Oil Prophets: Looking at World Oil Studies Over Time

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Note: This article was originally presented at the ASPO 2003 conference in Paris. The version here incorporates minor corrections.

All great truths begin as blasphemies. (George Bernard Shaw)

Trust everyone, but always cut the cards. (Mark Twain)

It wasn't raining when Noah built the ark. (Howard Ruff)

Broad world oil assessments generally tackle one of two different but related questions: how much oil will eventually be produced (Estimated Ultimately Recoverable oil, EUR), and when might daily world oil production peak? Geologists and oil research groups wrestle with the former question through detailed assessment of petroleum fields worldwide. A growing number of individuals and forecasting entities have addressed the latter. Some engage both questions.

Those seeking best-estimate answers to these two questions are hamstrung by lack of access to essential geological data. In particular, uncertainties about the size of Middle East reserves and resources abound. Most recent EUR estimates fall between 2000 and 3000 billion barrels of petroleum liquids.

When addressing the second question - when production will peak - the process becomes much more complex. In addition to geologic limits,

numerous political, economic, financial, social, and technological factors play very substantial roles in oil production and consumption, in the past, today and in the future. Commentators who disregard the import of these factors to focus on apparent geological constraints do so at their peril. The depletion of existing fields will play a key role, but since the bulk of remaining oil is in a dozen nations, investment constraints could be paramount in the timing of peak oil production. A brief listing of projected maximum daily production is attached; it falls well short of assumptions by the U.S. Energy Information Agency and the International Energy Agency.

In the face of these considerable analytical challenges, a growing list of indomitable individuals has studied these related questions. A work-in-progress list of nearly 100 estimates is attached. It expands on similar previously published lists (Bentley, Edwards, Nehring, McKenzie). The majority project a peaking between 2010 and 2020. The author invites additions, either recent or historic.

In the process of assembling this list, over a dozen listed US-based individuals not attending the ASPO 2003 conference were contacted for their then-current observations about world oil resource and oil peaking estimates. A selection of their comments is included.

I. EUR Assessments

The earliest identified global EUR oil assessment dates back to 1942, with the initial wartime effort conducted by Wallace Pratt and Lewis Weeks (Standard Oil Co. of New Jersey). In the intervening 60 years, the number of studies projecting EUR oil has reached over 75, perhaps as high as 100. Additional searching, including contributions from attendees at this conference, should lengthen the attached list.

How have their estimates fared? Given general agreement that we haven't yet reached the halfway point in eventual production, it's too early to offer definitive judgment. And as Colin Campbell acknowledged in one of his early publications, in what he termed an addition to Murphy's Laws:

> "ALL FIGURES ARE WRONG … without reliable statistics, there can be no real experts anyway, and the door is open for informed speculation by whoever cares to address the problem. We can at least try to understand the patterns and trends, and above

all, to study carefully the implications of successive revisions." *(Campbell: Golden Century of Oil)*

In line with that admonishment, several factors stand out from a review of the EUR assessment list.

Learning curve

Once the initial 1942 EUR assessment was published, before 2-D and 3-D seismic exploration had been developed, it took just 16 years for projections to emerge that are in line with lower-end projections of more recent studies.

At first glance, it appears the learning curve leads to a grouping of assessment at the 2000 billion barrel level. However, there were always more optimistic assessments. Weeks' 1959 assessment showed an upper end possibility for 3500 billion barrels of oil - in line with a number of studies reported over time. In recent times, the assessments generally fall between 2000 and 3000 billion barrels - still a very substantial differential. That differential tends to narrow when studies use the same reporting framework (discussed below).

Multiple studies leads to higher assessments

For those individuals and groups who conducted multiple studies, subsequent EUR numbers generally trend higher.

From Weeks' initial assessment in 1942 through his seventh projection in 1978, he steadily increased his projections - from 650 billion to 3600 billion EUR. Over a 10-year interval (1970 – 1979), Moody's six EUR estimates grew more gradually from 1750 to 2150 billion. Campbell's EUR figures increased from an initial 1650 billion to his present 2700 billion, though the latter figure represents a substantially different metric: "all liquids" in the latter vs. conventional oil (excluding heavy oil and unconventional enhanced recovery oil) in the former. Nehring's first and last estimates, calculated in 1978 and 1982, were relatively the same. Odell was an exception; between 1973 and 1983 his EUR estimates decreased from 4000 to 3000 billion barrels.

USGS estimates varied substantially over time in a non-linear fashion. During the mid-1970s, Grossling's figures reached a substantial new high for the USGS - as much as 5600 using one method. Earlier estimates by Hendricks during the 1960s were higher than EURs projected by Masters during the 1980s, though in line with the latter's last publication in 1994.

Common definitional framework: missing

The list of EUR estimates lacks a common definitional framework. Without a common measuring scale, any list won't be very useful.

A paper at last year's ASPO conference made the following reference: "There is a wide range of estimates for the world's original endowment of conventional oil (i.e., recoverable oil excluding the tar sands, etc.)" It is the "etc." that causes problems. The devil is in the details. Does "conventional oil" include lease condensate? Natural gas liquids? Polar and deepwater oil? Does "all liquids" include heavy oil and tar sands production?

The US Dept. of Energy's historic production tables include "crude oil, natural gas plant liquids, and other liquids" (EIA). BP's annual oil production tables in their Statistical Review of World Energy "includes crude oil, shale oil, oil sands, and natural gas liquids." However, the oil reserve figures in BP's tables historically exclude those resources. But the Oil & Gas Journal's annual assessment in December 2003 added 175 billion barrels of tar sands to Canada's "conventional oil reserves." Will BP follow suit?

When it comes to assessing peak oil, ASPO's Newsletter reported an "all liquids" figure. This acknowledges the fact that end-users have no way of differentiating most liquid fuels by origin.

Access to data: a significant weakness

While the ability to locate, evaluate and extract oil in the field has drastically improved over time, analysts continue to be hampered by lack of access to definitive data.

Limited Middle East data is the pivotal issue. We know that Prudhoe Bay peaked in 1987, but how many of the 40 giant fields in the Persian Gulf have also peaked? Such information is not in the public domain. Without solid numbers, EUR forecasting becomes like "Blind Man's Bluff." By most accounts, the Middle East holds about two-thirds of the world's remaining conventional oil. Thus the related data uncertainties tied to a single region in the world make the process quite difficult and related projections open to question.

Assessment methodology arguments

The methodology used by the USGS' world energy assessment team in 2000 has received harsh criticism, especially from Jean Laherrère (Laherrère). He argues that selecting a mean EUR oil figure, between

oil for which there is a 95% discovery possibility and oil that has a 5% chance of being found, leads to an unrealistically high assessment (3000 billion barrels of conventional oil). Off East Greenland, USGS says there's a 95% chance of at least 1 barrel, a 5% chance of nearly 100 billion, and thus a mean of around 50 billion. Campbell retorts, "you might as well say there's a 5% chance of my being a frog." The USGS cites support for their methodology from the AAPG Resources Assessment Committee, the National Academy of Sciences, and others.

Campbell and others argue that, seven years into the USGS study period, new discoveries should already be tracking higher if we are ever to meet the USGS' mean 3000 billion barrel EUR oil projection. Supporters counterpoint that producers, especially in the Middle East and other OPEC nations, don't have incentive in the current world-oil environment to explore for new oil they don't need immediately.

II. Peaking Estimates

Striving to determine how many petroleum liquids we have left and will ultimately produce is a useful exercise, but primarily as a means to help determine when daily worldwide production is likely to peak.

This effort, exercised judiciously, should help long-term planners make better decisions. Yet it is fraught with pitfalls.

Not all resources are created equal

Many of the larger new fields are located in harsh and remote regions, in politically unstable environments, or require larger energy inputs during extraction. There may indeed be 50 billion barrels of oil offshore Greenland - but will it ever be produced? Since demand is somewhat fickle, identifying a year or range of years when liquids production will peak qualifies as part art, part science. That said, the paper lists a wide range of estimates for a peak in petroleum liquids production. They range from 1992 to 2030.

Oil bears or pessimists argue that if oil is in relatively limitless supply, then why are we going to the ends of the earth, in harsh physical and political environments, to develop more expensive and riskier resources? Responding that the Middle East is off limits to increased production by international oil companies is an incomplete answer. Everywhere but the Middle East, and perhaps there too, the big easy pools of oil are draining fast.

The large role of non-geologic factors

Consider the world events of 1979-1983. Crude oil consumption declined 15% during that short span and didn't exceed the 1979 consumption level until 1996. The fall was primarily due to political, technological and economic drivers: a mix of wars, revolutions and production cuts driving up prices; a concerted effort by OECD nations to improve efficiency by consumers; substantial fuel-switching away from oil in power generation; and more.

On a smaller scale, consider the impact of the former Soviet Union's massive transformation during the early 1990s. Geologic constraints played a role in the precipitous 43% decline in oil production between 1988 and 1996. But the social, political and economic impacts of the break-up coincided with and partially triggered the steepest decline. From 1996-2001, during the era following the initial turmoil, nations of the former Soviet Union added nearly as much new net production than the rest of the non-OPEC world combined (BP).

Today, the range of non-geologic factors that can negatively impact the supply and demand situation is long and growing. Table 1 includes samples of each.

Table 1: Short sample of factors other than geology that can constrain world oil demand and supply.

Key demand-side variables	Key supply-side variables
World-wide economic health. Example: so-called "Asian flu" of 1997-1999; business and individual responses to world violence - less leisure and business travel.	Violence: war, revolution, guerillas blowing up pipelines, terrorist activities.
Extreme price volatility impacts business investment decisions and some personal purchase decisions - "demand destruction".	Financial support from the markets for exploration and drilling.
Unusually hot or cold weather.	Natural disasters: hurricanes, typhoons, earthquakes.

Key demand-side variables	Key supply-side variables
Political initiatives aimed at reducing demand: gasoline taxes, requirements or incentives to produce more efficient energy-consuming devices.	Environmentally-focused political initiatives (e.g., Alaska National Wildlife Refuge off limits to drilling; oil tanker off Spanish coast).
Political instability holding back economic development, slowing demand growth.	Strikes and other social/political unrest: Venezuela and Nigeria.
Market responses to higher energy prices: more efficient homes, cars; fuel switching; technology breakthroughs in hybrid-electric cars.	Corporate merger activity.
Social initiatives: groups lobbying individuals to "do the right thing."	Legislative road-blocks to participation by international oil companies.
Educational efforts, through schools, universities, the trades	Political initiatives aimed at diversifying supply. E.g.: more biofuels and wind energy.
Regional or world health problems. For example, SARS' impact on jet fuel demand	Financial investment in upstream infrastructure: pipelines, tankers, etc.
The Big Surprise	*The Big Surprise*

The "common framework" issue

With all the variables impacting rates of oil production, analysts trying to assess world oil peaking would benefit from a common framework. In our view, it makes most sense to use an "all liquids" template for future forecasts.

How have their estimates fared?

Projections for an early peaking of production, during the early-1990s through today, have not proven out. This provides critics with ammunition. Yet we're steadily approaching the time - 2010 to 2020 - when the largest grouping of analysts projects that daily petroleum liquids production will peak.

The scientific method is typically an iterative process: pose a hypothesis, test the hypothesis, study the results, adjust the hypothesis, retest, etc. Until the Wright brothers' plane actually lifted off the ground and flew for 12 seconds 100 years ago, all the previous hypotheses ended as "in-progress experiments." Peaking, no matter the ultimate shape of the curve, is a matter of "when," not "if."

The "grandfather of oil prophets" was M. King Hubbert, a former employee of Shell and the U.S. Geological Survey. First in 1948 and later in 1956, Hubbert projected an EUR oil figure for the US that led to him to predict a peaking of US production by 1970, plus or minus a year. By 1961, the USGS countered with an EUR figure nearly three times as large as Hubbert's, implying that his near-term peaking projection would not be a problem. Yet daily crude oil production from the US peaked in 1970, as Hubbert projected, at close to 10 Mb/day. Since then, it has declined to under 6 Mb/day.

The "if-then" approach

While Hubbert studied US oil in detail and issued a number of predictions, he was very reluctant to make firm projections at the world level, according to collaborator Ivanhoe. Instead, he offered up contingent estimates: if our EUR for world oil ends up at 2000 billion barrels, then world oil production should peak around 1995 – 2000. If the EUR figure ends up higher, the peak will be later.

Al Bartlett, a physics professor emeritus at the University of Colorado (Boulder, CO), takes a similar route (Bartlett). He adjusts his peaking projection based on the amount of EUR oil. During each of the 1,491 public

presentations (as of May 12, 2003) he has made of his talk, "Arithmetic, Population and Energy," he states the peak could occur in 2004 with 2000 billion barrels of EUR oil, 2019 if there are 3000 billion barrels, and so on. He assumes each additional billion barrels of oil production pushes the peak back 5.5 days.

A Douglas-Westwood world oil study, reported August 12, 2002 (Oil & Gas Journal Online), makes a similar distinction, but with respect to varying rates of demand growth. "A 1% annual growth in world demand for oil would cause global crude production to peak at 83 million b/d in 2016. A 2% growth in demand would trigger a production peak of 87 million b/d by 2011, while 3% growth would move that production peak to as early as 2006."

Production system limits

During the process of identifying projections as to when world oil production might peak, a number of individuals offered the level at which they felt daily oil production system might be constrained, for all the reasons cited above and more. A short list of such estimates follows, See Table 2. Note the IEA and EIA estimates are much larger than those offered by most other commentators. Expanding this list should help identify the "when" of world oil production.

Table 2: Comparison of estimates of the level at which the daily oil production system might be constrained.

Individual	*Association*	*When estimate offered*	*Level at which daily world oil production will be limited (million barrels/day)*
Sir John Browne	BP	Nov 2000	About 90 million b/day
Colin Campbell	ASPO	July 2002	About 87 million b/day (in 2010)

Individual	*Association*	*When estimate offered*	*Level at which daily world oil production will be limited (million barrels/day)*
Tom Ahlbrandt	USGS	May 2003	"I wouldn't venture a rate; ask Richard Nehring"
Richard Nehring	NRG & Associates	May 2003	Into the mid-80 Mb/day range; "probably can't reach 90."
Pete Stark	IHS Energy	2003	About 92 Mb/day
Agencies	*Publication*		
International Energy Agency	World Energy Outlook 2000	2000	Production might reach 115 Mb/day by 2020
US Energy Information Agency	International Energy Outlook 2003	2003	Production might reach 119 Mb/day by 2025

III. Broad observations by US individuals on both EUR and "peak"

Over the course of the last few weeks, these writers met with, interviewed by phone or corresponded by e-mail with people who either; work in the oil industry, retired from the oil industry, or have been closely following it at some professional level. Most of those individuals live in the US and are not attending the 2003 ASPO conference in Paris. Most have conducted world oil studies. Each was asked a range of questions about their earlier efforts, any updated studies, how their studies varied over time, key lessons learned, how large the EUR oil figure might eventually grow, and when they thought daily world oil production might peak.

The comments below are excerpted from those communications. Comments were selected that express the wide diversity of opinions on

EUR and world oil peaking. Yet there are also areas of broad agreement; those are summarized at the end of this section.

Tom Ahlbrandt, Ph.D. petroleum geologist, head of USGS World Oil Study Group (Denver, CO), on 5/14/03: "New world oil is all about Russia and the South Atlantic, not just the Middle East and certainly not about Europe … Field growth is just coming into its own in the world …We're optimists everywhere in the world except North America … I don't believe in the idea of a peak *per se,* I'm a plateau guy; I wouldn't venture a rate for the plateau; if you need a figure Richard Nehring is pretty reliable … Gas hydrates should be economically viable in 5 years [from MacKenzie Delta]."

Rich Duncan, Ph.D. electrical engineer (Seattle, WA), worked in Saudi Arabia energy sector; annual world oil analysis since 1996, on 5/21/03: "The world oil production peak can be reckoned by historical data alone [from the peaking rate of the world's top-producing nations] … The oil industry itself appears ready to accept that the peak is near … It's time to put the peak behind us and focus on the post-peak production decline rate and what to do about it."

L.F. "Buzz" Ivanhoe, retired petroleum geologist (Ojai, CA), creator of Hubbert Center Newsletter, on 5/18/03: "I'm not one to argue with data. Yet interpretation of data depends on your philosophy … There are not enough excellent plays out there to make the money people drool … Remember that during the peak decade of worldwide discoveries - the 1960s - we found all that oil with single full seismic, not the fancy new tools."

Michael Lynch, president of Strategic Energy and Economic Research, Inc. (Springfield, MA), on 5/20/03: "It's hard to compare different EUR estimated because of definitional problems, but those by single authors do tend to increase over time ... We have seen recent estimates much higher than the 2000 billion that was common in the 1970s/1980s, reflecting improved technology, better infrastructure, etc. … I don't see any peak for 20-30 years, unless it is demand driven."

Charlie Matthews, energy investment analyst, Weeden & Co (Greenwich, CN), on 2/11/02: "[The optimists are] in the grip of a view that comes from the concept: 'decide what you believe first, then

assemble the evidence to support it.' … [The pessimists] have hurt their case in the past by calling for an early peak. Then when it did not happen in 2000, and won't in 2006, they are unfortunately discredited ... I hold that we can see the non-OPEC peak quite clearly in the three-year period 2007 – 2009; that is the big one."

Jim MacKenzie, Ph.D., World Resources Institute (Washington, DC), authored world oil issues analysis in 1996, on 5/12/03: "It is a total enigma trying to understand resources in the Middle East … European and Japanese car makers plus Shell and BP are behaving in ways that suggest they know the problem is real … This is not a long way off … Fundamentally this isn't a resource problem, it's a matter of will power; or we can sit and play Russian roulette with our resources and the climate."

Richard Nehring, president NRG & Associates, a US petroleum database firm (Colorado Springs, CO), on 5/15/03: "An EUR range between 2500 and 3000 billion, including liquids from unconventionals, is reasonable; 3500 billion would be aggressive … I underestimated Iraq. It's been under-drilled and under-developed. It could end up with between 200 and 300 billion EUR … Since 1990, only 15 discoveries in the onshore Lower 48 have been over 5 million barrels … On worldwide production, we can get into the low 80s [crude oil, million b/d]. We'll probably never reach 90 million b/d; infrastructure systems will be stressed to get into the high 80s."

Joe Riva, petroleum geologist, researcher and author (Great Falls, VA), authored world oil study in 1995, retired from the Congressional Research Service and Library of Congress, on 5/18/03: "In science, we make a hypothesis, check it, change it as needed, then check it again. Saying about the pessimists, 'you guys were wrong before so you will be wrong again' is a dangerous mindset … I don't trust a lot of the numbers. I don't know how you verify them … It's simple: our big fields are old and our new fields are smaller … For any oil off Greenland and the Falkland Islands, the economics will be very tough."

Matt Simmons, president Simmons & Co. Intl (Houston, TX), frequent industry presenter and volunteer energy advisor to the Bush Administration, on 5/9/03: "I would not even try to put a date to the year when global oil (and probably natural gas not far behind) will

peak. Too many people do not appreciate that the peak does not mean 'out' … At a [Dept. of Defense] Energy Workshop, [I said] we all need to begin assuming Saudi is close to peaking …"

Pete Stark, IHS Energy, V.P. Industry Relations, Ph.D. (Denver, CO), on 5/15/03: "We have way too much oil coming to the market for the balance of the decade. By 2007, based on past discoveries that are allowing projects to come on stream, we could see adding a net [including depletion] 10.2 million barrels a day of new oil on the market. We don't think demand will be that high, so we expect lower supply and some project slow-downs … Reserve growth is significant … OPEC will lose share … We are showing Middle East reserves cresting."

Walter Youngquist, retired Ph.D. petroleum geologist, author of Geodestinies (Eugene, OR), in May 2003: "I rather doubt we can reach 90 million barrels a day of production. Two years ago, when I asked a member of the Saudi oil ministry how high their production would reach, he said '12 million barrels a day.' In my opinion we'll peak in 10 years or less. The tail [back side of production] will drop very slowly, extended by Canadian heavy oil."

Bottom line disagreement

With respect to the personal observations listed above, disagreements between two camps over EUR oil and a projected peaking date rage on. Current arguments between the Optimists and Pessimists, or Bulls and Bears, date back over 15 years. The USGS' 2000 world energy assessment, with its 3000 billion barrel EUR (mean figure for conventional oil), raised the argument's profile. This 700 Gb difference (compared to the 1994 assessment of 2300 Gb) is significant: depending on your viewpoint, almost half the world's conventional oil is gone - or two-thirds of it remains. At the end of the day, any policy makers investigating the broad energy picture can't escape the argument. The Bulls see substantially more oil to be produced than the Bears. While there are many other points of disagreements, this lies at the heart of the fray.

Yet … areas of broad agreement

1. World oil is a finite resource.
2. There is further room for daily world oil production to grow.
3. Russia, the deep Gulf of Mexico and the South Atlantic show

further promise.

4. Most of the world's oil is located in OPEC's hands.
5. More big oil will likely be found in under-developed structures in Iraq.
6. Limited access to OPEC data clouds our vision.
7. Some new oil could be developed in currently off-limits sections of non-OPEC.
8. Demand is a key variable in assessing any peaking timeframe.
9. Economic, financial, political, social and technology factors not related to geological limits are likely to constrain production over the next 10-15 years.
10. For purposes of analysis and planning, the most useful production figure is an "all-liquids" number.
11. The backside of the oil production curve is likely to be shallower than the front side, thanks to increased liquids production from heavy oil, tar sands and other unconventional sources.

While there was definitely not consensus on when daily world oil production might peak, the majority of those interviewed expect that peak will occur between 2010 and 2020.

IV. Personal observations

You can't be a good egg all your life. Sooner or later, you have to hatch or rot. (C.S. Lewis)

The Bulls and Bears can't both be right. There are some very convincing points as well as serious holes in arguments put forth by both sides. But at the end of the day, we lean towards the "harsh realists" as being closer to the mark.

We note that only people concerned with world oil peaking tend to make predictions. If bullish analysts had to project a range of dates for peaking, there might be as many wrong guesses on the far side of the peak as on the near side. Bullish agencies such as the US EIA show scenarios for decline curves that defy reality. By 2040, their oil decline curves could well look as farfetched as most of their energy price and natural gas supply prognostications over just the last five years. In due course, the much maligned "wrong early predictions" likely will be counterbalanced by overly optimistic ones.

Efforts to educate policy makers about world oil peaking should not leave consumers out of the mix. Most policy makers become very tentative when they get too far in front of their constituents. The educated consumer should be viewed as the foundation for the development of policies that reflect the visible long-term petroleum production problems. But to be effective, we believe the consumer education process may need some thinking outside the box.

The eleven broad areas of agreement listed above point towards world oil production constraints during the 2010 - 2020 timeframe. On an informed hunch, plus a dartboard, we pick a peaking date of 2013. But baring a sharp and sustained surge in demand, the "peak" is more likely to look like a bump on a long ridge than the classic bell-shaped curve. The speculation here is that it won't be in the Middle East nations' longer-term interests to invest in sufficient new production capacity to let a sharp production peak occur.

Price and production scenarios after the peak are not givens. There are still opportunities to change. But for long-term planning purposes, 2010 - 2015 is just around the corner, while 2020 would give very useful breathing room.

Think back to 1998, just five years ago. Oil prices crashed to a 10-year low, the UK hadn't yet experienced peak production, and natural gas in the US was available in the $2 range. Today, the UK is slipping down the back side of their oil production curve and the future of domestic natural gas has lost its shine. In the US, we import nearly 60% of our petroleum products. Our natural gas prices on the spot market have tripled with little likelihood that price pressures will recede substantially over the next three years.

The window of opportunity for substantial change feels like it's closing. Given the long lead times it takes to diversify energy systems and realign infrastructure investments, time could be extremely short. Without deliberate change, a business-as-usual scenario leaves us vulnerable to chaotic change.

To increase the chances for serious dialogue on this subject in the US and perhaps elsewhere, proponents of change will have to improve their message. Consider Harry Truman's observation about a major new factor in peoples' lives: "The release of atomic energy constitutes a new force too revolutionary to consider in the framework of old ideas." Replace "release of atomic energy" with "peaking of world oil" and the statement is equally valid.

One final note

During the early 1970s, history validated Hubbert's oil peaking prediction, though he missed badly with his estimates of natural gas EUR - a fact which he readily admitted. History also showed the USGS of that day to be wishful thinkers. There is a worrisome parallel between the Hubbert-USGS debate of the 1960s and the current disagreements: between those who project a world oil peaking by or well before 2020, and those who embrace the less worrisome EUR figures in the USGS's year 2000 World Energy Study. (The USGS does not project a peaking date for world liquids production.)

V. Summary comment

See Appendix 1 for a list of individuals and organizations that have studied world oil for its EUR potential and potential production peak. A simple majority pick some year or years during 2010 - 2020 as the time frame when daily world oil production is most likely to peak and thereafter slowly decline. A minority expects to see world oil peak within this decade. An even smaller number don't anticipate a peak until after 2020.

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Appendix 1

World Oil EUR Studies; and World Oil Production Peaking Projection

(Bold type indicates multiple estimates from a given author.)

Steve Andrews May 29, 2003 May 26-27, 2003
Updated for Paris ASPO Conference

Year of study or projection	Year of projected peak	Name	Group or organization	EUR (Gb) published* (if studied)	Notes
1942		Pratt, **Weeks**		650	
1946		Duce		400	
1946		Pouge		555	
1948		**Weeks**		650	
1949		Levorsen		1500	
1949		**Weeks**		1000	
1953		MacNaughton		1000	
1956	2000	**Hubbert**		1250	
1958		**Weeks**		1500 / 3000	
1959		**Weeks**		2000 / 3500	
1965		Hendricks	USGS	2000 / 2500	
1967		Ryman	ESSO	2150	
1968		Shell		1750	
1968		**Weeks**		2200 / 3350	
1969	2000	**Hubbert**		1350 / 2100	
1970		**Moody**	Mobil	1750	
1972	2000		ESSO	2100	"Oil increasingly scarce by 2000"
1972		Warman	BP	1200 / 2000	
1972		**Moody**/ Emmerich	Mobil	1800	
1972		Bauquis et al	IFP	1900	
1972		**Moody**		1800	
1972	2000	Ward and Dubois	report for UN	n/a	assumed 2500 billion barrels
1973		Schweinfurth	USGS	2950	
1973		Linden	Inst.Gas Tech.	2850	
1973		**Odell**	Erasmus	4000	
1974		Bonillas	SOCAL	2000	
1974		Howitt	BP	1750	
1975		**Moody & Esser**	Mobil	2000	1300 / 2000 / 3250

Year of study or projection	Year of projected peak	Name	Group or organization	EUR (Gb) published* (if studied)	Notes
1975		**Moody**	independent	2050	1700 / 2050 / 2500
1975		Adams & Kirby		1600 / 2000	
1976	about 2000	Marshall	UK Energy Dept	n/a	research paper
1976		Folinsbee		1800	
1976			Am.Petr.Inst.	2050	
1976		Grossling	USGS	1950 / 5600	Method 1 (note from Nehring)
				2200 / 3000	Method 2 (note from Nehring)
1976		**Klemme**		1600	
1977			W.E.Conf.	2250	
1977		Nelson	SOCAL	2000	
1977		Delphi	IFP	multiple means	1250 / 1800 / 2100 / 3050
1977	1996	Hubbert			Used Nehring's 2000 EUR figure
1977	2000	Erlich, Erlich,Holden	book		assumed 1900 EUR
1978		**Weeks**		3600	
1978		DeBruyne	Shell	1600	
1978		**Nehring**	Rand Corp.	1700 / 2300	
1978		**Klemme**		1750	
1978		Styrikovich		6000	conventional liquids (11000 total liquids)
1979		**Halbouty & Moody**		2150	1400 / 2150 / 3550
1979		**Nehring**	Rand Corp.	1600 / 2000	
1979		Roorda	Shell	2400	
1979		Meyerhoff		2200	
1980			W.E.Conf.	2600	
1981		Strickland	Conoco	2100	
1981		Colitti	AGIP	2100	
1981		**Halbouty**		2250	
1981	2000	**Hubbert/Root**		2000	reviewed estimates by others
1981	around 2000		World Bank	n/a	assumed 1900 EUR
1982		**Nehring**	Rand Corp.	2350	conventional petroleum liquids
1983	2025	**Odell**/Rosing		3000	
1983		**Masters/Root**	USGS	1700	and Dietzman (EIA)

Year of study or projection	Year of projected peak	Name	Group or organization	EUR (Gb) published* (if studied)	Notes
1984		Martin	BP	1700	
1984		**Ivanhoe**		1700	
1987		**Masters**	USGS	1750	
1987		Jenkins	BP	1700	
1989	2010	Bookout	Shell	2000	
1991	1992-1997	**Campbell**		1650	Excl. tar sands, heavy oil
1991		**Masters**		2200	
1992		Montadert/ Alazard		2200	
1993			OPEC	2150	
1993	2000	**Laherrère**		1700	
1993	2010	Townes		3000	
1994		**Masters**	USGS	2300	2100 to 2800 range
1995		Mabro		1800	
1995	2025	Jennings	Shell	n/a	
1995	2000	**Laherrère**		1750	
1995	2005	Bernabe	ENI SpA	n/a	
1995	2005	**Campbell/ Laherrère**	Petro consultants	1800	World's Supply of Oil: 1930-2050
1995		Riva		2300	CRS Report to Congress in 1995
1996	2014	MacKenzie	World Res. In.	n/a	Scenarios: 2007 - 2019 peaks
1996	2010	**Ivanhoe**		2000	
1996	2010	Appleby	BP	n/a	Oil & Gas Journal column
1996	2030	Romm & Curtis	94 Shell data	n/a	
1996	2005	**Duncan**			Peak production to be 29.0 Gb/yr
1997	1998 - 2008	**Campbell**		1800	Narrow def. of "conventional"
1997	2020	Edwards		2850	retired from Shell
1997	2007	**Duncan**/ Youngquist			Peak production to be 30.6 Gb/yr
1998	2013	Udall/ Andrews		n/a	Early SWAG; probably 2010-2020
1998		Perrodon/ **Laherrère**		2750	all liquids: 2300 - 4000
1998	2014		IEA	2300	Used latest USGS reference case
1998	2020	Schollnberger	BP		

Year of study or projection	Year of projected peak	Name	Group or organization	EUR (Gb) published* (if studied)	Notes
1998	2006	**Duncan**			Peak production to be 31.6 Gb/yr
1999	2005	**Duncan**			Peak production to be 31.1 Gb/yr
2000	2007	**Duncan**			Peak production to be 30.9 Gb/yr
2000		Alhbrandt et al.	USGS	3000	2250 / 3000 / 3850
2000	2005?	Magoon	USGS chart	n/a	Large chart displays peak
2000	2010	Browne	BP	n/a	
2000	2016 - 2037		US EIA	3000	Used latest USGS reference case
2001	2004-08	Deffeyes	book		
2001	2010 2015	Matthews	Weeden & Co	n/a	long-time financial analyst
2001	2006	**Duncan**			Peak production to be 28.8 Gb/yr
2002	2008	**Duncan**			Peak production to be 28.3 Gb/yr
2002	2015	**Laherrère**	at ASPO		All liquids
2002	by 2020	Leonard	at ASPO		with YUKOS
2002	by 2020	Bauquis	at ASPO		with TotalElfFina (but personal est.)
2002	2011 - 2016	Smith	Energyfiles	n/a	Used 2200 EUR; 2% and 1% growth
2003	2020-2040	Nehring	personal est.	2500 - 3000	all liquids; 3500 "aggressive"
2003	by 2013	Youngquist	personal est.	n/a	"within the next decade"
2003	2006	Bahktiari			Uses Campbell figure of 1900 bb EUR
2003	2010 - 2020	Ivanhoe	personal est.	n/a	
2003	2003 - 2016	**Duncan**			Oil & Gas Journal feature
2003	2010	**C.J. Campbell**	ASPO	2700	All liquids, through 2075

* EUR = Estimated Ultimately Recoverable, rounded to nearest 50 billion barrels (equivalent to Texas)

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