

World Oil Exports: A Comprehensive Projection

Introduction

Although the debate is growing around the point in time when global oil production starts to decline permanently, for countries or regions where oil production is null or very low, the amount of oil available for trade in the market is a much more relevant issue. Such is the case of the European Union; with oil consumption topping 14.5 Mb/d, only two of its member states figure in the exporting countries list, and both with marginal numbers. More than worrying with a Peak Oil date, importing countries should worry on the future availability of tradable oil.

It is therefore of the highest importance for importing countries to know in advance the amount of oil available to the market, and from which countries/regions it may come, in order to prepare correctly for the future.

This assessment uses as data sources the Statistical Review of World Energy, published yearly by BP, and the monthly newsletter published by ASPO, where assessments for future oil production are available for more than 40 individual countries. Future oil consumption and production is projected using static change rates for the period starting in 2006 and finishing in 2020. These rates are determined by current trends and by reserves/future discovery assessments made by Colin Campbell and published in the ASPO's newsletters.

In this text the word "oil" is used for simplicity as synonym of liquid hydrocarbons, for the past data on consumption and production used includes Liquefied Natural Gas (LNG).

Oil Exporters

Oil exporting countries are defined as having in 2005 an oil production greater than oil consumption, thus resulting in a surplus. Using the data published by BP on its Statistical Review of World Energy of 2006, the following countries are identified: Saudi Arabia, Former Soviet Union (where individual data is available for Russia, Kazakhstan and Azerbaijan), Norway, Venezuela, Iran, United Arab

Emirates, Kuwait, México, Algeria, Qatar, Canada, Malaysia, Ecuador, Argentina, Colombia, Denmark, Egypt and United Kingdom. Due to lack of data for consumption, Angola, Nigeria and Iraq are left out of this first assessment. This issue will be revisited in the concluding stages of this article.

The statistical review contains historical data from 1965 to present, which is worth observing:

The well know energy crisis of the past appear in an interesting fashion: the major declines in exports come after the events that generated it. Such might be a sign of a market ruled more from the Demand side than from the Supply side. That situation is likely to reverse as the peak in world oil production is approached. The early 1980s are years of marked difficulties for exporters, on both wealthy sides of the Atlantic internal production backed off demand (Alaska and North Sea). Exporting numbers of the 1970s are only surpassed in the mid 1990s. This fall on oil demand can be a reasonable explanation for the collapse of the Soviet Union.

Future Oil Production

Future oil production is projected applying the decline/growth rates identified by Colin Campbell to the data published by BP. In most cases the numbers of each source for daily production do not match, Campbell's assessments focus on Conventional Oil, while BP's historical data on "All Liquids" (a somewhat loose definition which includes Liquefied Natural Gas and other non-specified liquids). Still these differences are usually small, requiring special treatment only in three cases.

Following is a list of the countries assessed. Next to the country name is the year of original assessment by Colin Campbell and in quote the author's view at the time. A brief explanation of the rate used for projection then follows.

Saudi Arabia - 2006

Production stands at 9 Mb/d giving a low depletion rate of 1.9%,, which itself is reason to doubt the higher official reserve estimates The country is endeavouring to offset the natural decline of its aging fields by infill drilling as well as advanced horizontal drilling to tap the less productive zones in the reservoir. A tar-seal on the eastern flank of Ghawar, deprives it of a natural water drive, meaning that massive

amounts of water have to be injected. It is also bringing on new much smaller fields, including offshore extensions. While the country claims to be able to increase production to 12 Mb/d, it is here thought more likely that it will be hard pressed to hold present production, which is here modeled to remain about flat for another twenty years before decline sets in at about 3% a year. It may not be able even to do that. Sweet Oil production in Saudi Arabia has likely peaked leaving the country in some sort of momentarily difficulties to replace past production rates with sour crude. The declared recoverable reserves stand at 270 Gb, a number hardly with geological meaning, given that original oil in place is declared to be 720 Gb. Including the 105 Gb already produced; that would imply a mean recovery rate of over 50% for the entire country. The current assessment by Colin Campbell stays around 160 Gb, which is probably optimistic for it implies a mean recovery of 37%, roughly meaning the successful application of tertiary recovery methods for the entire country. Still this last estimate is used which make it plausible for Saudi Arabia to continue producing liquid hydrocarbons at rates in excess of 11 Mb/d.

Russian Federation - 2003

Accordingly, we may expect a second peak around 2010.

It is clear that the reserve estimates of around 50 Gb as reported by the Oil & Gas Journal were far too low. Exactly how far is difficult to know, but we tentatively favour an figure of about 60 Gb, still giving a fairly low depletion rate of 3%, which is one argument against higher estimates.

Production rose steeply up to 2005 and stalled there after; a peak is still expected circa 2010 at 10 Mb/d.

Kazakhstan - 2005

Insufficient is known about the country to make a very reliable assessment but the indications are that about 37 Gb have been discovered, of which only 6.6 have been produced. Future discovery is here assessed at about 8 Gb, giving a rounded total of 45 Gb. With such substantial reserves, the country has little incentive to explore for more. If this is approximately correct, it might be reasonable to model production rising to about 1.4 Mb/d by 2010 followed by a plateau to the onset of decline around 2030.

This projection is kept without change.

Azerbaijan -2004

Production is currently running at about 300 kb/d at far below capacity pending the construction of the new export pipeline when it may triple. The midpoint of depletion is forecast for around 2015, when production would decline at about 2.5% a year.

This projection is kept without change.

Norway - 2003

Oil production commenced in 1971 and has grown steadily to just over 3 Mb/d. Some 16 Gb have been produced, which is close to half the total discovered. Peak production was passed in 2001 (barring any shortlived surge from new small developments), and will be followed by a relatively high decline of almost 7% a year.

From 2004 to 2005 the depletion rate for Norway was actually 7%.

Venezuela - 2006

On this basis, the depletion rate of Regular Conventional production stands at no more than 2%, suggesting that even the present reserve assessment may be too generous. It is here assumed that production can be held at 1.8 Mb/d until around say 2015 before a gentle decline sets in. As already mentioned, the East Venezuela Basin has substantial reserves of Non-Conventional heavy oil, lying at depths of between 500 and 1500m.(...) Production commenced in 1990 and has risen to about 650 000 kb/d. It is assumed here that production will be flat to 2015 rising thereafter at 3% to peak in 2030 before declining at 2% a year.

This projection is kept without change.

Iran - 2003

(...) production could in resource terms rise to a second peak in 2009 at almost 5 Mb/d before commencing its terminal decline at 2.6% a year, but operational and investment constraints may prevent such a level being reached in practice, with 3-4 Mb/d peak being perhaps more likely .

Production rose to 4 Mb/d in 2004 and stalled beyond that. Based on the same resource base this daily production could be maintained up

to 2020. Like Saudi Arabia, Iran's declared recoverable reserves (130 Gb) have been under great criticism. While Colin Campbell's estimates sit around 70 Gb, Samsam Bakhtiari, a retired head-man of the Iranian Oil Company, declared this year that recoverable reserves stay around 40 Gb. The projection here used can be considered fairly optimistic.

Abu Dhabi (UAE) - 2004

Oil production stands at 1.8 Mb/d, and is here assumed to remain flat at that level to the depletion

midpoint in 2026, declining at about 2% a year thereafter to about 1 Mb/d by 2050.

Assessment not available for states other than Abu Dhabi. Production for UAE has in fact been flattening in the last years, making Colin Campbell's assessment quite plausible.

Kuwait - 2004

Kuwait's production is expected to rise from a present 1.8 Mb/d to a second peak (depletion midpoint) at 2.7 Mb/d in 2018, before entering its terminal decline at about 2% a year.

This projection is kept without change.

Mexico - 2003

Mexico is here assessed to be capable of producing a total of 50 Gb to 2075, giving a midpoint of

depletion in 1999, some fourteen years after what appears to be a premature actual peak in 1985.

Production now stands at about 3.2 Mb/d, being subject to a fairly high depletion rate of 5% a year.

Mexico seems to have peaked only in 2004, but the future decline rate is maintained.

Algeria - 2004

Production is currently running at 1 Mb/d, and is expected to rise to a peak of 1.4 Mb/d by 2006 at the midpoint of depletion, before falling to about 850 kb/d by 2020 and 300 kb/d by 2050.

Algeria produces large amounts of LNG, reaching a total of 1.8 Mb/d for Liquids in 2003 and 2 Mb/d in 2005. Future production is modeled with Colin Campbell's assessment (3% annual decline) for Conventional Oil plus a constant of 0.8 Mb/d for LNG.

Qatar - 2005

Conventional Oil
Production 2004 0.78
Forecast 2010 0.53
Forecast 2020 0.27

The country has been exporting Liquefied Natural Gas for some time, and has plans to expand the capacity greatly, such that production is expected to rise to 1.4 Mb/d by 2011, making it the world's largest exporter. Several gas-to-liquids plants are also being developed by Chevron/Sasol, Exxon, Shell and others, which are expected to yield 1 Mb/d in a few years' time. Petrochemical production, including the world's largest ammonia-urea plant providing critical synthetic nutrients for agriculture, is also set to expand.

Productions rises of 9% were experienced in last years, which should continue up to 2011, beyond that an annual increase of 3.5% is used.

Liquids:
2011 1.93
2020 2.67

Canada - 2004

[Tar Sands] production, including derivatives, is here estimated to rise from about 1 Mb/d today to a plateau at 2.6 Mb/d starting in 2020, in a slow, labour- and capital-intensive process, also carrying environmental costs.

Canada seems to produce around 1 Mb/d of LNG, a figure likely to fall due to Natural Gas depletion. Total liquids production is projected increasing around 2% annum to 4.1 Mb/d in 2020.

Malaysia - 2005

Production stands at 855 kb/d, which is believed to be the peak, being set to decline at about 6% a year, which is typical of an offshore

environment. If so, production will have declined to about 570 kb/d in 2010 and 300 kb/d in 2020.

Change rate from 2004 to 2005 was -4.3%; since this was the first decline year, Colin Campbell's 6% seems quite reasonable.

Ecuador - 2003

Production now stands at about 400 kb/d, the capacity of the line. The depletion peak has been accordingly somewhat delayed by the limits to export, not being expected until 2004. Production is likely to have fallen to about 250 kb/d by 2020 and 80 kb/d by 2050.

From 2004 to 2005 production still increased by 1.1%, which indicates a near term peak. A new projection is made with a decline of 4% to a liquids production of 290 kb/d by 2020.

Argentina - 2003

Production peaked in 1998 declining to 750 kb/d in 2002. It means that Argentina will become a net importer by around 2010 assuming no increase in demand, which will no doubt further stress its economy and financial stability.

Decline rates have been erratic since 1998, with a fall of 7% from 2003 to 2004 being the highest. Henceforth decline is modeled at 6% per year decreasing production to 290 Kb/d by 2020.

Colombia - 2006

Production, reflecting the two main discovery cycles, reached a peak of 816 kb/d in 1999 at the midpoint of depletion. It has since declined to 520 kb/d giving a current depletion rate of just under 5% a year. Projection kept without change.

Denmark - 2004

Indigenous production peaked in 2002 and is set to decline at about 7% a year.

A final peak was set in 2004 at 390 kb/d, with a decline of 3.3% for the next year. The 7% figure is here used for it's a common number for offshore terminal declines.

Egypt - 2003

Production 2002 0.27

Forecast 2010 0.17

Forecast 2020 0.09

Current Depletion Rate 5.9%

The country will become a net importer of oil within about five years as domestic production continues to fall.

There's a big gap from Colin Campbell's numbers to BP's, almost 500 kb/d; which most likely is LNG. Depletion rate for Liquids is has been stable around 4%, hence this is the figure used for projection.

United Kingdom - 2006

Current (2005) oil production of 1.8 Mb/d is set to decline at the current depletion rate of 7.5% a year, meaning that it will have halved in ten years.

The days of UK as an oil exporter are already over.

Future Oil Consumption

This is an all but easy assessment, and is performed with some risks. Unlike western importing countries, most of the analyzed countries experienced profound changes in consumption patterns since the turn of the century. Future consumption is mainly obtained by projecting the change rates observed in the last years, especially since 2003 when higher oil prices started being felt. There is a clear pattern in recent years of growing affluence in these exporting countries, which are mostly outside the wealthy importer blocs (Europe, North America, Japan and Oceania). The hardest question to answer is for how long will these countries continue in the soaring consumption growth path.

Saudi Arabia

After a period of slow growth during the years of low oil price, consumption in Saudi Arabia soared above 7% during 2 years to settle down at 4.7% in 2005. Future growth is modeled at 4% annum.

Oil consumption has been steadily growing around 1.5%/year, with 2004 being the exception with 2.6%. The increasing incomes from oil exports do not seem to affect much the country consumption; the 1.5% figure is kept.

Erratic decline/growth through the last years makes projections difficult. It is likely that the 2005 figure will be maintained for some

time as the country experiences greater affluence as an oil exporter. Future consumption growth is modeled as slowing down 1% each year from 10% to 5% from which point it settles.

After two spectacular declines in 2001 and 2002, the country came back to life the next three years, going above 10% in 2003 and 2005. Future growth is modeled has maintained at 10%/year, for Azerbaijan is currently a somewhat undeveloped country.

Consumption in the remaining countries is modeled as growing 2%/year.

Norway

Consumption history yields years of growth alternating with years of decline; still the mean since 2001 is positive. Future consumption growth is modeled at 1.2%/year.

In the last 5 years 2003 was a clear outlier with a decrease of almost 20%; without this year the mean growth stands at 8%/year. 2004 can be argued has a correction year from the previous crisis, but 2001 and 2002 had similar large numbers, thus 8% is the figure used to project future growth.

Steady growth since 2000 between 4% and 7% annum with 2001 a clear outlier. The mean of these figures from 2000 to 2005, barring 2001, is 5.75% which seems reasonable to project future growth.

After a long period of decline, consumption growth came back strongly in 2001. From 2003 onwards growth rates are settling on the 5-6% range. The mean of these last 3 years, approximately 5.5%, is thus used.

Strong growth in the late nineties was followed by tow years of stillness; from 2002 onwards growth picked up again with rates varying between 5% and 10% annum. The mean rate of these last 4 years, 8% is used for projection.

Since 2000 a trend of erratic slow growth is visible, with 2002 a clear outlier. The mean of these figures since 2000, and excluding 2002, is 1.75% and looks like a reasonable number for future growth.

Steady growth in the range of 3% to 6%, with an outlying 11% in 2002. The mean figure since 2000 without 2002, 4%, is thus used for future growth.

A nation very hard to model, registering growth rates of 22% for 2001 and 47% for 2002, followed by a 3% decrease in 2003, in turn followed by strong increases in 2004 and 2005. Oil production in the country will increase beyond 2020, hence a high growth rate, circa 10%, is quite probable.

After 4 years of growth with rates above 2%, 2005 comes as the first year of declining consumption in a long time. The mean figure for the 2001-2004 period is 3.8%, probably a too higher number for a wealthy country. Still oil production is projected to grow beyond 2020, making likely future consumption growth, here set at around half of the 2001 - 2004 period.

Growth years alternate with decline years in a nation already on terminal production decline. Future consumption is modeled as decreasing 2%/year; still Malaysia will stop being an exporter before 2020.

After a decline in 2002, growth came back in the following years staying above 3%. The mean of the last 3 years, approximately 4%, is thus used.

As for many others not so wealthy exporters, a decline period is followed by strong growth from 2003 onwards. Future growth is modeled at 5%, reflecting the last three years.

The country experienced shy consumption growth in the last 3 years, in spite of high decline rates in production. Future production is projected as growing 1.5%/year, a number close to the mean of the last 3 years.

2005 seems to be an exceptional year for the country, the first where consumption didn't decline since 1996. The good student is projected as keeping up the good work and declining consumption 3%/year, in line with the trend observed in the 2000 -2004 period. Such keeps Denmark as a marginal exporter through out 2020.

A country that illustrates perfectly the affluence growth in less wealthy oil exporters. After 3 difficult years of decline, consumption gets back on track toping 8.5% in 2005. The mean of these last 3 years, 5%, is

used for 2006; beyond that Egypt's days as an exporter are over, and consumption will probably have to accommodate to the declines in production.

Although experiencing a period of 3 years in a row with consumption growth above 1%, UK is a card out of the set of exporters.

The final result can be observed in Figure 23, obtained by subtracting the projected consumption from the projected production for each country. Once a country stops being an exporter is thereafter left out of the total. The countries leaving the exporters club are: United Kingdom in 2006, Egypt in 2007, Argentina in 2010, Mexico in 2015, Malaysia in 2019 and Colombia also in 2019.

The declines rates resulting from the projections made are never higher than those observed during the early 1980s, still in 15 years total oil exports decline almost 40% from 36.2 Mb/d to 22.6 Mb/d. This period ahead might not have much in common with the crisis lived in the 1970s and 1980s, but if economic recession takes over in importing countries, periods of heavy decline might happen, followed by periods of recovery.

The first acceleration is probably the most critical period and follows the peak in world oil production. The final years of the 2010s decade will present great challenges for oil importing nations. Finally is worth mentioning that these four periods seem to fit on Samsam Bakhtiari's Four Transitions of which the first started last year.

Important countries left out. There are three main countries for which consumption data is not available, hence not included in the calculations: Angola, Iraq [ed] and Nigeria. For the last two even if the data existed projection would be difficult. Both countries are experiencing serious social disturbances, Iraq is unfortunately undergoing what is technically a war, and in Nigeria social inequity is leading to rebellion from people to whom oil has only brought disadvantages. Some sort of social transformation is to expect in the following years in these countries, hopefully towards more stable environments.

As for Angola the times of social unrest seem to be gone, although elections are yet to take place, the liberal opposition is now unarmed. In 2003 the 5 million Angolans consumed little over 40 Kb/d. Today that number is unknown but is surely much higher, perhaps several

orders of magnitude, due to an explosion in the housing market, and to a sharp increase in population (there are reports of 1 million Chinese living in Luanda alone). The latest assessment made by Colin Campbell pushed the peak in Angola's production back to 2011 (from circa 2018), more inline with other specialists (e.g. Cramez). The adding of future oil exports from Angola would not change much the overall picture, probably softening the decline rates before 2011 and augmenting them thereafter. Still this is an oil exporting country worth assessing if consumption data can be found in the future.

Conclusions

This assessment should be taken "with a grain of salt", it is not to be expected that the future will follow these projections. But looking at these numbers, there are some trends that clearly arise, the most important being a decline from 2005 onwards of the amount of oil coming to the market. This situation is a consequence of consumption growth at a higher pace than production in most of oil exporting countries.

Once the amount of oil available for export becomes lower than the amount required by the importing countries, costs start to rise, forcing an abnormal wealth transfer from buyers to sellers. This newly acquired wealth will improve affluence in exporting countries, which in turn drives up internal consumption (better automobiles, better and farther from center houses, more goods imports and transportation, etc). This feedback loop will perpetuate itself until some event or constraint tackles consumption growth on the exporters' side, or until the importers collapse from lack of new wealth to transfer. The former is the most likely scenario.

For oil importing countries like the EU these projections bring a worrisome conclusion: mitigation strategies for oil scarcity should have started taking effect in 2005. For this to happen, planning should have started in the late 1980s or early 1990s. Although programs for liquid hydrocarbons replacement exist in the electric generation sector in the EU, US or Australia, none of these countries seems to have prepared to phase out oil in the transportation sector. In the case of the EU it is also important to note the failure to plan an alternative to nuclear electric generation, an important energy source in some member states, since it is stalling due to negative public opinion.

Finally another consequence must be observed: unfortunately, as laid down originally by Colin Campbell, the Oil Depletion Protocol may only

function if exporting countries restrain their oil consumption. Up to the Peak Oil epoch the Protocol can work if exporting countries match their consumption growth to the production, freezing the amount of oil coming on market. After Peak Oil these countries would have to decrease their internal consumption in order to mach the decline rate of world production with that of world consumption. It is hard to envision less wealthy countries reducing their consumption in order to provide oil to wealthier countries. Let's just hope for the best.