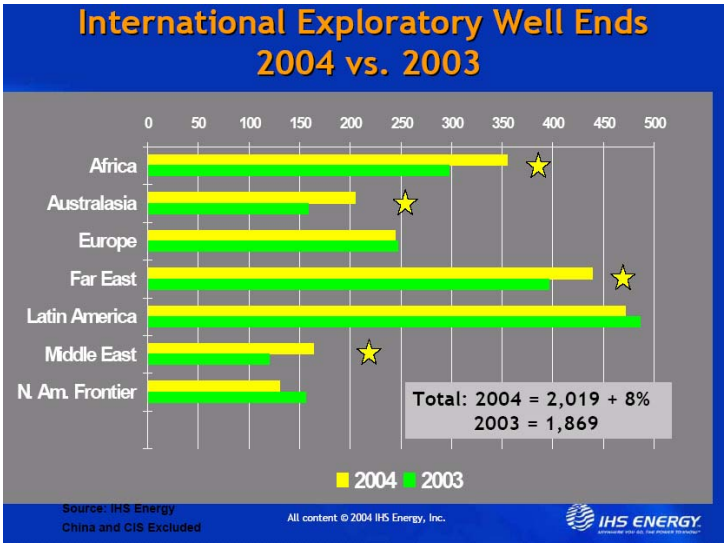


Figure 16 – IHS energy study of exploration wells at the end of 2004 versus the end of 2003.[50]

[48] IHS Energy, *Global oil supply issues and outlook*, 2005
[49] IHS Energy, *Global oil supply issues: recent trends and future possibilities*, March 2005
[50] IHS Energy, *Global exploration trends and outlook*, May 2005

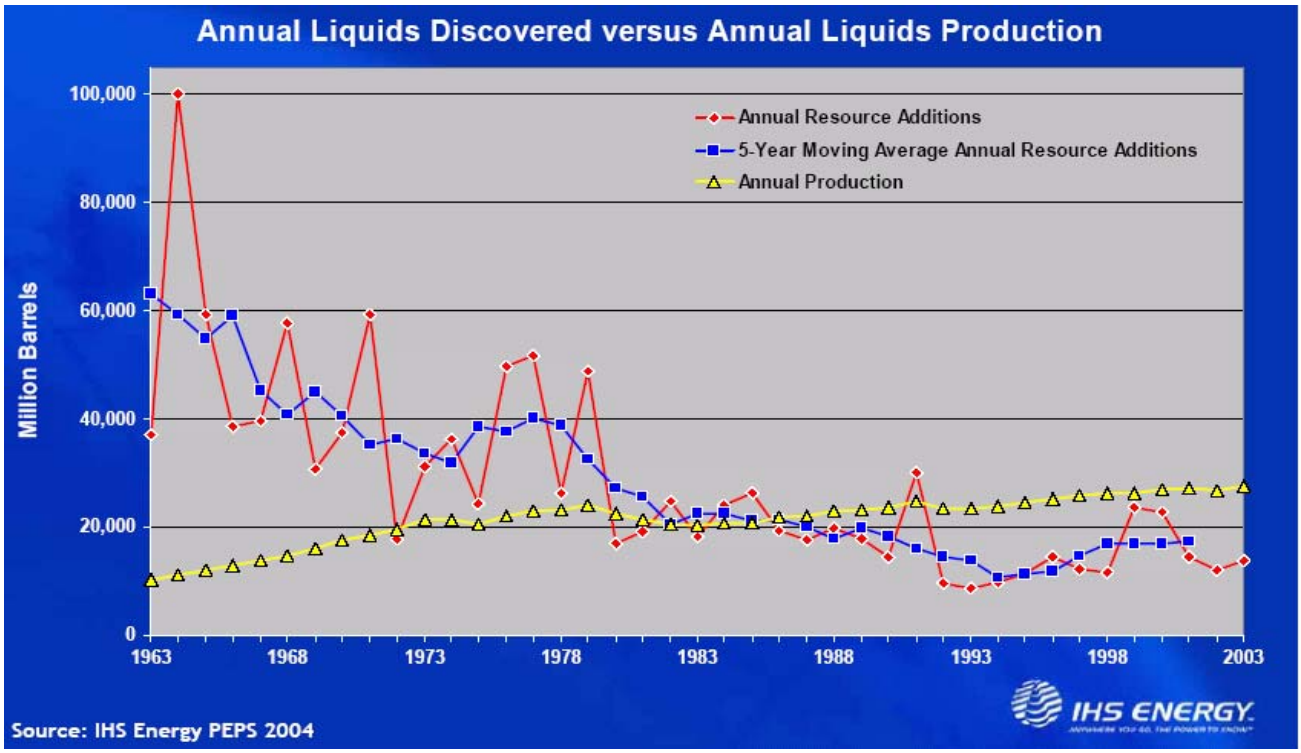
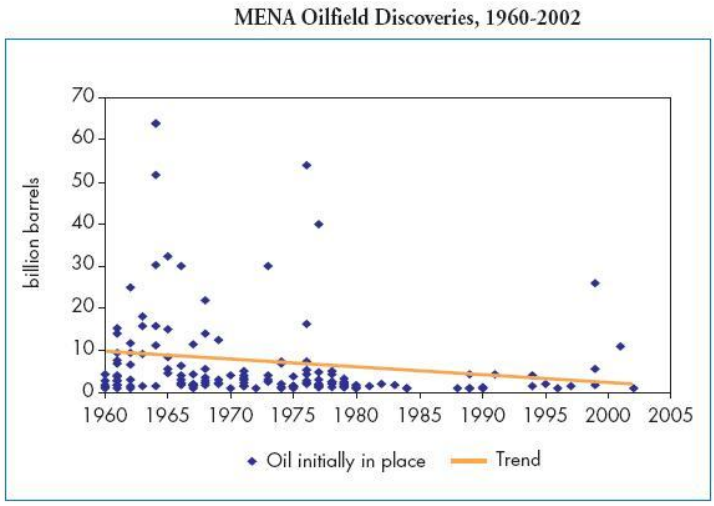


Figure 17 – Discovery trends in the world from 1963 to 2003.[51]

If we look closer to the oil discovery trend as shown in the figure above, the biggest oil discoveries took place before 1970. The rising prices due to the oil crisis did not halt the declining trend in discoveries. After 1973 oil discoveries temporarily rebounded but declined soon after. The financial incentive of the higher oil price did not achieve discoveries as big as those before 1970. Therefore, it seems likely that higher oil prices may prove to increase the exploration and will result in a slightly higher amount of oil discovered, but will certainly not break the declining trend observed since 1964.



What really matters though are the large discoveries from fields yielding enough oil to sustain the worlds consumption for several months. The last "super giant" field discovery was the Kashagan field in Iran in 2000 with 10 billion barrels of recoverable oil. Enough to sustain current world consumption for 112 days. The prediction of the IEA means that each year, three giant fields such as Kashagan have to be found. The increases in drilling in the Middle-East have not shown such a significant increase in discoveries. In this region, fields of substantial size have only been discovered in Iran between 2000 and 2005.

Figure 18 – Discovery trends in the Middle-East and Africa[52]

[51] IHS Energy, *Global oil supply issues: Recent trends and future possibilities*, March 2005

Other discoveries in Iran between 2000 and 2005 beside the Kashagan field are the Yadaravan field containing 3 billion barrels of recoverable oil, the Tossan field containing 400 million barrels of recoverable oil and three fields Koh-Mond, Zageh and Firdows containing approximately 30 billion barrels of very heavy oil that is extremely hard to produce. Although recently slightly more oil fields have been found in other Middle-Eastern countries, they are very small and contain little oil. Outside the Middle-East only a few giant fields have been discovered recently, but none near the size of the Kashagan field in Iran have been confirmed.

In 2004 there was some speculation about a "supergiant" discovery in the Gulf of Mexico[53]. The state oil company of Mexico, Pemex, supposedly had found a deepwater field that "*could total about 54 billion barrels of crude oil equivalent*". Later it appeared that the discovery in the Gulf of Mexico had been overstated by Pemex. The figure of 54 billion barrels that "*could*" be extracted had now been cut in half, and "*exploration had become economically unviable*".[54] In reality this announcement was based on scientific estimates. No test drilling had been done to substantiate this claim, the oil field was in fact, never discovered.[55] At the end of 2004 another huge theoretical discovery had taken place in the Bohai Bay in china, according to the press release the field contained 65 billion barrels of recoverable reserves.[56] This announcement later proved to be untrue, the same "discovery" had already circulated in 2002 on the Internet. The bigger problem outlined in these examples is that oil companies do not account oil reserves according to international standards and easily make unsubstantiated claims of oil discoveries. In 2004 approximately 8 billion barrels of reserves were added to proven Chinese reserves as stated by the Ministry of Land and and Resources.[57] But a large part of these reserves are in fact not "proven", or in other words extractable, when compared to international standards.

Another region that is often stated regarding future oil discoveries is the deepsea. In the deepsea, large oil fields have until now only been found in four regions, Nigeria, Angola, Brazil and the Gulf of Mexico. Some drilling has been done in deep west India which was unsuccessful and a big field (Kikeh) has been discovered in Malaysia, but the size of this field is small when compared to the fields found in the four regions mentioned above.[58] In the four big deepwater countries discoveries have peaked. Brazil in 1987, GoM in 1999, Angola in 1998 and Nigeria in 1996. This was the conclusion from a study done by Merril Lynch published in the oil and gas journal of july 26,2004. According to this study, total deepwater production could peak at 6.2-6.4 mb/d during 2011-2013 if no further large discoveries take place.

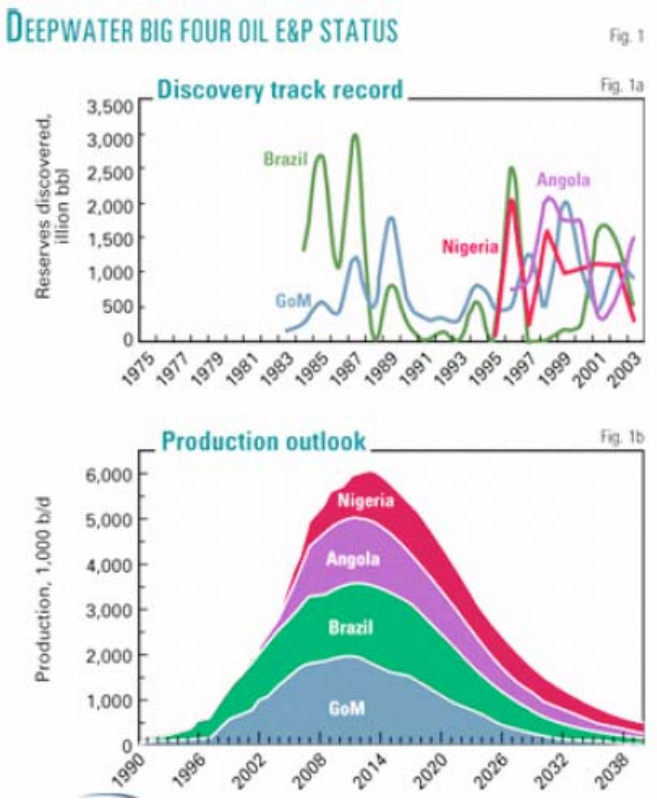


Figure 19 – Deepwater discoveries and production outlook in Nigeria, Angola, Brazil and the GoM.[59]

[52] IEA, *World energy outlook 2005*, 2005
[53] Reuters - http://www.energybulletin.net/1803.html
[54] The Herald - http://www.energybulletin.net/5438.html
[55] Mexican information and research associates - http://www.mexidata.info/id270.html
[56] The China Daily - http://www.chinadaily.com.cn/english/doc/2004-12/23/content_402814.htm
[57] Alexander's gas and oil connections – http://www.gasandoil.com/goc/discover/dix52118.htm
[58] J. Laherrère – *Fossil fuels future production*, Romanian oil and gas congress 2005

Based on the facts and figures above it is assumed in the PONL outlook that the declining discovery trend will continue. Possibly, more drilling effort will result in an small increase in oil discoveries. Therefore we added a slightly higher amount of discoveries then assumed by ASPO.

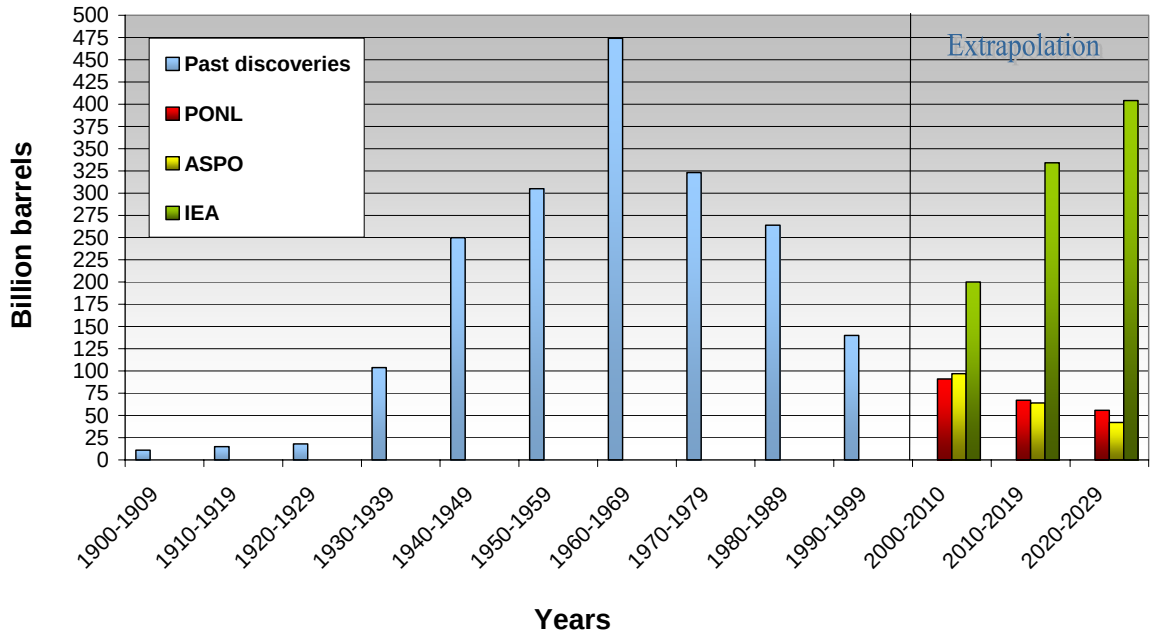


Figure 20 – Liquid discoveries from 1900 to 2030, 1900-1999 data was obtained from ASPO, 2000-2004 data was obtained from IHS Energy and included in the three discovery projections. IEA data was obtained from the world energy outlook 2005. PONL extrapolation was used in this outlook. [59]

In order to estimate future production from the discovery extrapolation above, discoveries were divided into five-year blocks. This method was chosen for convenience. There is a time lag between the discovery and the on-stream production of a field. Dividing discoveries into five-year blocks gives an accurate and easily quantifiable way of predicting future oil production. Because of the current high oil price, it was taken into account that discoveries are now coming on-stream far quicker then in the past. At the moment there are even oil fields coming on-stream 3 years after they have been discovered. Therefore it was assumed that 80% of the discoveries made in five-year period A come into production in five-year period B. The remaining 20% of the discoveries made in five-year period A were assumed to come in production in five-year period C.

From the project analysis it was observed that 18% of the total project additions between 2005-2010 are coming from the period 2000-2004. This corresponds with a production increase of 4.0 mb/d including the 20% from the period 1995-1999.

[59] ASPO - http://www.peakoil.net/DiscoverGap.html

From the observations above, oil production from future discoveries was estimated as shown in table 9 below. These figures were incorporated in this outlook.

Period	Increase in reserves from liquid discoveries (GB)	Oil Prod. increase 80% (mb/d)	Oil Prod. increase 20% (mb/d)	Total Oil. Prod Increase
2000-2004	54	/	/	/
2005-2009	45	3.3	0.7	4.0
2010-2014	35	3.2	0.7	3.9
2015-2019	32	2.5	0.6	3.2
2020-2024	29	2.3	0.5	2.8
2025-2029	27	2.1	0.5	2.5
2030-2034	24	1.9	0.4	2.4
2035-2039	21	1.7	0.4	2.1
2040-2044	18	1.5	0.3	1.9
2045-2049	15	1.3	0.3	1.6
2050-2054	13	1.1	0.3	1.3
2055-2059	11	0.9	0.2	1.1
2060-2064	9	0.8	0.2	1.0
2065-2069	7	0.6	0.2	0.8
2070-2074	6	0.5	0.1	0.6
2075-2079	5	0.4	0.1	0.5
2080-2084	4	0.4	0.1	0.4
2085-2089	3	0.3	0.1	0.4
2090-2094	2	0.2	0.1	0.3
2095-2099	2	0.1	0.0	0.2

Table 9 – Assumed declines in liquid discoveries and corresponding oil production increases from these discoveries

Production from discovered fields not yet on-stream

It appears that the existing reserve base is rapidly being brought into production. Old oil fields have been brought into production for the past 20 years because of major technological improvements.

IHS energy recently released a study stating that: "*90% of all known [liquid] reserves are now in production*" [60] The USA and Canada were not included in the calculations done by IHS Energy. However, since both Canada and the USA are past peak regions (excluding oil/tar sands) this omission has no influence on the conclusion drawn. Between 1983 and 2003 production from the existing reserve base increased from 80% to 90%, an annual increase of approximately 0.5 percent. A graphical representation of the analysis done by IHS Energy is represented in figure 21 below.[61]

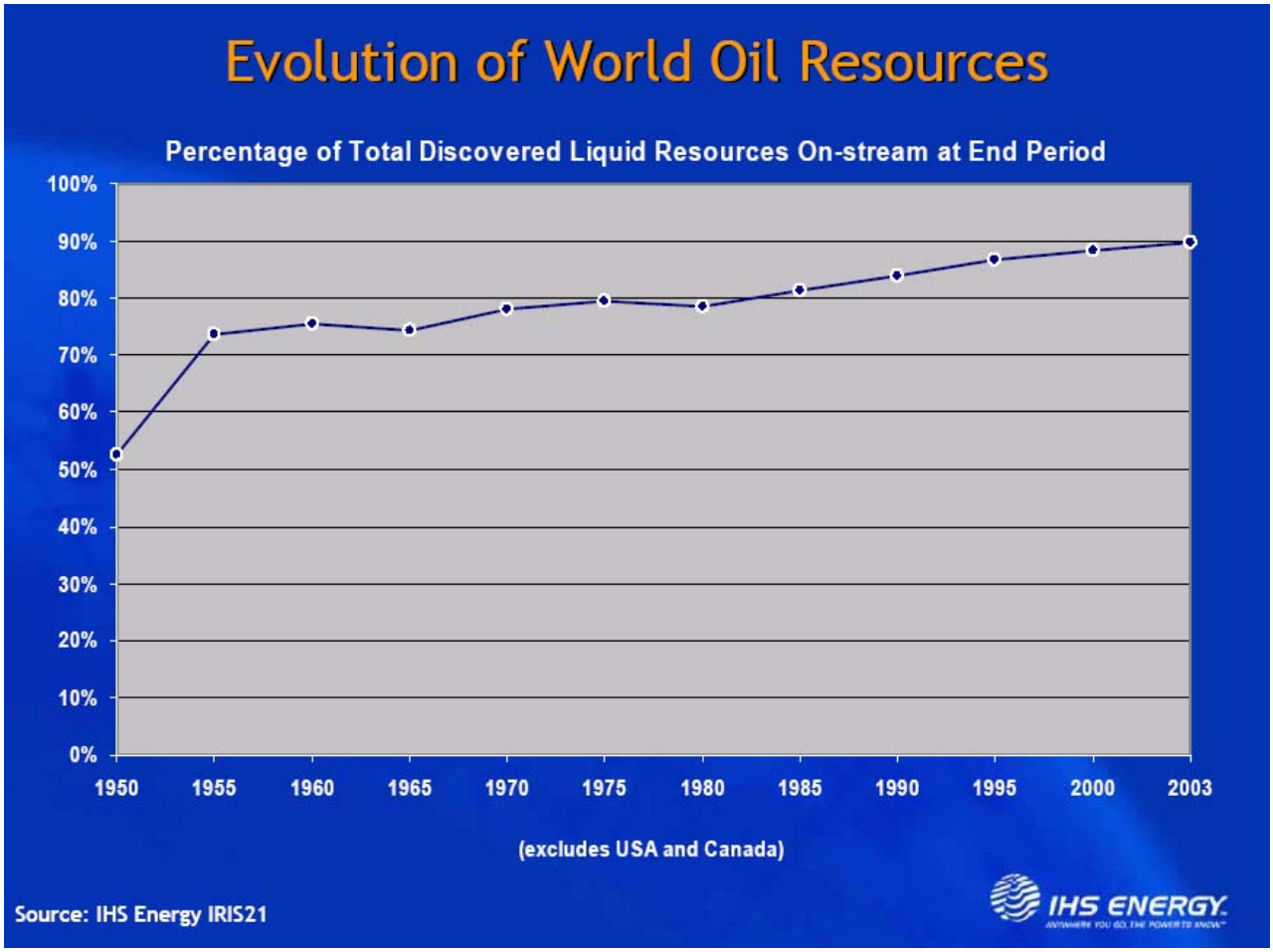


Figure 21 – Percentage of total discovered liquid resources On-stream at End Period.

We can conclude from the trend presented by IHS Energy that:

The amount of liquids production that can come from projects that increase production from an existing reserve base or, in other words, older fields not yet in production, is declining.

[60] The Guardian - http://www.guardian.co.uk/life/feature/story/0,13026,1464050,00.html
[61] IHS Energy - http://www.ifp.fr/IFP/en/events/Oapec2005/K_Chew.pdf

According to IHS Energy 1,265 billion barrels of liquid reserves were proven at the end of 2003 (including tar sands). This means that 10% of 1.265 billion barrels or 126.5 million barrels were not yet in production at the end of 2003. Recent discoveries from the years 2000-2003 have to be excluded when calculating the remaining possible increases from the existing reserve base. These recent discoveries are already included in the amount of production coming from the future discovery stream.

In the period of 2000 to end 2003 approximately 46.9 billion barrels of oil were discovered. This brings the total of reserves which could be brought into production in this period to 126.5 – 46.9 = 79.6 billion barrels. Corresponding with a total possible on-stream production (at the end of 2003) of 96%.

It appears that an increasing amount of old fields are coming on-stream and that this trend is accelerating. From the project analysis we observed that 48% of total project additions in the period between 2005-2010 came from before the year 2000. This corresponds with a production increase of 8.4 mb/d. In this figure an amount of 20% was subtracted from the period of 1995-1999 since this has already been included in the new production from discoveries stream. It can be concluded that, just as new discoveries are waning, the amount of production that can come from older fields is also decreasing.

From the observations above, oil production from the existing reserve base was estimated as shown in table 10 below. These figures were incorporated in this outlook.

Year	Production On-stream (percentage)	Liquids Production increase (mb/d)
End 2003	90%	?
End 2004	91%	?
End 2005	92%	1.9
End 2006	92%	1.9
End 2007	93%	1.9
End 2008	94%	1.8
End 2009	94%	1.3
End 2010	95%	1.2
End 2011	95%	.8
End 2012	96%	.5
End 2013	96%	.3
End 2014	96%	.4
End 2015	96%	.3

Table 10 – Percentage of production on-stream and corresponding increases in production from the existing reserve base.

Increased oil production due to reserve growth

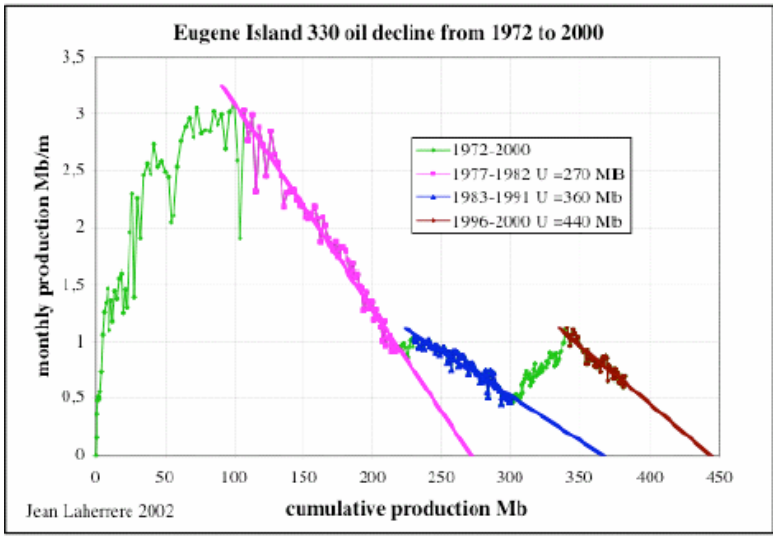
In order to sustain high oil production levels, a vast amount of fields already in production have to increase production considerably. This new amount of production is due to what is called reserve growth. Increases in the reserves of a field can occur due to a number of factors:

1. Application of enhanced oil recovery techniques (EOR)
2. Application and implementation of new technologies
3. Discovery of new reservoirs or extension of existing reservoirs in existing fields
4. Improvement of reservoir understanding
5. Development of more sophisticated reservoir simulation and an increase in available data
6. Conservative (initial) estimates of reserves
7. Lower drilling and operating costs

The central number used to describe reserve growth is the recovery rate of a field. Usually this number is used to express technological progress. Recovery rate describes the amount of oil that can be extracted out of the ground at current oil prices from known reservoirs, with current operating methods, as a percentage of the total amount of oil present in the field. When calculating (technical) reserves the oil originally in place is taken and multiplied with the recovery rate.

The 'normal' recovery of an oil field happens through pressure from the rock and water layers of the field. Because of this pressure, 4-6% of the oil can be recovered without any difficulties. Sometimes a natural gas drive is present which increases the natural recovery to 10-15%. Currently the percentage of oil that can be recovered is estimated at 35%. This is due to the application of techniques such as 3D seismic, horizontal wells and water injection. That this number is not very solid is rarely known. The IEA states that:

"*Numbers of this order [35%] are often quoted, but rarely supported by abundant data. In fact, it is in principle necessary to look at abandoned reservoirs, estimate original oil in place (which is always somewhat uncertain) and compare it with actual cumulative production up till abandonment. Also, because such analysis looks at the past, it does not necessarily take into account current, more advanced technology practices. The data available is mainly from the United States.*"[62]



An example of reserve growth is the Eugene Island field in the Gulf of Mexico, shown in figure 22 to the left. At the beginning of the first decline period (shown in pink), data seemed to suggest that the URR of the field would be 270 Mb. However, this had to be revised two times in the life of the field, due to two periods of increased production (shown in blue and brown). This example shows clearly that it is very difficult to assess the ultimate amount of reserves to be recovered and thus the increase of reserve growth over time.

Figure 22 – Production and decline cycles in the Eugene Island field.[63]

[62] IEA – *Resources to Reserves, oil and gas technology for the energy markets of the future*, 2005
[63] J. Laherrère, - *Fossil fuels future production*, Romanian oil and gas congress 2005

Projections of peaking at or beyond 2030 are claiming that recovery rates will increase from near 35% now to 50%-65% in the near term future. This claim is based on an assessment of technological improvements and the supposedly observed fact that the recovery rate has increased from approximately 22% in 1980 to 35% in 2004.[64]

IHS Energy calculated that at maximum 190 Billion Barrels of reserves were added before 1995 from reserve growth due to technology.[65] This estimate is lower than the figures from economists cited above. Reserve growth appears to have increased lately, approximately a gross figure of 250 billion barrels has been added to world reserves from reserve growth between 1995 and 2005. The question is thus if reserve growth will continue at the same pace. In figure 23 to the right it is shown that recovery factor increases in Norway have severely slowed down since 1997. Norway is one of the few countries in the world with very high recovery rates due to unique geological factors and the implementation of highly advanced technology.

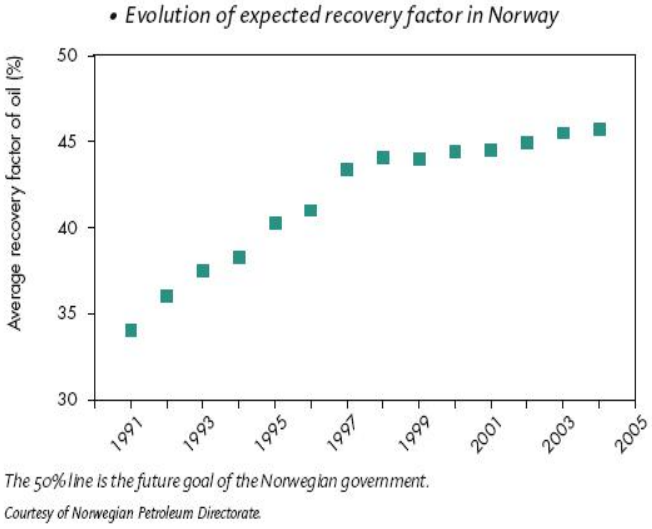


Figure 23 – Recovery factor increases in Norway from 1991 to 2004.[66]

The problem with increasing recovery rates is not only one of technological advancement. There are also large problems with the implementation of such techniques in countries including Iran, Iraq and Libya. This is due to either reluctance to let foreign companies in and/or a lack of a stable environment necessary to implement these techniques. Especially Iran has been conservative on these matters. A legislation to provide the possibility for foreign investement has been delayed due to disagreements between reformers and conservatives.[67] At the moment the recovery rate in Iran lies around 26%, which could probably be improved to 30%-35% if gigantic investments take place.

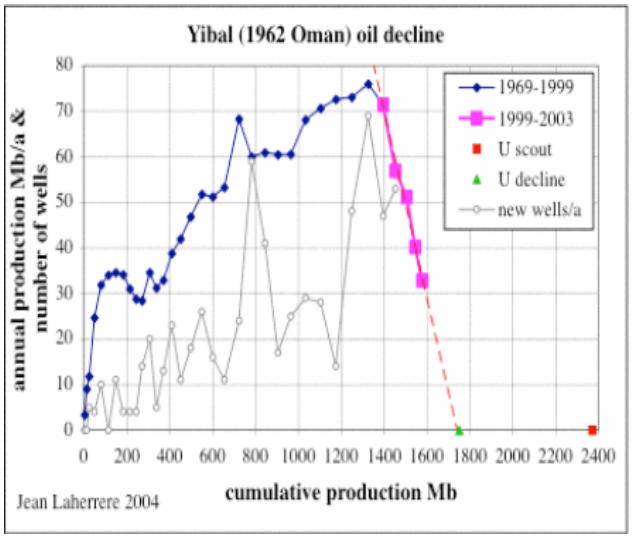
The biggest oil producer, Saudi Arabia, already has implemented first-class technology. According to many analysts including Sadad Al-Husseini, former head of Exploration and Production of Saudi Aramco there is no incentive to increase production in his country. He states that:

"*It is not clear why in the next 20 years Saudi Arabia would want to go above 13.5 million bpd with all its technical risks and consequences. People who say otherwise are using very simplistic assumptions and are not talking about how production can be sustained. Saudi-Arabia can raise output beyond 13.5 million bpd, but undeveloped reservoirs would have to be tapped. And that accelerates the depletion of reserves and reduces the life of the sustainable production plateau.*"[68]

The other fundamental problem lies in the lack of data regarding how reserve growth affects oil production. Several fields have shown a sharp increase in production for 5 to 10 years due to new recovery techniques including nitrogen injection, water injection, waterflooding, horizontal wells. This increase leads operators to believe that their oil field can in total produce more oil than in their past expectations. However, after this

[64] L. Mageuri, Policy Forum, *Never cry Wol,f why the petroleum age is far from over*, May 2004
[65] P. Stark, IHS Energy, *Role of mature fields in meeting the global O&G supply problem*, 2005
[66] IEA, *Resources to Reserves, oil and gas technologies for the energy markets of the future*, 2005
[67] EIA, c*ountry analysis briefs Iran*, October 2005
[68] Trade Arabia, *Saudi oil expansion plan 'may face delay*, November 2005

sharp increase a subsequent very sharp decline commences. The reserves of these field do not show any reserve growth, technology only helps to pump the oil up faster.



The best-known example of this trend is the Yibal field in Oman. In the beginning of the 1990's Shell, the operator, started to use horizontal wells instead of vertical ones to produce oil in this field. In 1997-1998 shell had assured the oil ministry of Oman that a 30 percent increase in Yibal's oil production rate would be sustainable for at least ten years. The fields production started to collapse in 1997 however, and has been declining ever since with 14% annually. In the year 2000 Shell still overstated Yibal-reserves with 40%, claiming that "*major advances in drilling*" were enabling the company "*to extract more from such mature fields*". This was published three years after the field had started to decline rapidly. The field has shown a production collapse since 1997 which was not halted by new technology.[69]

Figure 24 – Cumulative oil production in the Yibal field in Oman showing a significant production increase from the year 1990 until 1997 after which a very rapid decline sets in.[70]

Some other examples of fields where technology only increased production rates for a short while, after which a collapse set in, are the Duri and Minas fields in Indonesia, the Cantarell field in Mexico and the biggest field in the Eastern part of Texas shown in figure 25 to the right. In this field water injection was started in 1972 causing a significant production increase. When linearizing this increase, it would appear as if the URR would be 500 Million barrels higher then originally estimated. At the end of the field's life it was shown however, that the water injection had not increased the fields URR. It had only held production stable for a while longer.

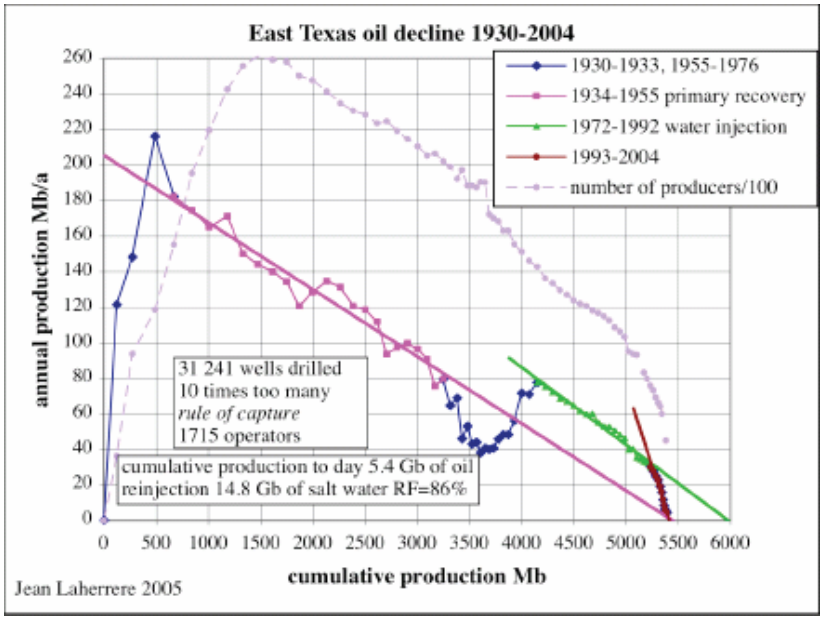
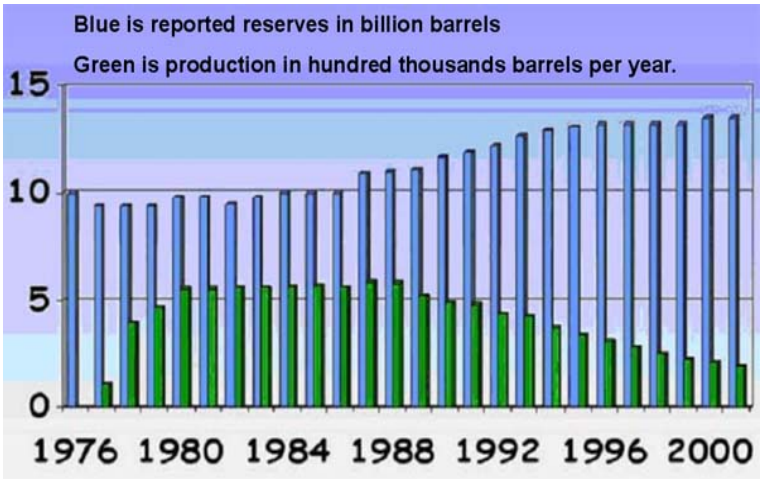


Figure 25 – Cumulative oil production in the the East Texas field showing a significant production increase from the year 1972 until 1992 following a very rapid decline. [71]

[69] M. Simmons, *Twilight in the desert, the coming Saudi oil shock and the world economy*, 2005
[70] J. Laherrère, Cern Meeting, *Peak oil and other peaks*, October 2005



Another issue that complicates the matter is that reserve increases do not necessarily result into increased production. Figure 26 to the left showing the reported reserves and production in the Prudhoe Bay field illustrates this. Production started to decline after 1988 while the total reported reserves grew, even after its peak. The question is whether the reserve increase was genuine or not. If it was, then this example shows that reserve growth does not necessarily result in the maintenance of, or increase in, oil production. It may only result in the prolonging of a lower production rate.

Figure 26 – Production growth and reserve additions in the Prudhoe Bay field.[71]

The central questions regarding reserve growth are concerning the amount of reserve growth and how reserve growth influences oil production. The examples mentioned above show that new technology does not always cause an increase in reserve growth and that political decisions restrict reserve growth in a majority of countries. This conflicting trend means that any claim of reserve growth due to technology should be carefully examined. Given the examples above it is likely that the larger part of reserve growth is necessary to maintain production and that optimistic oil production projections due to a vast amount of reserve growth are doubtful.

If we look at reserve growth prediction then companies such as Shell and Total estimate that a 8% to 10% recovery rate increase in the short term future is possible.[72] This represents an additional 200 billion to 300 billion of global reserves. The IEA predicts that in the coming 25 years approximately 308 billion barrels of oil will be added due to reserve growth.[73]

Regarding the influence of reserve growth on oil production, clear data is only available with respect to enhanced oil recovery. Shell estimates that currently 3 Mb/day are produced using EOR techniques.[74] From the project analysis it was observed that between 2005 and 2010 a total of 22.8% or 3.3 mb/d of liquids production comes on-stream from enhanced oil recovery projects, adding an average of 685.000 b/d annually.

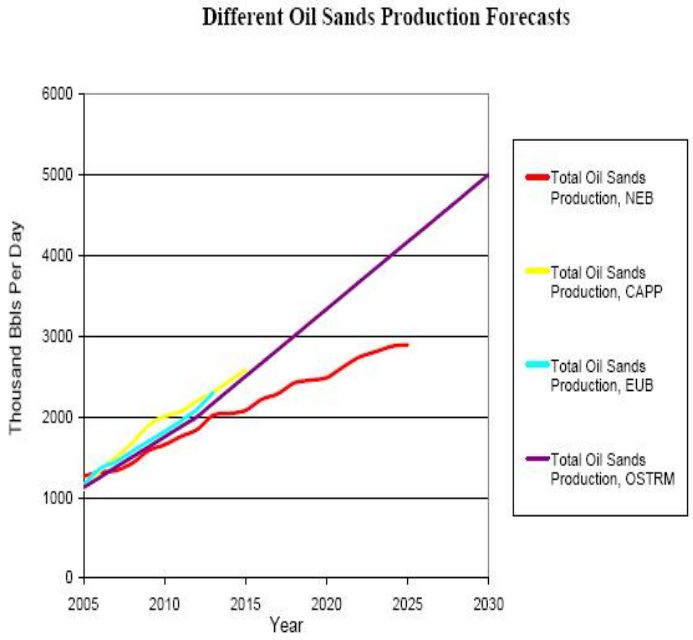
From the observations above oil production from reserve growth was estimated. The figures below were incorporated in this outlook.

An annual increase of 700.000 b/d was incorporated from EOR techniques based on observations from scheduled oil projects. No further additions due to reserve growth were incorporated. Although production could probably increase in the Middle-East if enough investment takes place this is not very likely. There is great cultural reluctance to let foreign companies into for instance Iran. When world oil production is past peak it was assumed that the rate of recovery increase would start to decline with 2% per year. This reflects the decline of an increasing amount of oil fields. Because of the uncertainty involving reserve growth an alternate scenario called “technological” was made. In this scenario it is assumed that new oil production due to reserve growth keeps increasing annually with 1.2 mb/d. It is also assumed that new production due to reserve growth would go on until 20 years after the oil peak. After this period it is assumed that the recovery rate increase, thus reserve growth increases would start to slow down.

[71] K. Aleklett, *An analysis of Chapter 3 of the World Energy Outlook 2004*, 2005
[72] Total, *corporate social responsibility report 2004*, 2005
[73] IEA, *World energy outlook 2005*,2005
[74] M. Brinded Shell, *Investing in uncertainty – the challenge of meeting expanding energy demand*, September 2005

Unconventional oil production

Another important stream of future oil production are unconventional oil resources. This includes oil/tar sands, Orinoco heavy oil and shale oil as well as current unconventional production as stated by the IEA. Production from oil/tar sands is already substantial while Orinoco heavy oil production is only in the beginning stage. The prospects for shale oil are unknown at the moment.



The prospects for tar or oil sands are extensively described in two scientific studies, the oil sands of Canada[75] and Canada's oil sand resources and its future impact on global oil supply.[76] There is a huge resource base in these oil sands; currently between 10 and 180 billion barrels are considered proven according to sources such as BP, Oil & Gas Journal and World Oil.The limitation in this case is not because of the amount of reserves but due to restrictions in production capacity. Almost all forecasts from Canadian institutes, give a production maximum of 5 mb/d until the year 2030 as shown in figure 27 to the left. The limiting factors are mostly CO_2 emissions, Canadian peak and subsequent decline of natural gas and a limit to the production capacity of mining operations.

Figure 27 – Production forecasts for Canadian Tar sands from various Canadian institutes.[62]

Less is known about Orinoco heavy oil, also a form of bitumen like Canadian oil sands. Currently, production lies at 550.000 b/d from 4 projects in this region. New projects have already been announced but no hard dates are set. Total wants to expand its operations in the region,[77] Statoil is investing to double Sincor production capacity,[78] and Chevron is also interested in expanding its operations.[79] Currently production is coming from the Faja Orinoco bloc. According to energy and oil minister Rafael Ramirez 235 billion barrels of reserves lie in this block, which will be divided into 27 different parts for tendering at the end of 2006.

Whether Oil Shale production is viable at a large scale remains uncertain. Because of the various negative indicators towards oil shale production, this resource has not been incorporated. Shell is the only company actively working on developing Oil Shale. Soon a final test will be started to decide if Shell will continue the development of shale oil.

[75] B. Soderbergh, Uppsala University, *Canada's oil sand resources and its future impact on global oil supply*, 2005
[76] R. James, *the oil sands of Canada*, July 2005
[77] Alexander's gas and oil connections - http://www.gasandoil.com/goc/company/cnl51234.htm
[78] Alexander's gas and oil connections - http://www.gasandoil.com/goc/company/cnl51902.htm
[79] Alexander's gas and oil connections - http://www.gasandoil.com/goc/company/cnl52918.htm

Steve Mut, The CEO of Shell Unconventional Resources recently stated at the ASPO-USA conference that

"*If oil shale production proves viable, it will still be pretty negligible by 2015, but might, if things go really well, get to 5mb/d by 2030.*"[80]

Even if a method is found to economically produce oil shale, significant production will not be in the near term future, therefore no impact to the peaking of world oil production is to be expected. For more information, we refer to a recent review on oil shale by Jean Laherrère which can be found at the http://www.oilcrisis.com/shale/ website.

From the observations above, the following estimates were made with respect to the production of unconventional oil. Unconventional oil production is expected to climb to 11 mb/d where after a decline sets in due to natural gas, environmental and material restrictions. In the "technological" scenario it was assumed that these problems would be dealt with. Hence, a production plateau of 12.4 mb/d was incorporated and maintained until beyond 2100.

This projection is slightly more optimistic then that from the IEA who expect 10.2 mb/d of unconventional oil production in 2030.[81]

[80] The Oil Drum - http://www.theoildrum.com/story/2005/11/12/0150/4833#more
[81] IEA, *world energy outlook 2005*,2005

8) A sum of five parts – When will world oil production peak?

A peak in liquids production is to be expected between 2012 and 2017 based on five factors:

- A production decline in an increasing amount of oil producing regions
- A decline in oil discoveries since the 1960's
- A limit to the increase in liquids production from the existing reserve base
- An estimate of additional production due to improvements in technology
- An increased production from oil/tar sands and Orinoco heavy oil production

A significant discontinuity in observed oil production trends is necessary to postpone the peak to a date later than 2017. However, there are large uncertainties regarding reserve data, the influence of reserve growth (specifically technological progress) on production and the progression of worldwide decline. Therefore any peak oil projection has a significant degree of inaccuracy and should not be followed blindly.

Two alternative scenarios have been made. One based on higher production from technological improvements and unconventional oil as outlined on pages 32-34 called "technological". The other based on the "turbulent world" scenario as presented on pages 20-22 called "disruption and delay". It is assumed in this disruption scenario that no timely mitigation efforts will be in place based on current governmental policy making. Therefore it was assumed that these disruptions and delays will increase. This assumption is based on an increase in social, political and economic disruption effects due to a resource shortage.

A refining capacity assessment was made as well as outlined in table 11 below:

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Refining capacity	85429	85972	86767	87641	88603	89661	90825	92105	93145	95063	96767

Table 11 – refining capacity forecast 2005-2015

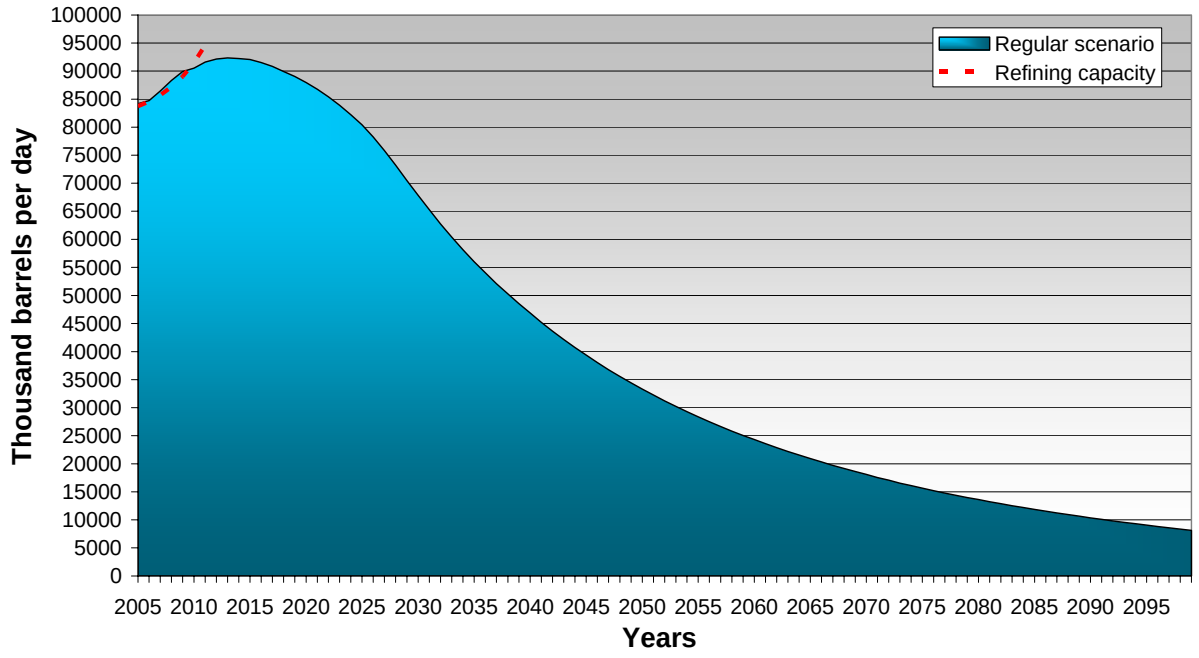


Figure 28 – World liquids production outlook "Regular" 2005 – 2100

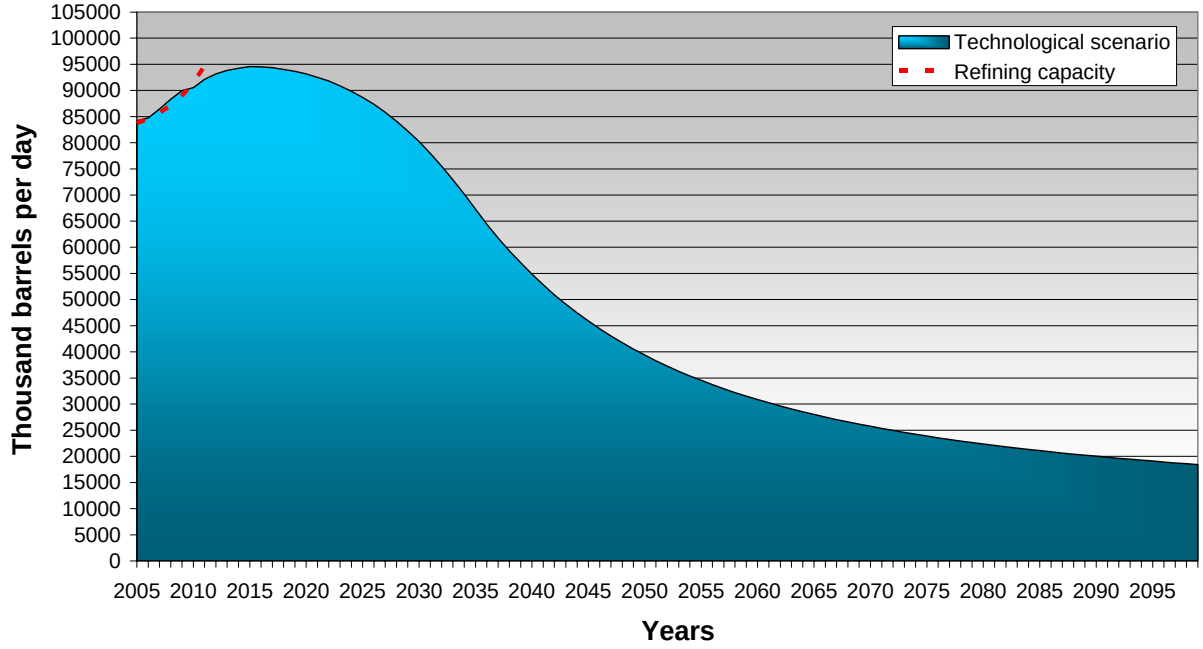


Figure 29 – World liquids production outlook "Technological" 2005 – 2100

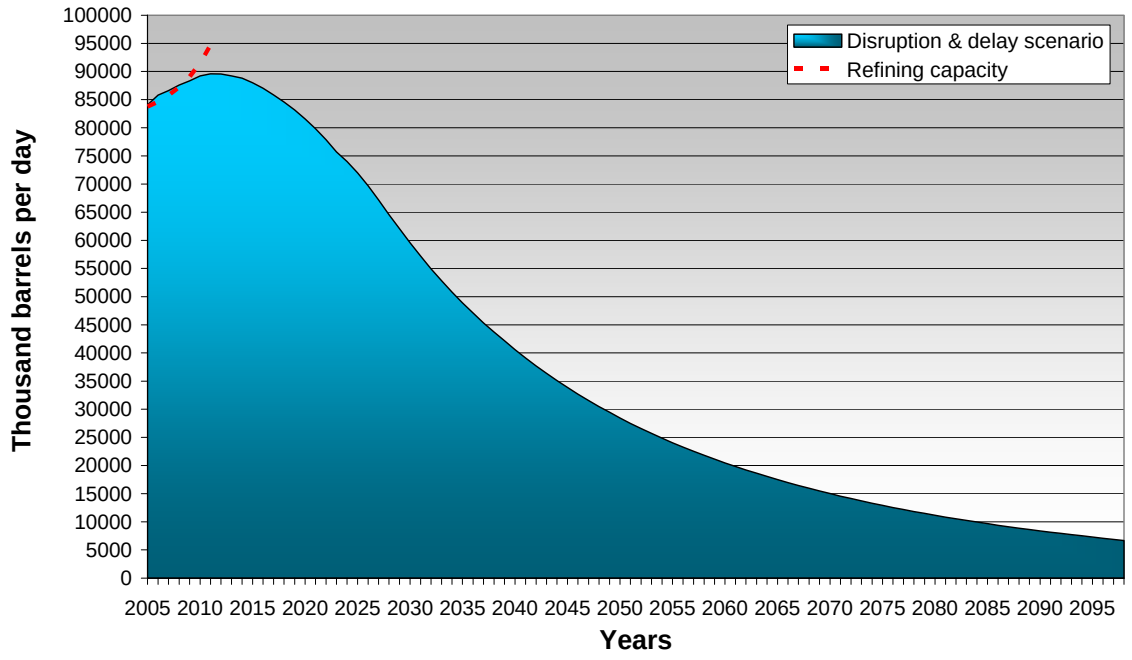


Figure 30 – World liquids production outlook "Disruption & Delay" 2005 – 2100

World Liquids Production	**End 2005**	**End 2006**	**End 2007**	**End 2008**	**End 2009**	**End 2010**	**End 2011**	**End 2012**	**End 2013**
World Prod. Regular	84759	86456	88329	89929	90532	91610	92172	92366	92240
Decline	2379	2261	2193	2050	2200	2266	2334	2404	2476
Technological increase	920	933	855	596	700	700	700	700	700
Recent discovery increase	727	737	676	471	778	778	778	778	778
Existing base increase	1976	1996	1836	1307	1200	800	500	300	400
Unconventional Production	2611	3064	3532	3957	4236	4836	5386	5936	6436
World Prod. Technological	84759	86456	88329	89929	90532	92110	93172	93866	94240
Decline	2379	2261	2193	2050	2200	2266	2334	2404	2476
Technological increase	736	763	700	489	1200	1200	1200	1200	1200
Unconventional Production	2611	3064	3532	3957	4236	4836	5386	5936	6436
World Prod. Disruption	84058	85781	86615	87604	88333	89207	89577	89563	89213
Disruption prod. offline	402	789	1353	2184	2225	2403	2595	2803	3027

	End 2014	End 2015	End 2016	End 2017	End 2018	End 2019	End 2020	End 2021	End 2022
World Prod. Regular	92072	91509	90845	89941	89024	87961	86732	85433	83915
Decline	2550	2627	2706	2787	2871	2957	3045	3137	3231
Technological increase	686	672	659	646	633	620	608	596	584
Recent discovery increase	631	631	631	631	631	560	560	560	560
Existing base increase	300	240	192	154	123	98	79	63	50
Unconventional Production	6866	7236	7656	7976	8416	8836	9286	9786	10186
World Prod. Technological	94572	94523	94387	94024	93662	93165	92517	91810	90896
Decline	2550	2627	2706	2787	2871	2957	3045	3137	3231
Technological increase	1200	1200	1200	1200	1200	1200	1200	1200	1200
Unconventional Production	6866	7236	7656	7976	8416	8836	9286	9786	10186
World Prod. Disruption	88803	87978	87032	85823	84577	83157	81544	79830	77864
Disruption prod. offline	3269	3531	3813	4118	4448	4804	5188	5603	6051
	End 2023	**End 2024**	**End 2025**	**End 2026**	**End 2027**	**End 2028**	**End 2029**	**End 2030**	**End 2031**
World Prod. Regular	82228	80423	78270	75847	73232	70471	67861	65256	62770
Decline	3328	3428	3530	3636	3745	3570	3418	3271	3133
Technological increase	572	561	549	538	528	517	507	497	487
Recent discovery increase	560	508	508	508	508	508	471	471	471
Existing base increase	40	32	26	21	12	7	4	3	2
Unconventional Production	10536	10886	11060	11084	11039	10975	10902	10733	10548
World Prod. Technological	89826	88648	87361	85814	84087	82222	80230	77958	75521
Decline	3328	3428	3530	3636	3745	3858	3973	4093	4215
Technological increase	1200	1200	1200	1200	1200	1200	1176	1152	1129
Unconventional Production	10536	10886	11286	11536	11716	11876	12026	12076	12106
World Prod. Disruption	75693	74018	71994	69696	67204	64563	62072	59583	57210
Disruption prod. offline	6535	6405	6276	6151	6028	5907	5789	5673	5560
	End 2032	**End 2033**	**End 2034**	**End 2035**	**End 2036**	**End 2037**	**End 2038**	**End 2039**	**End 2040**
World Prod. Regular	60405	58153	56029	54044	52107	50280	48539	46877	45219
Decline	3003	2880	2763	2650	2543	2443	2347	2257	2169
Technological increase	477	467	458	449	440	431	422	414	406
Recent discovery increase	471	471	422	422	422	422	422	370	370
Existing base increase	1	1	0	0	0	0	0	0	0
Unconventional Production	10357	10159	9976	9874	9716	9571	9418	9259	9074
World Prod. Technological	72928	70175	67279	64454	61782	59317	57021	54883	52817
Decline	4342	4472	4410	4176	3959	3758	3571	3397	3232
Technological increase	1107	1085	1063	1042	1021	1000	980	961	942
Unconventional Production	12126	12136	12156	12256	12296	12346	12386	12416	12416
World Prod. Disruption	54956	52813	50796	48916	47081	45355	43712	42147	40583
Disruption prod. offline	5449	5340	5233	5128	5026	4925	4827	4730	4636

	End 2041	End 2042	End 2043	End 2044	End 2045	End 2046	End 2047	End 2048	End 2049
World Prod. Regular	43644	42149	40728	39378	38043	36774	35568	34420	33328
Decline	2085	2006	1931	1860	1790	1724	1661	1602	1546
Technological increase	398	390	382	374	367	359	352	345	338
Recent discovery increase	370	370	370	319	319	319	319	319	267
Existing base increase	0	0	0	0	0	0	0	0	0
Unconventional Production	8893	8715	8541	8370	8202	8038	7878	7720	7566
World Prod. Technological	50896	49111	47450	45903	44412	43022	41727	40519	39390
Decline	3078	2936	2803	2679	2560	2448	2345	2248	2158
Technological increase	923	904	886	869	851	834	817	801	785
Unconventional Production	12416	12416	12416	12416	12416	12416	12416	12416	12416
World Prod. Disruption	39101	37697	36365	35102	33853	32668	31544	30476	29463
Disruption prod. offline	4543	4452	4363	4276	4190	4106	4024	3944	3865
	End 2050	**End 2051**	**End 2052**	**End 2053**	**End 2054**	**End 2055**	**End 2056**	**End 2057**	**End 2058**
World Prod. Regular	32236	31197	30208	29265	28368	27475	26624	25813	25039
Decline	1489	1436	1385	1337	1292	1246	1203	1163	1124
Technological increase	331	325	318	312	306	300	294	288	282
Recent discovery increase	267	267	267	267	230	230	230	230	230
Existing base increase	0	0	0	0	0	0	0	0	0
Unconventional Production	7414	7266	7121	6978	6839	6702	6568	6437	6308
World Prod. Technological	38285	37252	36286	35382	34536	33706	32928	32199	31514
Decline	2069	1987	1910	1837	1770	1703	1641	1583	1528
Technological increase	769	754	739	724	710	695	682	668	655
Unconventional Production	12416	12416	12416	12416	12416	12416	12416	12416	12416
World Prod. Disruption	28448	27485	26570	25700	24874	24051	23269	22525	21817
Disruption prod. offline	3788	3712	3638	3565	3494	3424	3355	3288	3222
	End 2059	**End 2060**	**End 2061**	**End 2062**	**End 2063**	**End 2064**	**End 2065**	**End 2066**	**End 2067**
World Prod. Regular	24301	23562	22856	22183	21540	20925	20304	19711	19144
Decline	1087	1050	1015	982	950	920	890	861	833
Technological increase	276	271	265	260	255	250	245	240	235
Recent discovery increase	195	195	195	195	195	161	161	161	161
Existing base increase	0	0	0	0	0	0	0	0	0
Unconventional Production	6182	6058	5937	5818	5702	5588	5476	5366	5259
World Prod. Technological	30871	30231	29629	29063	28530	28028	27520	27041	26589
Decline	1476	1425	1377	1332	1289	1249	1208	1170	1134
Technological increase	641	629	616	604	592	580	568	557	546
Unconventional Production	12416	12416	12416	12416	12416	12416	12416	12416	12416
World Prod. Disruption	21143	20467	19824	19211	18627	18071	17507	16969	16457
Disruption prod. offline	3158	3095	3033	2972	2913	2855	2797	2741	2687

	End 2068	End 2069	End 2070	End 2071	End 2072	End 2073	End 2074	End 2075	End 2076
World Prod. Regular	18602	18083	17552	17044	16558	16094	15649	15202	14775
Decline	807	782	756	732	708	686	665	644	623
Technological increase	230	226	221	217	213	208	204	200	196
Recent discovery increase	161	126	126	126	126	126	106	106	106
Existing base increase	0	0	0	0	0	0	0	0	0
Unconventional Production	5154	5051	4950	4851	4754	4659	4566	4474	4385
World Prod. Technological	26162	25758	25341	24946	24573	24220	23885	23547	23227
Decline	1100	1067	1034	1002	973	944	918	891	865
Technological increase	535	524	514	503	493	483	474	464	455
Unconventional Production	12416	12416	12416	12416	12416	12416	12416	12416	12416
World Prod. Disruption	15969	15503	15023	14566	14130	13714	13316	12917	12535
Disruption prod. offline	2633	2580	2529	2478	2429	2380	2332	2286	2240
	End 2077	**End 2078**	**End 2079**	**End 2080**	**End 2081**	**End 2082**	**End 2083**	**End 2084**	**End 2085**
World Prod. Regular	14366	13974	13599	13221	12860	12513	12180	11861	11537
Decline	604	586	568	551	534	518	502	488	473
Technological increase	192	188	185	181	177	174	170	167	163
Recent discovery increase	106	106	89	89	89	89	89	72	72
Existing base increase	0	0	0	0	0	0	0	0	0
Unconventional Production	4297	4211	4127	4044	3964	3884	3807	3730	3656
World Prod. Technological	22923	22635	22360	22082	21817	21566	21326	21097	20862
Decline	841	817	796	773	752	732	713	694	676
Technological increase	446	437	428	420	411	403	395	387	379
Unconventional Production	12416	12416	12416	12416	12416	12416	12416	12416	12416
World Prod. Disruption	12171	11823	11490	11155	10835	10528	10235	9955	9669
Disruption prod. offline	2195	2151	2108	2066	2025	1984	1945	1906	1868
	End 2086	**End 2087**	**End 2088**	**End 2089**	**End 2090**	**End 2091**	**End 2092**	**End 2093**	**End 2094**
World Prod. Regular	11226	10928	10642	10367	10086	9815	9556	9306	9066
Decline	459	445	432	420	407	395	383	372	361
Technological increase	160	157	154	151	148	145	142	139	136
Recent discovery increase	72	72	72	55	55	55	55	55	37
Existing base increase	0	0	0	0	0	0	0	0	0
Unconventional Production	3583	3511	3441	3372	3305	3238	3174	3110	3048
World Prod. Technological	20637	20423	20219	20024	19820	19626	19440	19263	19093
Decline	658	641	624	609	592	577	562	548	534
Technological increase	372	364	357	350	343	336	329	323	316
Unconventional Production	12416	12416	12416	12416	12416	12416	12416	12416	12416
World Prod. Disruption	9396	9135	8884	8644	8397	8161	7935	7717	7509
Disruption prod. offline	1830	1794	1758	1723	1688	1654	1621	1589	1557

	End 2095	End 2096	End 2097	End 2098	End 2099
World Prod. Regular	8818	8579	8349	8128	7915
Decline	350	339	329	319	
Technological increase	134	131	128	126	
Recent discovery increase	37	37	37	37	
Existing base increase	0	0	0	0	0
Unconventional Production	2987	2927	2869	2811	2755
World Prod. Technological	18912	18739	18574	18416	18265
Decline	520	506	493	480	
Technological increase	310	304	298	292	
Unconventional Production	12416	12416	12416	12416	12416
World Prod. Disruption	7292	7083	6883	6692	6508
Disruption prod. offline	1526	1495	1466	1436	1407

Table 12 - World Liquids production data between 2005 and 2100.

10) Summary of arguments and conclusions

This analysis leads to the following conclusions:

Peak – world liquids production will approximately peak around 2012. Liquids production is expected to form a "plateau" for approximately 6 years starting around 2010. This peak could arrive earlier if our estimate for world decline rates proves to be too low. It could also arrive later, around 2017, if oil companies succeed in improving the recovery rate of oil due to technological improvements.

Capacity added – Total gross world liquids production is expected to increase with approximately 18.4 mb/d between 2005 and 2010. Due to declining oil production net world liquids production is expected to increase with approximately 7.1 mb/d between 2005 and 2010

Supply and demand balance – Maximum possible average production growth in the period 2005-2010 lies around 1.5%, a far lower level then the years 2003 (3.51%) and 2004 (4.16%). This means that oil production growth levels like those in 2003 and 2004 will not be able to continue.

Sharp Prices increases – Because of little to zero spare capacity on the market, any oil disruption due to political, economical or natural events will have a profound effect on oil prices. A global oil shock owing to rising oil prices is likely in the period 2005-2010. At the very least, the current tightness in the international oil market will persevere. After 2010, continued price increases will become a structural problem if the current reliance on oil is maintained.

OPEC – Total gross OPEC liquids production is expected to increase with approximately 7.4 mb/d per day between 2005 and 2010. Large gross production increases are coming from Iran (1.0 mb/d), Nigeria (1.2 mb/d) and Saudi Arabia (2.4 mb/d). Due to declining oil fields in Iran, Libya, Saudi Arabia, Dubai, Venezuela and Indonesia, net OPEC liquids production is expected to increase with 4.2 mb/d between 2005 and 2010.

Non-OPEC – It is expected that Non-OPEC liquids production will peak and plateau around 2008

Total gross Non- OPEC liquids production is expected to increase with approximately 11 mb/d per day between 2005 and 2010. Large gross liquids production increases are coming from Azerbaijan (0.77 mb/d), Kazakhstan (0.85 mb/d), Russia (1.5 mb/d) Canada (1.1 mb/d), Brazil, (1.6 mb/d) and Angola (1.3 mb/d). Due to declining oil fields in the North Sea, USA, Canada, Mexico, Oman, Syria, Yemen, Egypt, Australia, China, Malaysia, Russia and various other countries, net non-OPEC liquids production is expected to increase with 2.9 mb/d between 2005 and 2010.

Countries that are probably going to peak between 2005 and 2010 are China (2006), Malaysia (2007), India (2008), Denmark (2005), Brunei (2007) and Peru (2^{nd} peak in 2008).

Refining Capacity – The current refining capacity shortage is expected to last until around 2010

These conclusions were based on the following arguments:

Decline rate – An average of approximately 2.2 mb/d of new oil production has to come on-stream annually between 2005 and 2010 to offset declining oil production. This will sharply increase within 10 to 15 years due to sharp decline rates from offshore/deepwater oil fields and the decline of the "supergiant" oil fields such as Ghawar that are now truly starting to become old. Nearly all oil fields coming on-stream at the moment are offshore or deepwater oil fields. This 2.2 mb/d estimate could be too low given estimates from the International Energy agency and oil companies.

Discoveries – The trend in declining discoveries since 1964 will continue. Less oil will be discovered every year. Slightly more oil could be discovered due to financial incentives but we think that this will not cause a break in the declining discovery trend.

Production on-Stream – Approximately 90% of all oil ever discovered is already in production. This leaves very little growth for the future from fields already discovered. Nearly all oil fields ever discovered will be in production after 2010.

Production from new technology – A moderate assessment of production increases from reserve growth (an increase in the recovery rate). Although oil companies and the IEA project far higher reserve growth there is great doubt to the influence of reserve growth on oil production due to a general lack of data. Therefore two scenarios were made. One with a reasonable certainty as to production increases due to technology. The other with a more optimistic approach. From these scenarios it can be conluded that technology can push the peak backwards, but not for a very long time because of increasing decline rates.

Unconventional oil – A projection for unconventional oil production which gives a production maximum of approximately 12 mb/d around 2030.

11) Implications of a world oil production peak

One could keep arguing about issues of data quality and its implications for the accuracy of peak oil predictions. Nevertheless, the time for a transition to a sustainable society is certainly very short, even in the improbable case that world oil production would peak as late as 2030. According to research done by SAIC which was sponsored by the American Department of Energy:

"*at least 20 years are needed for timely mitigation. Without this time the economic, social and political costs involved will be unprecedented.*"[82]

It is frequently overlooked that long before the peak arrives the international energy markets will already start to experience some changes:

- In recent years spare oil capacity went to almost zero
- Light sweet crude oil has probably peaked[83]
- There is a refining capacity shortage
- A real gap between supply and demand has formed
- Liquid fuel prices are already rising dramatically and becoming more volatile every day.

In the near future, cheap oil will no longer be abundant and society as we know it will begin to change. Not enough affordable oil will be available to fuel today's transport system. This does not mean that everything will suddenly come to an end; rather the shortage of oil will gradually increase over time. Without timely mitigation, the economy will face serious difficulties, nationally as well as internationally.

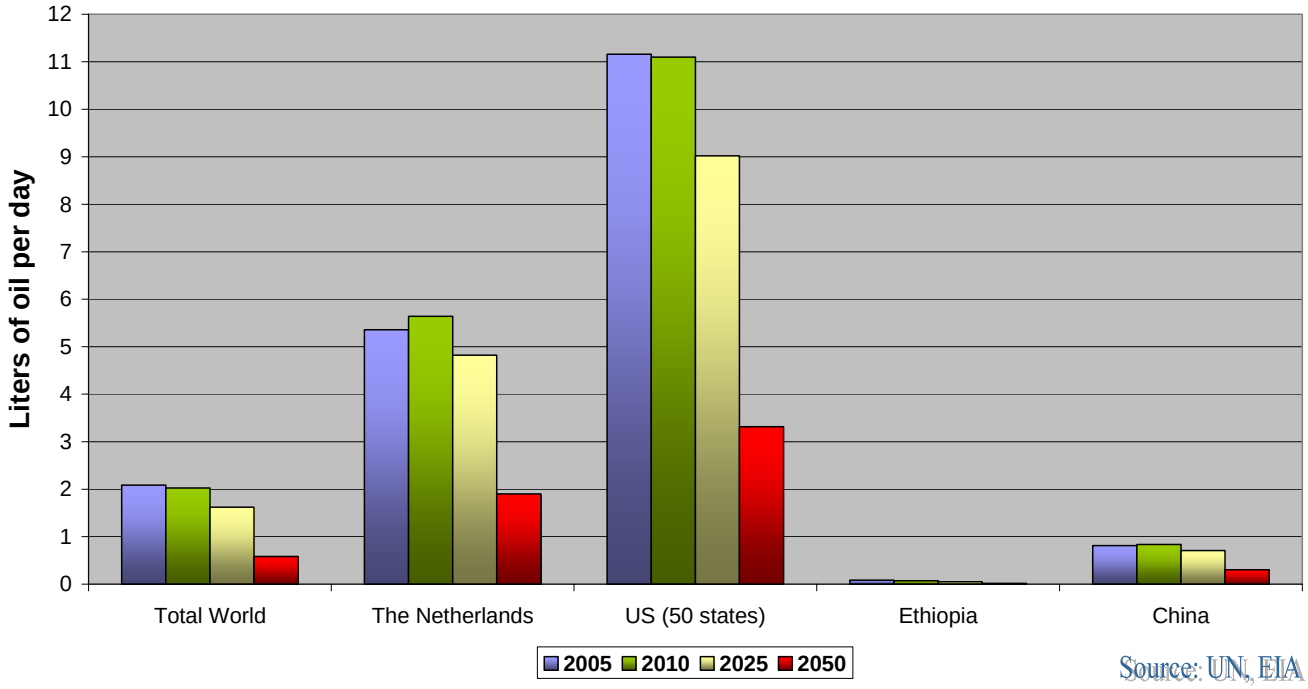


Figure 31 – Average consumption of oil per capita when the decline is evenly distributed across the world if world population keeps increasing towards 9 billion in 2050.

[82] Hirsch, Bezdek, Wendling, SAIC, *Peaking of world oil production: Impacts, Mitigation and Risk Management,* 2005
[83] OPEC Montly Oil Market - http://www.opec.org/home/Monthly%20Oil%20Market%20Reports/2005/MR082005.htm

At the moment, most opinion leaders, politicians, scientists and industry leaders do not seem to be aware of the seriousness of this issue. The Dutch government, for instance, bases its energy policies on a projected future oil price that hardly resembles any realism at all; the projected price until 2010 is the lowest when compared to a wide variety of sources such as oil companies, banks and the optimistic International Energy Agency.

	2006	**2007**	**2008**	**2009**	**2010**
Dutch Government[84]	50 dollars	27 dollars	27 dollars	27 dollars	27 dollars
CIBC[85]	84 dollars	93 dollars	80 dollars	90 dollars	101 dollars
Goldman Sachs[86]	74 dollars	103 dollars	135 dollars	unknown	unknown
Beyond Petroleum[87]	40 dollars	40 dollars	40 dollars	40 dollars	40 dollars
International Energy Agency[88]	52 dollars	51 dollars	49 dollars	48 dollars	47 dollars

Table 13 – Oil price predictions made by the Dutch Government, international banks, BP and the IEA

Above all we must realize that we live in an economical system based on growth. Growth can by definition not go on forever when it relies on limited physical resources. The overall issue is how to bring about a society with a sustainable level of population, energy and natural resource consumption. Non-renewable energy sources like coal, natural gas and uranium can only be a temporal solution. Every effort towards an economical reorientation from a growth-based society towards a sustainable society is therefore meaningful and necessary.

In order to achieve a sustainable future we should embark on four necessary paths:

- Behavioral change, going from an exponential growing society to a stable based society
- Energy efficiency, decreasing the amount of energy needed to do the same
- Energy saving, diminishing the excess amount of energy to provide needs
- Renewable energies, implementing them as fast as possible.

[84] Ministry of economic affairs, *Nu voor later, Energierapport 2005*, 2005
[85] CIBC, *Montly indicators*, April 2005
[86] Goldman Sachs, *Superspike Report*, March 2005
[87] BBC News - http://news.bbc.co.uk/1/hi/business/4406054.stm
[88] Internation Energy Agency, *World Energy Outlook 2005*, 2005

Appendix A – Datasets used in the production model

Production in thousand barrels per day	1996	1997	1998	1999	2000	2001	2002	2003	2004	1st qtr 2005
OPEC										
Algeria	1356	1428	1431	1377	1436	1486	1521	1794	1930	2067
Indonesia	1622	1592	1532	1503	1380	1385	1304	1200	1143	1132
Iran	3718	3649	3705	3572	3760	3775	3510	3959	4149	4161
Kuwait	1905	1941	1926	1768	1880	2141	2010	2297	2469	2563
Libya	1419	1470	1535	1438	1471	1427	1381	1488	1614	1693
Nigeria	2252	2390	2199	2059	2160	2222	2116	2276	2513	2551
Qatar	581	724	751	744	821	822	796	942	1020	1027
Saudi Arabia	8661	8848	8909	8325	8807	8568	8556	9774	10135	10358
United Arabic Emirates	2423	2467	2516	2286	2458	2385	2205	2469	2561	2593
Venezuela	3306	3623	3562	3229	3369	3302	3069	3113	3523	3837
Iraq	581	1152	2127	2536	2582	2377	2032	1335	2010	1812
	483	533	545	591	632	565	538	605	597	597
Total OPEC	**28307**	**29817**	**30738**	**29428**	**30756**	**30455**	**29038**	**31252**	**33664**	**34391**

Table 14 – OPEC production data from 1996-2005 taken from the International Energy Agency - Oil, Gas Coal & Electricity Quarterly Statistics 1999 to 2005.

Production in thousand barrels per day	1996	1997	1998	1999	2000	2001	2002	2003	2004	1st qtr 2005
Former Soviet Union										
Azerbaijan	181	181	231	276	280	298	306	309	309	345
Kazakhstan	473	507	525	613	707	798	960	1044	1209	1275
Russia	6026	6110	6122	6158	6503	7017	7661	8488	9227	9343
Uzbekistan	125	114	94	99	91	80	77	87	82	71
Other Former USSR	277	281	323	347	353	367	387	401	390	375
FSU Total	**7082**	**7193**	**7295**	**7493**	**7934**	**8560**	**9391**	**10329**	**11217**	**11409**

Table 15 – FSU production data from 1996-2005 taken from the International Energy Agency - Oil, Gas Coal & Electricity Quarterly Statistics 1999 to 2005.

Production in thousand barrels per day	1996	1997	1998	1999	2000	2001	2002	2003	2004	1st qtr 2005
Non OPEC										
USA	8511	8635	8370	8097	8109	8069	8032	7829	7668	7714
Canada	2429	2558	2672	2561	2739	2728	2859	2996	3089	2944
Mexico	3306	3448	3496	3345	3451	3560	3585	3789	3825	3746
Argentina	824	878	895	849	814	827	839	828	780	755
Brazil	1053	1131	1222	1358	1496	1558	1716	1801	1796	1849
Columbia	627	652	758	815	687	604	578	541	528	522
Ecuador	384	385	375	373	385	430	392	418	526	530
Peru	119	118	116	106	99	97	97	91	84	79
Trin & Tobago	120	124	124	125	123	113	131	135	123	168
Other S & Central America	124	135	148	155	163	183	195	217	236	258
Denmark	208	230	238	300	363	346	371	373	389	393
United Kingdom	2712	2803	2840	2926	2705	2534	2496	2326	2054	2005
Norway	3230	3286	3135	3244	3409	3408	3334	3264	3188	3075
Italy	103	112	107	85	77	65	84	90	110	120
Romania	135	128	126	125	121	124	120	117	114	109
Other Europe	435	415	383	353	358	349	361	361	370	360
Oman	885	900	899	906	953	952	895	815	758	736
Syria	612	570	602	570	583	567	495	477	450	433
Yemen	365	361	384	393	436	439	438	431	402	378
Other middle east	69	63	63	211	210	206	269	276	277	278
Angola	691	714	729	748	745	739	897	879	988	1123
Cameroon	110	121	102	91	85	78	72	70	67	66
Congo Brazzaville	201	239	260	257	266	263	249	247	230	225
Egypt	914	893	880	853	811	758	738	744	708	702
Gabon	360	365	352	331	310	275	258	242	235	230
Tunisia	84	77	78	79	80	68	77	76	80	80
Other Africa	634	678	704	757	872	863	938	1041	1361	1412
Australia	597	643	616	608	781	732	710	605	538	512
Brunei	195	195	179	180	190	195	219	219	216	210
China	3116	3189	3193	3186	3229	3297	3390	3410	3485	3629
India	738	755	749	745	734	742	778	785	799	803
Malaysia	707	725	736	712	708	748	785	831	857	841
Papua New Guinea	106	80	79	99	64	60	55	50	45	31
Vietnam	192	180	228	297	316	341	340	347	405	357
Other Asia-Pacific	218	272	275	279	298	363	392	423	410	420
Non OPEC total	**42196**	**43251**	**43408**	**43612**	**44704**	**45241**	**46576**	**47473**	**48408**	**48502**

Table 16 – Non OPEC production data from 1996-2005 taken from the International Energy Agency - Oil, Gas Coal & Electricity Quarterly Statistics 1999 to 2005.

Country	Existing production declining	2005	2006	2007	2008	2009
Algeria	1207	1195	1183	1171	1159	1148
Indonesia	968	910	855	804	756	710
Iran	3930	3773	3622	3477	3338	3204
Kuwait	2046	2026	2005	1985	1965	1946
Libya	1546	1515	1485	1455	1426	1397
Nigeria	2323	2300	2277	2254	2231	2209
Qatar	770	762	755	747	740	732
Saudi Arabia	3200	2944	2708	2492	2292	2109
UAE	2353	2329	2306	2283	2260	2238
Venezuela	2168	2081	1998	1918	1841	1768
USA	5428	5157	4899	4654	4421	4200
Canada	1793	1703	1618	1537	1460	1387
Mexico	3077	2915	2620	2358	2126	1920
Argentina	699	677	656	636	616	597
Brazil	618	565	516	472	433	396
Colombia	528	505	483	461	441	422
Ecuador	526	521	516	510	505	500
Peru	84	80	75	72	68	64
Denmark	389	381	341	315	296	271
United Kingdom	2059	1767	1518	1305	1123	968
Norway	2797	2545	2316	2108	1918	1745
Italy	40	34	29	24	21	18
Romania	114	111	108	105	102	99
Oman	780	723	670	621	576	534
Syria	450	429	410	391	373	356
Yemen	402	385	369	353	339	324
Angola	988	978	968	959	949	940
Cameroon	63	59	55	51	48	45
Congo Brazzaville	230	220	211	202	193	185
Egypt	594	568	544	521	498	477
Gabon	235	220	205	192	180	168
Australia	452	405	362	324	290	260
Brunei	190	188	186	184	183	181
China	1903	1856	1751	1632	1509	1395
India	260	251	243	235	227	219
Malaysia	762	732	702	674	647	621
Papua New Guinea	45	42	39	36	33	31
Russia	8949	8815	8683	8509	8254	8006
Uzbekistan	2010	1889	1889	1889	1889	1889

Table 17 – Decline rate data used in this outlook, taken from various sources.

Appendix B – comparison of different oil project reports

There are some major differences between the oil project reports made by ODAC[89], CERA[90] and PONL. Of the three the CERA study is the only commercial one, therefore only the general outlines are publicly available. The main difference on the project side is that this report includes oil projects at or above 20.000 b/d while CERA includes projects at or above 75.000 b/d. ODAC includes projects above 50.000 b/d.

The decline is also calculated in a different way. PONL relies on individual country assessments either based on extrapolated historic decline rates or various publicly available internet sources. The ODAC study relies on historic decline rates that have been extrapolated. It is assumed that the CERA study relies on individual country assessments, how these were calculated is unknown. The PONL and CERA study, in contrast to the ODAC study, incorporate increases due to potential projects or "yet to find" resources.

The biggest difference lies with the projected decline. Cera has taken a decline rate that is almost certainly too low gives the observed type II + III decline rates from official sources. These sources state far more aggressive decline rates. Examples are the Norwegian Petroleum Directorate for Norway and the Danish Energy Authority for Denmark. ODAC projects a steeper decline then PONL, this is a possibility given the decline rate estimates from oil companies, although probably too pessimistic.

The gross increase is quite similar when comparing CERA and PONL. The number from ODAC is lower due to a very conservative addition of projects. Many projects incorporated by PONL are deemed potential projects by ODAC that are too uncertain to rely on.

	CERA				**ODAC**			
	Gross increase	**Type II + III decline**	**Type III decline**	**Net increase**	**Gross increase**	**Type II + III decline**	**Type III decline**	**Net increase**
2005	?	?	?	?	2.40	3.20	1.10	-0.80
2006	?	?	?	?	3.10	3.00	1.20	0.10
2007	?	?	?	?	3.10	3.00	1.30	0.10
2008	?	?	?	?	2.80	3.40	1.40	-0.60
2009	?	?	?	?	2.80	3.40	1.50	-0.60
Total	**17.7**	**?**	**1.4**	**16.3**	**14.2**	**16.0**	**6.5**	**-1.8**
	PONL							
	Gross increase	**Type II + III decline**	**Type III decline**	**Net increase**				
2005	3.90	2.42	1.28	1.47				
2006	4.05	2.38	0.82	1.67				
2007	4.10	2.26	0.86	1.84				
2008	3.76	2.19	0.88	1.57				
2009	2.62	2.05	1.06	0.57				
Total	**18.4**	**11.3**	**4.9**	**7.1**				

Table 18 – differences between the three oil project reports.

[89] http://www.globalpublicmedia.com/news/539
[90] http://www.cera.com/news/details/print/1,2317,7453,00.html

Appendix C – Specific country data

OPEC

A) Algeria

In 2004 oil production was 1.21 mb/d and NGL production was 723.000 b/d, giving a total liquids production of 1.93 mb/d in 2004. Due to a lack of data, a conservative decline rate of 1% over 2004 oil production of 1.21 mb/d has been added. NGL production was assumed to remain stable. On top of this a total of 500.000 b/d from 3 projects and 200.000 b/d from potential projects and yet to find has been added.

Specific information:

"*In coming years, it is likely that Algeria's oil production capacity will rise, as the country plans to increase investments in exploration and development efforts. Algeria's production goal is 1.5 million bbl/d of crude oil by 2005 and 2.0 million bbl/d by 2010, a level it will likely reach at current levels of production growth.*"[91]

B) Indonesia

In 2004 oil production was 968.000 b/d and NGL production was 175.000 b/d, giving a total liquids production of 1.143 mb/d. The country's oil production has peaked. From 1998 to 2004 the average decline was 4.71% per year. From 2001 to 2004 the average decline was 6.19% per year. An annual decline rate of 6.19% over 2004 oil production has been added. NGL production was assumed to remain stable. On top of this a total of 205.000 b/d from 3 projects has been added.

Specific information:

"*Four-fifths of Indonesia's oil production is from depleting resources that are decades old, Apco's Vriens said. The oldest producing field, Talang Akar in South Sumatra, was discovered in 1921 and developed by Standard Oil Co. of New Jersey, before being nationalized in 1956 and folded into the state oil company, according to a Pertamina document.*"[92]

C) Iran

In 2004 oil production was 3.93 mb/d and NGL production was 219.000 b/d, giving a total liquids production of 4.15 mb/d. An annual decline rate of 4% over 2004 oil production has been added. NGL production was assumed to remain stable. On top of this a total of 987.000 b/d from 11 projects and 100.000 b/d from potential projects has been added.

Specific Information:

"*Iran has ambitious plans to increase national oil production - to 4.5 million bbl/d by the end of 2005, more than 5 million bbl/d by 2009, and 7 million bbl/d by 2024. The country is counting on billions of dollars in foreign investment to accomplish this, but this is unlikely to be achieved without a significant change in policy to attract such investment (and possibly a change in relations with the West).*" [3]

"*Iran's existing oilfields have a natural decline rate estimated at 8-13 percent per year (300,000-500,000 bbl/d) and are in need of upgrading, modernization, and enhanced oil recovery efforts (i.e., gas reinjection).*"[93]

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[91] Energy Intelligence Agency, Country analysis briefs - http://www.eia.doe.gov/emeu/cabs/contents.html
[92] Bloomberg - http://www.gasandoil.com/goc/company/cns51906.htm
[93] Energy Intelligence Agency, Country analysis briefs - http://www.eia.doe.gov/emeu/cabs/contents.html

D) Iraq

In 2004 oil production was 1.99 mb/d and NGL production was 18.000 b/d, giving a total liquids production of 2.01 mb/d in 2004. Because of the highly uncertain nature of Iraq's oil production a slight annual increase of 2% starting in 2006 has been added. 2005 production is set at 1.89 mb/d.

E) Kuwait

In 2004 oil production was 2.34 mb/d and NGL production was 125.000 b/d, giving a total liquids production of 2.47 mb/d. Due to a lack of data, a conservative decline rate of 1% over 2004 oil production of 2.34 mb/d has been added. NGL production was assumed to remain stable. On top of this a total of 350.000 b/d from project "Kuwait" has been added.

Specific information:

"*Project Kuwait aims at increasing daily output in the four fields bordering Iraq from the current 530,000 bpd to 900,000 bpd. But the targeted output will only be sustained for six years during the proposed 20-year period, setting average daily production at 680,000 bpd, or just 150,000 bpd above the current level.*
Kuwait, which sits atop around 10 % of global reserves, has already prequalified some 25 operator and non-operator foreign companies for Project Kuwait, including Shell, ExxonMobil, BP Amoco, ENI, Total and Chevron."[94]

F) Libya

In 2004 oil production was 1.55 mb/d and NGL production was 68.000 b/d, giving a total liquids production of 1.61 mb/d. An annual decline rate of 2% over 2004 oil production has been added. NGL production was assumed to remain stable. On top of this a total of 165.000 b/d from 2 new projects and 200.000 from yet to find has been added.

Specific information:

"*Overall, Libya would like foreign company help to increase the country's oil production capacity from 1.60 million bbl/d at present to 2 million bbl/d by 2008-2010, and to 3 million bbl/d by 2015. In order to achieve this goal, and also to upgrade its oil infrastructure in general, Libya is seeking as much as $30 billion in foreign investment over that period. Libya is considered a highly attractive oil province due to its low cost of oil recovery (as low as $1 per barrel at some fields), the high quality of its oil, its proximity to European markets, and its well-developed infrastructure.*"[95]

"*Production from Libya's traditional areas is on the decline and the country is pushing exploration in the less developed Murzuk Basin, where Spain's Repsol-YPF and four partners appear to have brought in another successful well.*"[96]

"*With reserve replacement slipping since the 1970s, and with state-operated oil fields undergoing a 7%-8% natural decline rate, Libya's challenge is maintaining production at mature fields (Brega, Sarir, Sirtica, Waha, Zueitina) while finding new oil and developing new discoveries. With production at existing fields expected to fall by around 400,000 bbl/d by 2010, NOC hopes that EOR techniques will help add 250,000 bbl/d of overall oil production capacity by 2010.*"[97]

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[94] Arab Times - http://www.gasandoil.com/goc/news/ntm52122.htm
[95] Energy Intelligence Agency, Country analysis briefs - http://www.eia.doe.gov/emeu/cabs/contents.html
[96] Liquid Africa - http://www.gasandoil.com/goc/company/cna42963.htm
[97] Energy Intelligence Agency, Country analysis briefs - http://www.eia.doe.gov/emeu/cabs/libyareserves.html

G) Nigeria

In 2004 oil production was 2.32 mb/d and NGL production was 190.000 b/d, giving a total liquids production of 2.51 mb/d. Due to a lack of data, a conservative decline rate of 1% over 2004 oil production of 2.32 mb/d has been added. NGL production was assumed to remain stable. On top of this a total of 1.32 mb/d from 11 projects has been added.

Specific information:

"07-10-04 Nigeria and Angola must speed up expansion plans if they were to meet targets of doubling oil output and growing Africa's share and influence of the global industry, an Exxon-Mobil executive said. Kevin Biddle, Exxon-Mobil's vice-president for Africa, told an oil and gas conference in South Africa that Angola wanted to raise production to 2 mm bpd from just above 1 mm, while Nigeria wanted to double to 4 mm bpd by 2008.
"Things will have to be accelerated to meet these targets in just four years," Biddle said. "There are opportunities there, but to meet the desires of the two countries some things will need to be done quickly to spur the process." [98]

"25-01-04 Group Managing Director of the Nigerian National Petroleum Corporation (NNPC) Engr. Funso Kupolokun said that the nation's crude oil production would by the year 2007, go up to 4 mb/d as against the current production level of 2.2 mb/d. Moreover, he said the nation would be earning up to $ 6 billion annually from gas by the year 2010."[99]

"03-03-05 Multinational oil companies operating in Nigeria's deep offshore oil region, have threatened to halt further investment in protest against plans to significantly amend the tax laws governing operations in the area.
The threat, if carried out, may affect the $ 15 billion expected to be invested in exploration and drilling in Nigeria's deep offshore over the next five years."[100]

H) Qatar

In 2004 oil production was 770.000 b/d and NGL production was 250.000 b/d, giving a total liquids production of 1.02 mb/d. Due to a lack of data, a conservative decline rate of 1% over 2004 oil production of 770.000 b/d has been added. NGL production was assumed to remain stable. On top of this a total of 140.000 b/d from 1 project has been added.

I) Saudi-Arabia

In 2004 oil production was 8.75 mb/d, NGL production was 1.31 mb b/d and unconventional oil production was 80.000 b/d, giving a total liquids production of 10.14 mb/d. An annual decline rate of 8% over 3.2 mb/d (Abqaiq, Berri, and a part of Ghawar) has been added. Remaining oil, NGL and neutral zone production was assumed to remain stable. On top of this a total of 1.51 mb/d from 5 projects and 900.000 b/d from potential project and spare capacity has been added.

Special Note: The khurais project as announced by Saudi Aramco has not been added due to the unlikely nature of the project.

[98] Business report - http://www.gasandoil.com/goc/company/cna44320.htm
[99] Vanguard - http://www.gasandoil.com/goc/company/cna40629.htm
[100] This day - http://www.gasandoil.com/goc/company/cna51206.htm

Specific information:

"*One challenge for the Saudis in achieving this objective is that their existing fields sustain 5 percent-12 percent annual "decline rates," (according to Aramco Senior Vice President Abdullah Saif, as reported in Petroleum Intelligence Weekly and the International Oil Daily) meaning that the country needs around 500,000-1 million bbl/d in new capacity each year just to compensate*."[101]

"*Saudi Aramco has continued aggressively expanding its crude oil production capacity with multiple mega projects. "These projects are at various stages of planning, design and construction, with a total capacity about 2.2 mm bpd," said Jum'ah. "These projects will lift Saudi Aramco's maximum production capacity to close to 12 mm bpd, thereby consolidating the company's leading role in the oil industry*."[102]

"*It is puzzling to consider that Saudi Aramco would entertain spending $3 to $4 billion on Khurais, thinking that the field could produce as much as 800,000 barrels of oil a day. The odds of reaching that production goal must be relatively long. The fact that Aramco announced that this project was almost ready to proceed, only to quickly reverse itself and question whether a major expansion would actually go ahead, seems to signal the serious nature of the difficulties and challenges the Khurais expansion faces*."[103]

J) United Arabic Emirates

In 2004 oil production was 2.35 mb/d and NGL production was 208.000 b/d, giving a total liquids production of 2.56 mb/d. Due to a lack of data, a conservative decline rate of 1% over 2004 oil production of 2.35 mb/d has been added. NGL production was assumed to remain stable. On top of this a total of 580.000 mb/d from 4 projects has been added.

Specific information:

"*He added UAE's crude oil output currently stands at 2.5 mm bpd. However, this will rise to 3 mm bpd according to ADNOC's plans. The production capacity of ADNOC for onshore oil operations will increase from the current ceiling of 1.2 mm bpd to 1.4 mm bpd while offshore oil output capacity will also be increased from the current 47,000 bpd to 600,000 bpd*."[104]

K) Venezuela

In 2004 oil production was 2.58 mb/d, NGL production was 395.000 b/d and unconventional oil production was 548.000 b/d, giving a total liquids production of 3.52 mb/d. An annual decline rate of 4% over 2004 oil production has been added. NGL and unconventional oil production was assumed to remain stable. On top of this a total of 450.000 b/d from 2 projects and 300.000 b/d from potential Orinoco production has been added.

Specific information:

"*On the other hand, the loss of 18,000 employees who were fired for joining the anti-government strike could make it difficult for the company to counter normal oil production capacity depletion rates for Venezuela of an estimated 25% per year*."[105]

[101] Energy Intelligence Agency, Country analysis briefs - http://www.eia.doe.gov/emeu/cabs/contents.html
[102] Opec Bulletin, May 2005 - http://www.opec.org/library/OPEC%20Bulletin/2005/pdf/OB052005.pdf
[103] Twilight in the Desert: The coming Saudi Oil Shock and the world Economy, *Matthew R. Simmons*, July 2005
[104] Xinhua - http://www.gasandoil.com/goc/company/cnm44508.htm
[105] Energy Intelligence Agency, Country analysis briefs - http://www.eia.doe.gov/emeu/cabs/contents.html

"*After a strike that resulted in a near complete shutdown of PdVSA's operations in late 2002 and the early months of 2003 and in a loss of nearly half its employees, current oil production levels in Venezuela are a bit uncertain. While PdVSA insists that oil production has recovered to pre-strike levels, outside observers, as well as former PdVSA employees, claim that production remains considerably lower*."[22]

Non-OPEC

1) USA

In 2004 oil production was 5.43 mb/d, NGL production was 1.81 mb/d and unconventional oil production was 425.000 b/d, giving a total liquids production of 7.67 mb/d. The country's oil production has peaked. From 1998 to 2004 the country's oil production showed an average decline rate of 2.3%. An annual decline rate of 5% over 2004 oil production has been added. NGL and unconventional oil production was assumed to remain stable. On top of this a total of 810.000 b/d from 7 projects has been added.

2) Canada

In 2004 oil production was 1.79 mb/d, NGL production was 691.000 b/d and unconventional oil production was 605.000 b/d, giving a total liquids production of 3.09 mb/d. An annual decline rate of 5% over 2004 oil production has been added. NGL production was assumed to remain stable. On top of this a total of 1.32 mb/d from 14 projects has been added.

Specific information:

"*By 2015, conventional production is projected to drop more than 40 per cent, to 600,000 barrels a day*."[106]

3) Mexico

In 2004 oil production was 3.38 mb/d and NGL production was 442.000 b/d, giving a total liquids production of 3.83 mb/d. An annual decline rate of 10% over 388.000 b/d of 2004 oil production has been added. An annual decline rate of 12% over 2.14 mb/d of 2004 oil production (Cantarell) has been added. An annual decline rate of 3% over 548.000 b/d of 2004 oil production has been added. NGL production was assumed to remain stable. On top of this a total of 850.000 mb/d from 2 projects has been added.

Specific information:

"*According to then Exploration and Production Director Ramírez Corzo, Cantarell's production should remain stable until 2006, but would decline by 14% per year after that. However, Ramírez Corzo recently stated on November 2, 2004 that "Our best estimate is that Cantarell will start to decline toward the middle of next year* [2005]*," raising the possibility that Cantarell's decline could come sooner than originally had been thought*."[107]

4) Argentina

In 2004 oil production was 698.000 b/d and NGL production was 82.000 b/d, giving a total liquids production of 780.000 b/d. The country's oil production has peaked. From 1998 to 2004 the country's oil production showed an average decline rate of 3.1%. An annual decline rate of 3.1% over 2004 oil production has been added. NGL production was assumed to remain stable.

Specific information:

"*10-08-04 ChevronTexaco's country manager in Argentina warned that the South American country could be a net oil importer within three years if government policies continue driving away investment. Noting that*

[106] Toronto Star - http://www.energybulletin.net/1191.html
[107] Energy Intelligence Agency, Country analysis briefs - http://www.eia.doe.gov/emeu/cabs/contents.html

Argentine oil production has declined in recent years, Richard Cohagan told a Council of the Americas-sponsored conference that "at this pace, Argentina could need to import oil by 2007."[108]

5) Brazil

In 2004 oil production was 1.48 mb/d, NGL production was 61.000 b/d and unconventional oil production was 258.000 b/d, giving a total liquids production of 1.80 mb/d. An annual decline rate of 4% over 140.000 b/d of 2004 oil production has been added. An annual decline rate of 10% over 460.000 b/d of 2004 oil production has been added. Remaining oil, NGL and unconventional oil production was assumed to remain stable. On top of this a total of 1.6 mb/d from 9 projects has been added.

Specific information:

"*Albacora is in the north part Campos basin It had an estimated 400 million barrels of oil equivalent recoverable. It was discovered in 1984 and began producing in 1996. The production has already peaked in 1998 at 174,000 barrels of oil equivalent per day (boe/d). Thus this field produced 139,860 barrels of oil per day in 2003. It is a declining field.*"[21]

"*Marlin was discovered in January 1985. It has 1.7 billion barrels of oil reserves. It will peaked production in 2002 at 586,000 boe/d. It is a declining field. In 2003 it produced 532, 000 boe/d. This illustrates how rapidly a field can decline*."[109]

6) Colombia

In 2004 oil production was 528.000 b/d, giving a total liquids production of 528.000 b/d. The country's oil production has peaked. From 2001 to 2004 the country's oil production showed an average decline rate of 4.4%. An annual decline rate of 4.4% over 2004 oil production has been added.

Specific information:

"*In total, the government hopes companies will drill 40 oil wells this year, up from 21 wells drilled last year. According to a study in January by the finance ministry, oil production will fall to 510,000 bpd in 2005 from 528,830 bpd last year and well below an all-time high of 830,000 bpd in 1999*."[110]

7) Ecuador

In 2004 oil production was 526.000 b/d, giving a total liquids production of 526.000 b/d. Due to lack of data, a conservative decline rate of 1% over 2004 oil production of 1.21 mb/d has been added.

8) Peru

In 2004 oil production was 84.000 b/d, giving a total liquids production of 84.000 b/d. The country's oil production has peaked. From 1998 to 2004 the country's oil production showed an average decline rate of 5.4%. An annual decline rate of 5.4% over 2004 oil production has been added.

Specific information:

"*2005 - Output in February reached an average 114,571 barrels of oil and other hydrocarbon liquids per day, up 35.4 % compared to the same month a year earlier, mainly due to hydrocarbon liquids from Camisea*."[111]

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[108] Dow Jones Newswires - http://www.gasandoil.com/goc/company/cnl43583.htm
[109] DMD Publishing - http://home.entouch.net/dmd/brazil.htm
[110] Dow Jones Newswires - http://www.gasandoil.com/goc/company/cnl52140.htm
[111] Dow Jones Newswires - http://www.gasandoil.com/goc/company/cnl51459.htm

9) Trinidad & Tobago

In 2004 oil production was 123.000 b/d, giving a total liquids production of 123.000 b/d. Current liquids production was assumed to remain stable. On top of this a total of 100.000 b/d from 1 project has been added.

10) Denmark

In 2004 oil production was 389.000 b/d, giving a total liquids production of 389.000 b/d. According to the Danish Energy Authority production will peak in 2005.[112] Liquids production added as taken from the report oil and gas production in Denmark 2004, published by the Danish Energy Authority.[24]

11) United Kingdom

In 2004 oil production was 1.85 mb/d and NGL production was 209.000 b/d, giving a total liquids production of 2.05 mb/d. The country's oil production has peaked. From 1999 to 2004 the country's oil production showed an average decline rate of 7.2%. From 2002 to 2004 NGL production showed an average decline rate of 7%. The decline appears to be accelerating, at the moment the UK is declining with 15% comparing June 2005 with June 2004. An annual decline rate of 15% over 2004 oil production has been added. An annual decline rate of 7% over 2004 NGL production has been added. On top of this a total of 190.000 b/d from 1 project has been added.

12) Norway

In 2004 oil production was 2.80 mb/d and NGL production was 391.000 b/d, giving a total liquids production of 3.19 mb/d. The country's oil production has peaked. From 2000 to 2004 the country's oil production showed an average decline rate of 3.3%. The decline appears to be accelerating, at the moment Norway is declining with 9% comparing June 2005 with June 2004. An annual decline rate of 9% over 2004 oil production has been added. NGL production was assumed to remain stable. On top of this a total of 420.000 b/d from 6 projects has been added.

13) Italy

In 2004 oil production was 102.000 b/d and unconventional oil production was 8.000 b/d, giving a total liquids production of 110.000 b/d. From 1998 to 2001 the country's oil production showed an average decline rate of 15.2%. Assuming that this decline rate has continued a base of 40.000 b/d is still declining in 2004. An annual decline rate of 15.2% over 40.000 b/d of 2004 oil production has been added. The remaining liquids production was assumed to remain stable. On top of this a total of 50.000 from 1 project has been added.

14) Romania

In 2004 oil production was 114.000 b/d, giving a total liquids production of 114.000 b/d. The country's oil production has peaked. From 2000 to 2004 the country's oil production showed an average decline rate of 2.8%. An annual decline rate of 2.8% over 2004 oil production has been added

15) Oman

In 2004 oil production was 758.000 b/d, giving a total liquids production of 758.000 b/d. The country's oil production has peaked. From 2001 to 2004 the country's oil production showed an average decline rate of 7.3%

[112] Danish Energy Authority - http://www.ens.dk/graphics/Publikationer/Olie_Gas_UK/Oil_gas_Production_GB_2004/html/chapter08.htm

An annual decline rate of 7.3% over 2004 oil production has been added. On top of this a total of 140.000 b/d from 1 project has been added.

16) Syria

In 2004 oil production was 450.000 b/d, giving a total liquids production of 450.000 b/d. The countries oil production has peaked. From 1998 to 2004 the countries oil production showed an average decline rate of 4.6%. The decline has increased, since 2001 the country has shown annual oil production decline rates of 7.3%. An annual decline rate of 4.6% over 2004 oil production has been added. On top of this a total of 30.000 b/d from 1 project has been added.

17) Yemen

In 2004 oil production was 402.000 b/d. Giving a total liquids production of 402.000 b/d. The country's oil production has peaked. From 2000 to 2004 the country's oil production showed an average decline rate of 4.2%
An annual decline rate of 4.2% over 2004 oil production has been added. Above this a total of 25.000 b/d from 1 project has been added.

18) Angola

In 2004 oil production was 988.000 b/d ,giving a total liquids production of 988.000 b/d. Due to lack of data, a conservative decline rate of 1% over 2004 oil production of 988.000 b/d has been added. NGL production was assumed to remain stable. On top of this a total of 1.32 mb/d from 7 projects and 200.000 b/d from yet to find has been added.

19) Cameroon

In 2004 oil production was 67.000 b/d, giving a total liquids production of 67.000 b/d. The country's oil production has peaked. From 1998 to 2004 the country's oil production showed an average decline rate of 6.7%. An annual decline rate of 6.7% over 2004 oil production has been added.

20) Congo Brazzaville

In 2004 oil production was 230.000 b/d, giving a total liquids production of 230.000 b/d. The country's oil production has peaked. From 2001 to 2004 the country's oil production showed an average decline rate of 4.3%. An annual decline rate of 4.3% over 2004 oil production has been added. On top of this a total of 75.000 b/d from 1 project has been added.

21) Egypt

In 2004 oil production was 594.000 b/d and NGL production was 114.000 b/d, giving a total liquids production of 708.000 b/d. The country's oil production has peaked. From 2000 to 2004 the country's oil production showed an average decline rate of 4.3%. An annual decline rate of 4.3% over 2004 oil production has been added. NGL production was assumed to remain stable. On top of this a total of 40.000 from 1 project has been added.

22) Gabon

In 2004 oil production was 235.000 b/d, giving a total liquids production of 235.000 b/d. The country's oil production has peaked. From 1998 to 2004 the country's oil production showed an average decline rate of 6.5% An annual decline rate of 6.5% over 2004 oil production has been added.

23) Tunisia

In 2004 oil production was 80.000 b/d, giving a total liquids production of 80.000 b/d. Current liquids production was assumed to remain stable.

24) Australia

In 2004 oil production was 449.000 b/d and NGL production was 86.000 b/d, giving a total liquids production of 538.000 b/d. The country's oil production has peaked. From 2000 to 2004 the country's oil production showed an average decline rate of 10.55%. An annual decline rate of 10.55% over 2004 oil production has been added. NGL production was assumed to remain stable. On top of this a total of 200.000 from 2 projects has been added.

25) Brunei

In 2004 oil production was 190.000 b/d and NGL production was 26.000 b/d, giving a total liquids production of 216.000 b/d. The country's oil production has peaked. An annual decline rate of 1% over 2004 oil production has been added. NGL production was assumed to remain stable. On top of this a total of 30.000 b/d from 1 project has been added.

Specific information:

"*Brunei's oil production peaked in 1979 at about 240,000 bbl/d, but was cut back deliberately to extend life of the fields and to improve recovery rates*."[113]

26) China

In 2004 oil production was 3.49 mb/d, giving a total liquids production of 3.49 mb/d. Continued decline from the Daqing, Luaohe, Huabei and Tuha fields with decline rates and 2004 production numbers as shown in Table 4 has been added. Daqing and Liaohe declines are set to increase annually to a level of 8% in 2008 because of the enormous water cuts. The Shengli field, which produced 580.000 b/d in 2004, is set to start declining again in 2007 to an annual level of 8%. Remaining liquids production of 1.61 mb/d was assumed to remain stable. On top of this a total 160.000 b/d from 2 projects and 125.000 b/d from potential projects has been added.

Specific information:

Five fields in China are declining, the Daqing, Luaohe, Huabei, Tuha and Shengli field[114].

Production in Thousand of barrels per day	2002	2003	2004	Average decline rate
Daqing	1020.5	985.3	942.0	3.92%
Liaohe	259.1	253.6	245.4	2.7%
Huabei	89	88.4	87.6	.8%
Tuha	54.1	50.7	48.4	5.41%

Table 19 - Oil production between 2002 and 2004 in four Chinese oil fields

"*The crude oil in the Daqing region had an average water cut of 89.1% increased from the water cut of 88.4% in 2003*."[31]

[113] Energy Intelligence Agency, Country analysis briefs - http://www.eia.doe.gov/emeu/cabs/contents.html
[114] SEC –http://www.sec.gov/Archives/edgar/data/1108329/000114554905001175/u99842e20vf.htm

"*In 2004 the oil we produced in the Liaohe region had an … average water cut of 72.5%*"[31]

27) India

In 2004 oil production was 683.000 b/d and NGL production was 116.000 b/d, giving a total liquids production of 799.000 b/d. From 1989 to 2005 the Bombay field showed an average decline rate of 3.37%, from 400.000 to 260.000 b/d. An annual decline rate of 3.37% over Bombay's 2004 oil production has been added. NGL production was assumed to remain stable. On top of this a total of 80.000 from 1 project has been added.

28) Malaysia

In 2004 oil production was 762.000 b/d, NGL production was 80.000 b/d and unconventional oil production was 15.000 b/d, giving a total liquids production of 857.000 b/d. An annual decline rate of 4% over 2004 oil production has been added. NGL production was assumed to remain stable. On top of this a total of 125.000 b/d from 2 projects has been added.

Specific information:

"*Malaysia is an oil exporter, but if we do not find new oil reserves, then by 2009, we will become a net importer," said Deputy Prime Minister Najib Razak. "This means we cannot continue to lean on the oil sector.*"[115]

Annual average consumption increase has been 4.1% since 2001. Assuming that this trend will continue consumption will increase to 616.000 barrels per day in 2009.

To become a net importer an annual decline of 4% is necessary starting in 2004.

Thousand barrels per day	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Consumption	448	489	480	504	525	546	569	592	616	641
Production	666	698	738	762	732	702	674	647	621	570

Table 20 – Malaysian oil consumption and production from 2001 tot 2010

29) Vietnam

In 2004 oil production was 405.000 b/d and NGL production was 405.000 b/d, giving a total liquids production of 405.000 b/d. Current production was assumed to remain stable.

Specific information:

"*In January 2005, however, the Vietnamese government announced that its 2004 record oil production of 401,548 bbl/d may fall to 352,000 bbl/d in 2005 due to decreases in output at Bach Ho and Su Tu Den to prolong the life of the fields.*"[116]

30) Azerbaijan

[115] Associated Press, July 23rd 2005 - http://www.forbes.com/work/feeds/ap/2005/07/23/ap2153640.html
[116] Energy Intelligence Agency, Country analysis briefs - http://www.eia.doe.gov/emeu/cabs/contents.html

In 2004 oil production was 309.000 b/d, giving a total liquids production of 309.000 b/d. Current production was assumed to remain stable. On top of this a total of 868.000 b/d from 3 projects has been added.

31) Kazakhstan

In 2004 oil production was 1.01 mb/d and NGL production was 198.000 b/d, giving a total liquids production of 1.21 mb b/d. Current production was assumed to remain stable. On top of this a total of 1.17 mb/d from 4 projects has been added.

32) Russia

In 2004 oil production was 8.95 mb/d and NGL production was 278.000 b/d, giving a total liquids production of 9.23 mb/d. An annual decline rate of 1.5% over 2004 oil production has been added increasing to 3% in 2008. NGL production was assumed to remain stable. On top of this a total of 1.10 mb/d from 7 projects and 300.000 b/d from potential projects has been added.

Specific information:

"*Russian production growth [in 2006] is estimated at just 80.000 – 100.000 b/d, compared to 730,000 b/d in 2004 and 170,000 b/d in 2005. Ongoing field ramp ups, brownfield developments, and new field start-ups offshore Sakhalin are expected to offset Russia's estimated decline of 150.000 b/d per year and further production losses at Yukos and other producers.*"[117]

"*In a recent interview, Vagit Alekperov, president of No. 1 Russian producer OAO Lukoil, said he expects industry production to stabilize between 9.2 million and 9.4 million barrels a day over the next several years after ["slight growth"] this year. Rising domestic demand is likely to leave less crude for export, he said. Government forecasts also see production stagnating through at least 2008, after rising 9% or more annually in recent years.*"[118]

[117] Oil Magazine, A quarterly magazine published by the ministry of oil, Kuwait - http://www.moo.gov.kw/magazine/
[118] Rigzone, June 3rd 2005 - http://www.rigzone.com/news/article.asp?a_id=22927

Appendix D – Oil Projects Data

Projects below a production level of 20.000 b/d have not been included. It is recommended that analysts who want to confirm or redo the analysis in this report contact the author for further detail regarding oil projects. Not all details have been disclosed below regarding the timeframe wherein oil projects come to full production.

2005 oil projects

Project	Country	Type	Discovery Date	Reserves (MB)	Production increase (b/d)
Bonga	Nigeria	Deepwater	1995	600	225000
Oman	Mukhaizna	Onshore (EOR)	1975	1000	140000
Oudeh	Syria	Onshore (EOR)			30000
Kizomba B	Angola	Deepwater	1997-1999	1000	250000
Albacora Leste	Brazil	Deepwater	1986	700	180000
White Rose	Canada	Offshore	1984	200-250	92000
Pelican Lake & Foster Creek	Canada	Tar sands			23000
Suncor	Canada	Tar sands			120000
Firebag	Canada	Tar sands			105000
Mad Dog	Gulf of Mexico	Deepwater	1998		100000
Barracuda	Brazil	Deepwater	1989	867	150000
Block 51	Yemen	Onshore			25000
Cataringa	Brazil	Deepwater	1994	362	125000
Okwori	Nigeria	Offshore	1972		40000
Elephant (Murzuk Basin)	Libya	Offshore	2000	150	140000
Severnaya Neft	Russia	Onshore	1990		154000
Staer and Svale	Norway	Offshore	2002		70000
Block 186 (Murzuk Basin)	Lybia	Offshore	2000-2001		45000
Soroush and Norouz	Iran	Onshore	1962 & 1966	2500	110000
Karachaganak	Kazachstan	Onshore		2400	250000
Dharkovin/ Darquain phase I	Iran	Onshore		1400	50000
Adar Yeil and tale	Sudan	Onshore			200000
Cheshmeh-Khosh	Iran	Onshore			40000
Aghajari	Iran	Onshore (EOR)			100000
Prirazlomnoye	Russia	Offshore	1989	545	1500000
ACG Megastructure phase I	Azerbaijan	Deepwater	1989	5400	93000
Luda	China	offshore	2000-2002		40000
Peng Lai Phase II	China	offshore	1997	500	150000
Hassi Messaoud	Algeria	Onshore (EOR)	1956	5980	300000
South Pars phase 4 &5	Iran	Onshore			80000
Ku-Maloob-Zaap	Mexico	Onshore (EOR)		4000	450000
Jubarte	Brazil	Offshore	2001	600	150000
Greater Angostura	Trinidad & Tobago	Offshore	1999	160	100000
Kristin	Norway	Deepwater	1997		125000
Etim/Asasa	Nigeria	Onshore (EOR)			25000
Bomboco & Sanha	Angola	Offshore			100000
Moho North & South,	Congo	Deepwater	1995-1997		75000

Bilondo	Brazzaville				
Muniteer-Exeter	Australia	Offshore			100000
Haradh Phase III	Saudi Arabia	Onshore (EOR)	1948		300000
West Seno phase II	Indonesia	Offshore	1998		60000
Oyong	Indonesia	Offshore	2001	7	20000
Devon Dover SAGD	Canada	Tar sands			26000
Alpine phase II	Canada	Onshore (EOR)	1996		40000

Table 21 – 2005 oil projects data

Bonga, between 1996 and 2005 more oil was found in the bonga field. Due to this discovery the bonga reserves are now totaling approximately 1.2 billion barrels. Only the 600 million barrels from the initial discovery are currently being exploited. Full production is estimated within 6 months of initial production.

Mukhaizna, currently 10.000 b/d increasing to 150.000 b/d

Pelican Lake & Foster Creek, currently 47.000 boe/d increasing to 62.000 b/d in 2005 and 70.000 b/d in 2007

Suncor, currently 260.000 boe/d increasing to 400.000 b/d in 2008

Firebag , currently 35.000 boe/d increasing to 140.000 b/d in 2008

Severneya Neft, current production of 46.000 b/d increasing to 190.000 b/d around 2007

Block 186 (Murzuk Basin), already producing 40.000, increasing to 85.000 b/d in 2005.

Soroush and Norouz, 2004 production was 80.000 b/d increasing to 190.000 b/d in 2005

Karachaganak, already producing 250.000 in 2005, ramping up to 500.000 b/d in 2010

Dharkovin/ Darquain phase II, the second phase of the Dharkhovin field will increase production to 160.000 b/d. This phase is expected to be finished around 2008.

Adar Yeil and tale, these two fields might produce an extra 100.000 barrels in 2006. Extra discoveries have been made recently according to CNPC in block 3/7 were the Adar Yeil field is located. It is unclear when the oil fields were discovered and how much the reserves for these 2 specific fields amount to.

Cheshmeh-Khosh, current production lies at 40.000 b/d and the goal is to increase this to 80.000 b/d within a few years.

Aghajari, currently producing 200.000 b/d increasing to 300.000 b/d in the coming years. Finishing date of the gas injection program is unknown. In March of 2005 logistics, construction and installation operations of the project had progressed 93.57 % and 42.66% respectively. It is estimated that the daily crude oil output from the field will increase to 300,000 barrels a day after the gas injection program is finished. Current production lies near 200.000 b/d.

ACG Megastructure phase, production from this complex was 132.000 b/d in 2004 and new production for 2005 is estimated at 93.000 b/d. Production is expected to increase to a total of 500.000 b/d at the end of 2007 with the completion of central Azeri. Phase II intends to bring on-stream East Azeri and West Azeri with an increase of 300.000 b/d and Phase III intends to bring on-stream the Gunashli field with an extra production of 200.000 b/d around 2009.

Peng Lai phase II, current production lying around 20.000 to 35.000 b/d should increase with phase II to a level of 100.000 to 150.000 b/d. Completion date of phase II is not yet clear, it includes multiple wellhead platforms, central processing facilities and an FPSO. The FPSO vessel is scheduled for completion at mid-2008, this will probably be the time when full production is reached

Hassi Messaoud, Production of 350,000 bbl/d in 2004, down from 550,000 bbl/d in the 1970s, but up from 300,000 bbl/d in 1989. Sonatrach hopes to double production at the field to 700,000-750,000 bbl/d within 5-7 years.

Ku-Maloob-Zaap, current production lies around 350.000 b/d. Ku-Maloob-Zaap is expected to be connected to the same nitrogen injection system that is being used in Cantarell, where production has nearly doubled to more than 1.8 mm bpd as a result of the nitrogen injection. This should bring production up to 800.000 b/d. This project has commenced and full production is expected around 2010-2012.

West Seno phase II, The phase II of the West Seno phase has been delayed due to increased costs. Current production lays around 40.000 b/d. New production is probably coming online in 2005 but this could also be in 2006.

Devon Dover SAGD, currently producing 4.000 boe/d increasing to 30.000 b/d in 2007.
Operator: Devon Canada

Alpine phase II, Currently producing 100.000 b/d increasing to 140.000 b/d in 2005.

2006 oil Projects

Project	Country	Type	Discovery Date	Reserves (MB)	Production increase (b/d)
South Pars phase 6,7 & 8	Iran	Onshore			120000
Banyu Urip	Indonesia	Offshore	2001	250	165000
Dorood	Iran	Onshore (EOR)	1956		80000
Tengiz	Kazachstan	Offshore	1979		420000
Mansuri	Iran	Onshore (EOR)	1963	3300	85000
East Area Oil Recovery	Nigeria	Offshore (EOR)		500	110000
Bosi	Nigeria	Offshore	1996		50000
Guntong Hub	Malaysia	Offshore			30000
Egret	Brunei				30000
Surmont	Canada	Tar sands			110000
Thunder Horse	Gulf of Mexico	Deepwater	1999	250	250000
Long Lake	Canada	Tar sands			70000
Constitution	Gulf of Mexico	Deepwater	2002		70000
Bonga Southwest	Nigeria	Offshore	2001	1000	145000
Sakhalin I	Russia	Offshore	1996-2001	2250	250000
Al Dabb'iya, Rumaitha, Shanayel	UAE	Onshore			100000
Shaybah	Saudi Arabia	Onshore (EOR)	1968	16000	500000
Crudo Ligero Marino	Mexico	Deepwater		928	280000
In Amenas	Algeria				50000
Buzzard	United Kingdom	Offshore	2001	400	190000

Bu Hasa	UAE	Onshore (EOR)	1962		180000
Erha	Nigeria	Deepwater	1999	500	150000
Atlantis	Gulf of Mexico	Deepwater	1998	635	150000
Dalia	Angola	Offshore	1998		225000
Golfinho	Brazil	Offshore	2003		100000
Enfield (Laverda-Vincent)	Australia	Offshore	2001	300	100000
Bab	UAE	Offshore (EOR)			100000
Corocoro	Venezuela	Offshore	1999		55000
Primerose & Wolf Lake	Canada	Tar sands			100000
Syncrude phase III	Canada	Tar sands			100000
BBLT	Angola	Deepwater	1998-2000		245000
Thar Jath	Sudan	Onshore	2001	250	80000
Tui	Maui	Offshore	2002-2004	25	30000
Chinguetti	Mauritania	Offshore	2001	120	75000

Table 22 – 2006 oil projects data

Dorood, production lies near 160.000 b/d at the moment increasing to 240.000 b/d in 2006.

Tengiz, current production is 300.000 b/d, increasing to 500.000 b/d in 2007 and 720.000 b/d in 2010

Mansuri, current production of around 65.000 b/d is expected to increase in 2 phases. Phase 1 is scheduled to attain a production level of 100.000 b/d around April 2006. Phase 2 is scheduled to increase production to 150.000 b/d for which no date is set yet.

East Area Oil Recovery, The $1.7 billion project will re-inject gas to improve oil recovery from multiple reservoirs in the Joint Venture area and eliminate routine flaring. The development is expected to increase production with approximately 110,000 barrels per day and ultimate recovery in the NNPC/MPN Joint Venture area by more than 500 million barrels.

Shaybah, current production of 500.000 increasing to around 1 mb/d between 2006 and 2008.

Bu Hasa, the field is currently producing 550.000 b/d and the goal is to increase sustainable production capacity to 730.000 b/d in 2006.

Bab, current production amounts to 200.000 b/d with plans to increase this to 300.000 b/d.

Primerose & Wolf Lake, currently producing 50.000 boe/d increasing to 150.000 boe/d around 2006/2007

Syncrude phase III, currently 250.000 boe/d increasing to 350.000 boe/d in 2006

2007 oil Projects

Project	Country	Type	Discovery Date	Reserves (MB)	Production increase (b/d)
Roncador	Brazil	Deepwater	1996	2700	480000
Okume	Equatorial Guinea	Offshore	2000-2002		40000
Rosa/Liro	Angola	Deepwater	1998		140000

Tahiti	Gulf of Mexico	Offshore	2002	400	120000
Kikeh	Malaysia	Offshore		400	120000
Saqqara	Egypt	Onshore	2003		40000
Greater Plutonio	Angola	Deepwater	1999-2001		230000
Ormen Lange	Norway	Deepwater	1998		30000
Statfjord Late Life	Norway	Deepwater (EOR)	1998		65000
Tempa Rossa	Italy	Onshore	1987		50000
Sakhalin II (Piltun-Astokhskoye and Lunskoye)	Russia	Offshore	1996-2001	635	150000
Marlim Leste	Brazil	Deepwater	1987	150	150000
Frade	Brazil	Deepwater	1986		100000
El Merk and El Kheit Et Tesseka	Algeria	Offshore	1993-1998		100000
Azadegan	Iran	Onshore	1999	6000	260000
Upper Zakum	UAE	Offshore (EOR)			200000
Neptune	Gulf of Mexico	Deepwater	1995	100	50000
Hawiyah	Saudi Arabia	Onshore	1953		310000
Abu Hadriya, Fadhili, Khursaniya	Saudi Arabia	Onshore (EOR)	1956		500000
Sincor II	Venezuela	Orinoco Belt			400000
Tucker & Sunrise Thermal	Canada	Tar Sands			230000
Alvheim / Vilje	Norway	Offshore	1994	200	50000
Mangala & Aishwariya	India	Offshore	2004		80000
Project Kuwait phase I	Kuwait	Offshore & Onshore			350000

Table 23 – 2007 oil projects data

Roncador, in 2003 production from the Roncador field was 77,000 boe/d. In the first half of 2007, the P-52 and the P-57 units, each with capacity to produce 180,000 bpd, should start operations on the Roncador field.

Sakhalin II (Piltun-Astokhskoye and Lunskoye), current production lies around 70.000 b/d, phase II of the Sakhalin II project attempts to make production year round instead of the current 180 days. Total production is not clear but probably lays around 150.000 b/d of oil and gas condensates.

Azadegan, Initial production of 50,000 bpd is expected within 40 months, rising to 150,000 bpd after 52 months and 260,000 bpd in 8 years.

Upper Zakum, currently production is 550.000 b/d increasing to 750.000 b/d in the near future (probably 2007).

Sincor II, fully operational in 2010, with 400.000 boe/d or double the capacity of SINCOR I

2008 oil Projects

Project	Country	Type	Discovery Date	Reserves (MB)	Production increase (b/d)
Agbami	Nigeria	Offshore	1998	800	250000
Akpo	Nigeria	Deepwater	2000	600	220000

Kearl Mine	Canada	Tar Sands			100000
Marlim Sul	Brazil	Deepwater	1987	1700	280000
Kizomba-C	Angola	Offshore	1998-2000	984	125000
Kashagan	Kazakhstan	Offshore	2000	8000	450000
Talakan	Russia	Onshore		780	160000
Yuzhno-Khylchuyuskoye	Russia	Onshore, arctic		1200	200000
Salym	Russia	Onshore, Siberia	2002-2004	700	120000

Table 24 – 2008 oil projects data

2009 oil Projects

Project	Country	Type	Discovery Date	Reserves (MB)	Production increase (b/d)
Shell's Gas to Liquids	Qatar	Natural Gas			140000
Nuayyim	Saudi Arabia	Onshore	1990		100000
Fort Hills	Canada	Tar Sands			50000
Northern Lights	Canada	Tar Sands			100000
Tyrihans	Norway	Offshore	2002		80000

Table 25 – 2009 oil projects data

2010 oil Projects

Project	Country	Type	Discovery Date	Reserves (MB)	Production increase (b/d)
Usan	Nigeria	offshore	2002-2005		150000
Jackipe mine	Canada	Tar Sands			200000

Table 26 – 2010 oil projects data

Usan, another discovery was made by Total near the Usan field in 2005. Strangely enough Total, the operator states that the field will start production in 2010 while Exxon-Mobil who has a 30% working states production commencing in 2006.

Potential Projects:

Ixtal-Manik (Mexico), Yaxche (Mexico), Foroozan & Esfandir (Iran), Abkatún-Pol-Chuc (Mexico), Tabasco Litoral (Mexico), Chicontepec (Mexico), Kurmangazy (Kazakhstan), Salman (Iran), Aje (Nigeria), Tahiti (Gulf of Mexico), CEPU (Indonesia), Kharampurskoe (Russia), Severo-Komsomolskoe (Russia), Severo-Vankorsky (Russia), Udmurtsko-Chatylkinsky (Russia), Sakhalin III (Russia), South Pars 11 till 18 (Iran), Chayandinskoye (Russia), Kynsko-Chaselskoye (Russia), Ishpingo Tambococha Tiputino (Ecuador), Hosseynie (Iran), Bangestan (Iran), Kooh-e-Mond and Zaghe (Iran), Parsi (Iran), Gachsaran (Iran), Khurais (Saudi Arabia), Maneefa Arab Heavy (Saudi Arabia), Tiof (Mauritania), Hebron (Canada), Yadaravan (North-Azadegan), Ba (Sudan), Arash (Iran), kushk (Iran)