

Peaking of World Oil Production: Recent Forecasts

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Executive Summary

Because oil is a depleting, finite natural resource, world conventional oil production will reach a maximum, called “the peak,” after which production will decline. Using differing methodologies and information of widely varying quality, experts and organizations have attempted to forecast the likely year of conventional oil production peaking. Their range of estimates extends from late last year to an apparent denial that it will ever happen. Almost all forecasts are based on differing, often dramatically differing geological assumptions. Explicit account of investment rates in new and expanded production has been relatively rare.

Because of the large uncertainties, it is difficult to define an overriding geological basis for accepting or rejecting any of the forecasts. However, the IEA recently warned that worldwide investment in expanded oil production has been considerably less than needed to continue world oil production that is adequate to meet expected world demand. Thus, geological limits may be yielding to investment limitations.

As noted in previous literature, peak oil presents the world with a risk management problem of tremendous complexity and enormity. Prudent risk minimization requires the implementation of mitigation measures roughly 20 years before peaking to avoid a very damaging world liquid fuels shortfall. Since it is uncertain when peaking will occur or whether it will be due to geological or investment limitations, the challenge is indeed vexing.

I. Introduction

For decades, the world has been consuming increasingly more oil than it has been finding. Because oil is a depleting natural resource, world conventional oil production will reach a maximum, called “the peak,” after which production will go into decline.¹ Using different methodologies and information of widely varying quality, various experts and organizations have attempted to forecast the likely year of oil production peaking. Forecasts vary because of uncertainty in the data and because various forecasters tend to be more optimistic or more pessimistic about future prospects based on their experience and interpretation of available information. The mitigation of the post peaking oil shortage will require extremely large-scale action, starting roughly 20 years before the onset of peaking,² so it is important to have a general idea of when peaking might occur.

The purpose of this report is to summarize forecasts for the peaking of world oil production with emphasis on those forecasts that have been publicly noted since early 2005, when our report on peak oil mitigation was released.³ In addition, we revisit and update the forecasts in our earlier report. Our focus has been on people and organizations that have special oil industry expertise and/or significant influence, recognizing that we may have overlooked some that are worthy of mention.

The organization of this report is as follows: Section II provides a brief description of peak oil, including factors that make it’s forecasting so difficult. Section III provides a list of notable recent statements relating to the end of the era of easy and/or cheap oil. Section IV provides tables of important recent peak oil forecasts. Section V revisits the peak oil forecasts noted in our 2005 study on peak oil mitigation⁴ and provides some updates. Section VI describes recent IEA views on world oil production investment, and Section VII provides some general commentary and concluding remarks.

II. The Peaking of World Oil Production⁵

According to the International Energy Agency (IEA), “Worldwide, the rate of [oil] reserve additions from discoveries has fallen sharply since the 1960s. In the last decade, discoveries have replaced only half the oil produced. Nowhere has the fall in oil discoveries been more dramatic than in the Middle East, where they plunged from 187 billion barrels in 1963-1972 to 16 billion barrels during the

¹ The distinction between conventional and unconventional oil is discussed in Section IV.

² Hirsch, R.L., Bezdek, R., Wendling, R. Peaking of World Oil Production: Impacts, Mitigation & Risk Management. DOE NETL. February 2005.

³ Ibid.

⁴ Ibid.

⁵ This section is excerpted from Bezdek, R.H., Wendling, R.M., Hirsch, R.L. Economic Impacts of U.S. Liquid Fuel Mitigation Options. DOE/NETL-2006/1237. July 8, 2006

decade ending in 2002.”⁶

No one knows precisely when peaking will occur because much of the data needed for an accurate forecast fall into one or more of the following categories:

- 1) Proprietary to companies,
- 2) State secrets in the major oil exporting countries, and/or
- 3) Politically/economically biased.

However, even large differences in estimated remaining world oil reserves will not significantly change the date of world peaking, when viewed from the perspective of mitigation. According to EIA, “(Our) results (related to oil peaking) are remarkably insensitive to the assumption of alternative resource base estimates. For example, adding 900 Bbbl (billion barrels) – more oil than had been produced at the time the estimates were made – to the mean USGS resource estimate in the two percent growth case only delays the estimated production peak by 10 years. Similarly, subtracting 850 Bbbl in the same scenario accelerates the estimated production peak by only 11 years.”⁷

A number of forecasters have accepted OPEC reserves estimates at face value in part because there is no independent source of verification. This acceptance is troubling in light of the fact that past history raises significant questions about the validity of OPEC reporting. In the words of the IEA⁸, “What is clear is that revisions in official (Middle East and North Africa [MENA] reserves) data had little to do with actual discovery of new reserves.”⁹ Total reserves in many MENA countries hardly changed in the 1990s. Official reserves in Kuwait, for example, were unchanged at 96.5 billion barrels (including its share of the Neutral Zone) from 1991 to 2002, even though the country produced more than 8 billion barrels and did not make any important new discoveries during the period. The case of Saudi Arabia is even more striking, with proven reserves estimated at between 258 and 262 billion barrels in the past 15 years, a variation of less than 2 percent (in spite of production of well over 100 billion barrels).”

III. The Era of Easy Oil

A number of influential people have recently remarked about the end of the era of easy and/or low cost oil. While the definition of “easy oil” may vary, their views reflect their belief that the world oil enterprise has entered a new, more difficult,

⁶ International Energy Agency, *World Energy Outlook 2005*, November 2005, page 132.

⁷Wood, J.H., Long, G.R., and Morehouse, D.F., “World Conventional Oil Supply Expected to Peak in 21st Century.” Offshore. April 2003.

http://www.eia.doe.gov/pub/oil_gas/petroleum/feature_articles/2004/worldoilsupply/oilsupply04.html, or <http://www.eia.doe.gov/neic/speeches/Caruso061305.pdf>.

⁸ International Energy Agency, *World Energy Outlook 2005*, op. cit., p. 125.

⁹However, while the lack of transparency about OPEC reserves is troubling, the fact that they made no new discoveries does not rule out major additions to reserves through extensions and revisions – which are common in many oil provinces.

more expensive phase. Table I provides a short list of important commentators and their remarks. It is notable that three of the commentators are heads of major oil production organizations, which have been reluctant to speak about a major change in the past.

**Table I.
Notable Recent Statements Relating to the End of the Era of
Easy and/or Cheap Oil.**

| Commentator | Statement | Reference |
|--|--|--|
| David O'Reilly, Chairman, Chevron | "The time when we could count on cheap oil... is clearly ending." | CERA Energy Conference. February 2005. |
| Samuel Bodman, U.S. Secretary of Energy | "The era of cheap and abundant petroleum may now be over." | Christian Science Monitor. July 8, 2006 |
| Jeroen van der Veer, Shell Chief Executive. | "Peak oil does exist for easy-to-drill oil..." | Cummins, C., Williams, M. Shell's Chief Pursues Simple Goals. WALL STREET JOURNAL. January 17, 2006. |
| Alpha Oumar Konare, African Union Commission Chair. | "The era of cheap oil is over." | Era of cheap oil is over. Reuters. 02/04/2006 |
| Viktor Khristenko, Russian Energy Minister | "... the era of cheap hydrocarbons is over". | Hope, C. RUSSIA: 'ERA OF CHEAP FUEL IS OVER'. The Telegraph. 06/06/2006. |
| Guy Caruso, Administrator. U.S.EIA | "The era of low cost oil is probably over." | Holmes, J. Four Corners Broadband Edition. Australian Television Program. 10 July 2006. |

IV. Notable Recent Forecasts

To understand peaking forecasts, it is important to know the types of liquids each forecaster has considered. This is not always obvious.

Over 95% of current world oil production is of relatively light oil, often referred to as “conventional oil.” Unfortunately, the definition of conventional oil can vary between forecasters. It always includes onshore and shallow offshore light oil; it can also include light oil from deepwater offshore oil fields, natural gas liquids, arctic oil, and/or refinery gains, etc.

Worldwide, unconventional oil is produced at relatively modest levels (modest compared with the roughly 85 million barrels per day currently consumed). Unconventional oil includes heavy oil / oil sands, gas-to-liquids (GTL), coal-to-liquids (CTL), shale oil, biomass-to-liquids, etc. Heavy oil / oil sands is the largest current contributor of unconventional oil but contributes less than 3% of world liquid fuels supply; the contributions of GTL, CTL and biomass are considerably less. In this report, we are interested in the broad range of notable peak oil forecasts; finer scale differentiation between conventional and unconventional oil in the various forecasts was beyond the scope of this effort.

The following tables list important peak oil forecasts by time period. Table II shows forecasts for the next five years; Table III lists forecasts for the period 2011–2021; Table IV covers the years beyond 2021; and Table V lists some recent concerns about peak oil by important people and organizations.

It is noteworthy that OPEC apparently denies that the peaking problem even exists.¹⁰ In the past, OPEC has been reluctant to discuss such matters. It has been speculated that OPEC may believe that it is in their self-interest to deny the peaking problem, lest it undercut their near-term market control. Their denial cannot be physically based, because it is well established that production from individual oil fields reaches a peak and then goes into decline and that regions composed of many oil fields behave similarly.¹¹

CERA has been outspoken on the subject of peak oil and is often quoted in the media. Recently, they extended their time frame for peak oil beyond 2030 (See Section V).

¹⁰ Neil Chatterjee, OPEC needs clear demand signals for spare capacity, Mail & Guardian Online, July 11, 2006; "We in OPEC do not subscribe to the peak-oil theory" -- quotation attributed to OPEC acting secretary general Mohammed Barkindo, http://www.mg.co.za/articlePage.aspx?articleid=276971&area=/breaking_news/breaking_news___business/

¹¹ For instance, Hirsch, R.L. The Shape of World Peak Oil Production. World Oil. October 2005.

Table II
Important Recent Peak Oil Forecasts Ranging to 2012 (5 years)

| | |
|---|--------------------------------|
| Pickens, T. Boone ¹² (Oil & gas investor)..... | 2005 |
| Deffeyes, K. ¹³ (Retired Princeton professor & retired Shell geologist).. | December 2005 |
| Westervelt, E.T. et al. ¹⁴ (US Army Corps of Engineers)..... | At hand |
| Bakhtiari, S. ¹⁵ (Iranian National Oil Co. planner)..... | Now |
| Herrera, R. ¹⁶ (Retired BP geologist)..... | Close or past |
| Groppe, H. ¹⁷ (Oil / gas expert & businessman)..... | Very soon |
| Wrobel, S. ¹⁸ (Investment fund manager)..... | By 2010 |
| Bentley, R. ¹⁹ (University energy analyst)..... | Around 2010 |
| Campbell, C. ²⁰ (Retired oil company geologist; Texaco & Amoco)..... | 2010 |
| Skrebowski, C. ²¹ (Editor of Petroleum Review)..... | 2010 +/- a year |
| Meling, L.M. ²² (Statoil oil company geologist)..... | A challenge around 2011 |

¹² Boone Pickens Warns of Petroleum Production Peak. EV World. May 4, 2005.

¹³ http://www.defense-and-society.org/fcs/crisis_unfolding.htm .February 11, 2006

¹⁴ Energy Trends and Implications for US Army Installations.ERDC/CERL TN-05-1 Sept 2005.

¹⁵ King, B.W. No more business as usual. Energy Bulletin. August 11, 2006.

¹⁶ Bailey, A. HAS OIL PRODUCTION PEAKED? Petroleum News. May 4, 2006.

¹⁷ Henry Groppe. PEAK OIL: MYTH VS. REALITY. DENVER WORLD OIL CONFERENCE. November 10, 2005.

¹⁸ Hotter, A. Global Oil Output to Peak in 2010 – Diapason. Schlumberger. May 16, 2006.

¹⁹ Bentley, R. The Case for Peak Oil. DOE/EPA Modeling the Oil Transition. April 21, 2006.

²⁰ An Updated Depletion Model. THE ASSOCIATION FOR THE STUDY OF PEAK OIL AND GAS "ASPO"NEWSLETTER No. 64 – APRIL 2006.

²¹ Skrebowski, C. Peak Oil - The emerging reality. ASPO-5 Conference. Pisa Italy. July 18, 2006.

²² Leif Magne Meling, Statoil ASA.. Oil Supply, Is the Peak Near? Centre for Global Energy Studies. September 29-30, 2005.

Table III.
Important Recent Peak Oil Forecasts Ranging From 2012 - 2022.

| | |
|---|-------------------------------|
| Pang, X., et al. ²³ (China University of Petroleum)..... | Around 2012 |
| Koppelaar, R.H.E.M. ²⁴ (Dutch oil analyst)..... | Around 2012 |
| Volvo Trucks ²⁵ | Within a decade |
| de Margerie, C. ²⁶ (Oil company executive) | Within a decade |
| al Hussein, S. ²⁷ (Retired Exec. VP of Saudi Aramco)..... | 2015 |
| Merrill Lynch ²⁸ (Brokerage / Financial)..... | Around 2015 |
| West, J.R., PFC Energy ²⁹ (Consultants)..... | 2015-2020 |
| Maxwell, C.T., Weeden & Co. ³⁰ (Brokerage / Financial)... | Around 2020 or earlier |
| Wood Mackenzie ³¹ (Energy consulting)..... | Tight balance by 2020 |
| Total ³² (French oil company)..... | Around 2020 |

²³ Pang, X, Meng, Q., Zhang, J., Natori, M. The Challenges Brought By The Shortage of Oil And Gas In China And Their Countermeasures. ASPO IV International Workshop on Oil and Gas Depletion. 19-20 May, 2005.

²⁴ Koppelaar, R. World oil Production & Peaking Outlook. Stichting Peakoil-Nederland. 2005.

²⁵ Volvo web site

²⁶ ASPO NEWSLETTER No. 65 – MAY 2006

²⁷ Motavalli, J. End of an Era. Cosmos. April 2006.

²⁸ Mario Traviati, et al. Oil Supply Analysis: From “Upstream” Incapacity to Spare Capacity: It’s Now a Better Story “Downstream.” Merrill Lynch. 12 October 2005.

²⁹ West, R. Energy Insecurity. Testimony before the Senate Committee on Commerce, Science & Transportation. September 21, 2005.

³⁰ Maxwell, C.T. The Gathering Storm. Barron’s. November 14, 2004.

³¹ MacroEnergy Long Term Outlook – March 2006. Wood Mackenzie.

³² Bergin, T. Total Sees 2020 Oil Output Peak, Urges Less Demand. Reuters. June 7, 2006.

**Table IV.
Important Recent Peak Oil Forecasts Ranging Beyond 2022.**

| | |
|--|-------------------------------------|
| UBS³³ (Brokerage / Financial)..... | Mid to late 2020s |
| CERA³⁴ (Energy consulting)..... | Well after 2030 |
| CERA³⁵ (Energy consulting)..... | “Peak oil theory is garbage” |
| ExxonMobil³⁶ (Oil company)..... | No sign of peaking |
| Browne, J.³⁷ (BP CEO)..... | Impossible to predict |
| OPEC³⁸ | Deny peak oil theory |

Table V is noteworthy in that three important institutions (Royal Swedish Academy of Sciences, IEA, and Raymond James) and two noted individuals have expressed concerns about future world oil production and the coming of peak oil.

V. Previously Noted World Oil Peaking Forecasts.

In our 2005 report on peak oil mitigation,³⁹ we presented a tabulation (Table II-1) of various peak oil forecasts from respected sources. Table VI is reproduced from our earlier report in order to note recent changes, shown in Table VII.

³³ Oil Output set to peak, but no fuel shortage-UBS. REUTERS. 24 August 2006

³⁴ Strahan, A. Global Petroleum Capacity to Rise 25 Percent by 2015. Bloomberg. August 8, 2006.

³⁵ Morrison, M. Plenty of Oil—Just Drill Deeper. Business Week. SEPTEMBER 18, 2006; quotation attributed to Robert W. Esser, a director of CERA

³⁶ www.exxonmobil.com.

http://www.exxonmobil.com/Corporate/Files/Corporate/OpEd_peakoil.pdf

³⁷ As Profit Rises, BP Chief Seeks To Allay Anger. Washington Post. July 27, 2006.

³⁸ Neil Chatterjee, op. cit.

³⁹ Hirsch, R.L., Bezdek, R., Wendling, R. Peaking of World Oil Production: Impacts, Mitigation & Risk Management. DOE NETL. February 2005.

**Table V.
Important Recent Statements of Concern.**

| | |
|--|---|
| <p>Royal Swedish Academy of Sciences⁴⁰</p> | <p><i>“Already 54 of the 65 most important oil-producing countries have declining production and the rate of discoveries of new reserves is less than a third of the present rate of consumption.”</i></p> |
| <p>IEA⁴¹</p> | <p><i>“By 2011 ... global growth will marginally exceed supply-side expansions.”</i></p> |
| <p>Raymond James⁴² (Brokerage / Financial)</p> | <p><i>“The peak in global oil production, which we believe is approaching, will occur no matter what the economic circumstance.”</i></p> |
| <p>Schlesinger, J. R.⁴³ (Former Secretary of Energy, Secretary of Defense, CIA Director, and AEC Chairman)</p> | <p><i>“In the decades ahead, we do not know precisely when, we shall reach a point, a plateau or peak, beyond which we shall be unable further to increase production of conventional oil worldwide. We need to understand that problem now and to begin to prepare for that transition.”</i></p> |
| <p>Greene, D.⁴⁴ (Oak Ridge National Laboratory energy analyst)</p> | <p><i>“Peaking of conventional oil production is almost certain to occur soon enough to deserve immediate and serious attention.”</i></p> |

⁴⁰ Statements on Oil by the Energy Committee at the Royal Swedish Academy of Sciences. October 14, 2005.

⁴¹ INTERNATIONAL ENERGY AGENCY - MEDIUM-TERM OIL MARKET REPORT. JULY 2006.

⁴² THE POLITICS OF OIL: IS HISTORY REPEATING ITSELF? Raymond James Insight. June 26, 2006.

⁴³ STATEMENT OF JAMES SCHLESINGER BEFORE THE COMMITTEE ON FOREIGN RELATIONS UNITED STATES SENATE. 16 NOVEMBER 2005

⁴⁴ Greene, D, et al. Have we run out of oil yet? Oil peaking analysis from an optimist's perspective. Energy Policy 34 (2006).

Table VI. Past Projections of the Peaking of World Oil Production

| <u>Projected Date</u> | <u>Source of Projection</u> | <u>Background & Reference</u> |
|------------------------|-----------------------------|--|
| 2006-2007 | Bakhitari, A.M.S. | Iranian Oil Executive ⁴⁵ |
| 2007-2009 | Simmons, M.R. | Investment banker ⁴⁶ |
| After 2007 | Skrebowski, C. | Petroleum journal Editor ⁴⁷ |
| Before 2009 | Deffeyes, K.S. | Oil company geologist (ret.) ⁴⁸ |
| Before 2010 | Goodstein, D. | Vice Provost, Cal Tech ⁴⁹ |
| Around 2010 | Campbell, C.J. | Oil company geologist (ret.) ⁵⁰ |
| After 2010 | World Energy Council | World Non-Government Org. ⁵¹ |
| 2010-2020 | Laherrere, J. | Oil company geologist (ret.) ⁵² |
| 2016 | EIA nominal case | DOE analysis/ information ⁵³ |
| After 2020 | CERA | Energy consultants ⁵⁴ |
| 2025 or later | Shell | Major oil company ⁵⁵ |
| No visible peak | Lynch, M.C. | Energy economist ⁵⁶ |

⁴⁵Bakhtiari, A.M.S. "World Oil Production Capacity Model Suggests Output Peak by 2006-07." OGJ. April 26, 2004.

⁴⁶Simmons, M.R. ASPO Workshop. May 26, 2003.

⁴⁷Skrebowski, C. "Oil Field Mega Projects - 2004." Petroleum Review. January 2004.

⁴⁸Deffeyes, K.S. Hubbert's Peak-The Impending World Oil Shortage. Princeton University Press. 2003.

⁴⁹Goodstein, D. Out of Gas – The End of the Age of Oil. W.W. Norton. 2004

⁵⁰Campbell, C.J. "Industry Urged to Watch for Regular Oil Production Peaks, Depletion Signals." OGJ. July 14, 2003.

⁵¹Drivers of the Energy Scene. World Energy Council. 2003.

⁵²Laherrere, J. Seminar Center of Energy Conversion. Zurich. May 7, 2003

⁵³DOE EIA. "Long Term World Oil Supply." April 18, 2000. One of many scenarios studied.

⁵⁴Jackson, P. et al. "Triple Witching Hour for Oil Arrives Early in 2004 – But, As Yet, No Real Witches." CERA Alert. April 7, 2004.

⁵⁵Davis, G. "Meeting Future Energy Needs." The Bridge. National Academies Press. Summer 2003.

⁵⁶Lynch, M.C. "Petroleum Resources Pessimism Debunked in Hubbert Model and Hubbert Modelers' Assessment." Oil and Gas Journal, July 14, 2003.

Table VII. Peaking Year Forecast Changes from February 2005 to September 2006.

| <u>Forecast as of 2005</u> | <u>Source of Forecast</u> | <u>September 2006 Update.</u> |
|----------------------------|---------------------------|--|
| 2006-2007 | Bakhitari, A.M.S. | No significant change ⁵⁷ |
| 2007-2009 | Simmons, M.R. | Changed – Peaking is now ⁵⁸ |
| After 2007 | Skrebowski, C. | Changed – 2010 + / - one year ⁵⁹ |
| Before 2009 | Deffeyes, K.S. | Changed – It was Dec. 2005 ⁶⁰ |
| Before 2010 | Goodstein, D. | No known change |
| Around 2010 | Campbell, C.J. | No known change |
| After 2010 | World Energy Council | No known change |
| 2010-2020 | Laherrere, J. | Position reaffirmed ⁶¹ |
| 2016 | EIA nominal case | Changed – Peaking after 2030 ⁶² |
| After 2020 | CERA | Changed – Peaking after 2030 ⁶³ |
| 2025 or later | Shell | No known change. |
| No visible peak | Lynch, M.C. | Position reaffirmed ⁶⁴ |

⁵⁷ Global oil output at a peak, 'set to fall' Gulf Times. 11 July, 2006.

⁵⁸ "For some time, I have suspected that peak oil is probably here." Simmons, M. Private communication. August 30, 2006. also: CFA Society of St. Louis, May 24, 2006, Brentwood, MO., slide 23, "World Should Assume We Are At Peak For Oil AND Gas"

⁵⁹ Skrebowski, C. Peak Oil - The Emerging Reality. 5th ASPO Workshop. San Rossore, Italy. June 18-19 2006.

⁶⁰ Deffeyes, K.S. http://www.defense-and-society.org/fcs/crisis_unfolding.htm. February 11, 2006.

⁶¹ Laherrere, J. Private communication. September 11, 2006. Includes all liquids.

⁶² Morehouse, D. Private communication. June 1, 2006.

⁶³ "Barring unforeseen events there is no reason to believe capacity couldn't meet demand well after 2030, CERA researchers said." Strahan, A. Global Petroleum Capacity to Rise 25 Percent by 2015. Bloomberg. 2006-08-08

⁶⁴ Lynch, M. Private communication. August 30, 2006. "That's a good representation." "My view is definitely formed by a mix of resource economics theory and empirical evidence."

Bakhitari and Simmons believe that world oil production may now be peaking. Deffeyes believes that peaking occurred late last year, while Skrebowski's view is firmed to 2010 +/- one year.

One might ask how Pickens, Deffeyes, Bakhitari and Simmons can suggest a current peak, when the world is not yet aware that one now exists. The answer is that the phrase "oil peak" does not mean knife-edge sharp. Experience in individual oil fields and large oil producing regions repeatedly demonstrates that maximum oil production is usually characterized by a few year gentle rollover. North American oil peaking displayed a relatively gentle peak around the year 1985, as shown in Figure 1.⁶⁵ We know of no region that has reached maximum production in recent years and stayed on a plateau for an extended period of time.⁶⁶

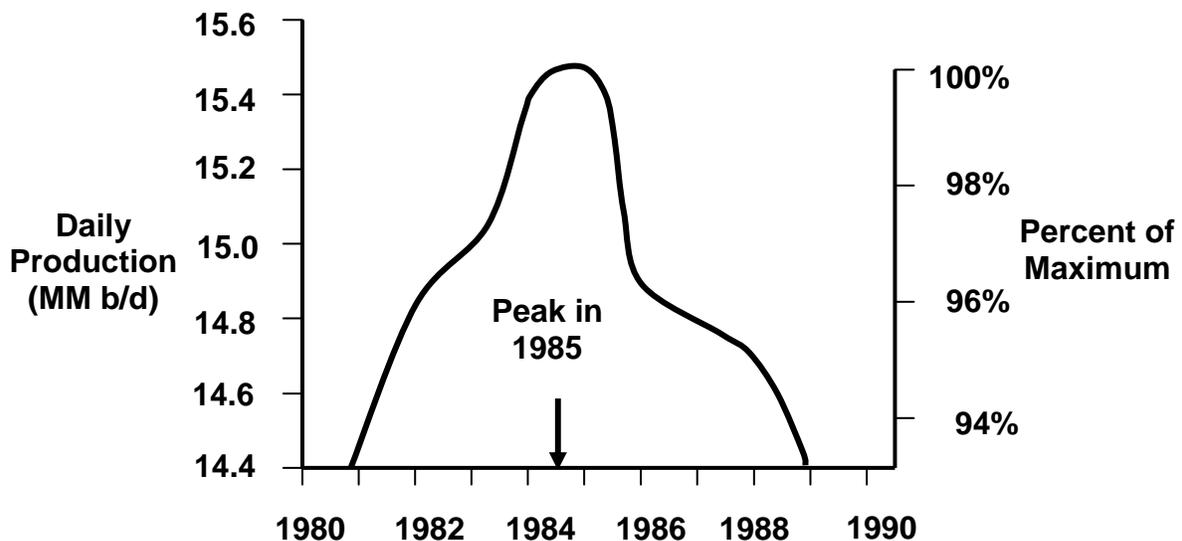


Figure 1. The peak of oil production in North America.

The EIA position on world oil peaking has become progressively more optimistic. In the year 2000, EIA developed 12 scenarios for world oil production peaking using three U.S. Geological Survey (USGS) estimates of the world conventional oil resource base (Low, mean, and high probability) and four annual world oil

⁶⁵ Hirsch, R.L. The Shape of World Peak Oil Production. World Oil. October 2005

⁶⁶ The qualifier "in recent years" is important, because behaviors in the distant past may have been controlled by political events, economic circumstances, or more primitive technology that transitioned to improved technology, allowing for a production plateau. The term "plateau" in the context of peak oil is not well defined. It is probably safe to assume oil production level to less than 1% per year. CERA postulates an "undulating plateau" after world oil production reaches a maximum. Jackson, P.M., Esser, R.W. Expansion Set To Continue – Global Liquids Productive Capacity to 2015. CERA . August 2006.

demand growth rates (0, 1, 2, and 3 percent per year).⁶⁷ In our 2005 study,⁶⁸ we stated our belief that the most likely of the EIA scenarios was the one based on the USGS mean ultimate world recoverable oil of 3,003 billion barrels coupled with a 2% annual world oil demand escalation (EIA nominal case in Tables VI & VII). The production profile in what we called the EIA “nominal” scenario was similar to the relatively symmetric U.S. Lower 48 production profile before and after the peak year of 1970, which represented actual experience in a very large, geologically varied oil-producing region. The corresponding EIA scenario indicated a world peak oil production in the year 2016.

In a subsequent study,⁶⁹ EIA reconsidered its earlier work and concluded the following: “In any event, the world production peak for conventionally reservoired crude is unlikely to be “right around the corner” as so many other estimators have been predicting. Our analysis shows that it will be closer to the middle of the 21st century than to its beginning.” Recently, EIA verified that it still does not forecast oil peaking before 2030;⁷⁰ thus remaining among the most optimistic about future world oil production.

CERA has become increasingly more optimistic about future world oil production: “Barring unforeseen events, there is no reason to believe capacity couldn't meet demand well after 2030, CERA researchers said.”⁷¹ In their recent written analysis, CERA was a bit less specific: “The much-discussed “peak oil” is not imminent, nor is the start of the “undulating plateau.”⁷²

VI. The Recent IEA Warning

In their recently released World Energy Outlook (WEO), the International Energy Agency (IEA) sounded a sharp warning with regard to future world oil production:⁷³

“The energy picture has changed appreciably since the 2004 Outlook, the last major update of the IEA's global energy projection. The realities of the energy market have become harsher and the relative competitive position of fuels has changed. Oil and gas prices this year have been between three and four times higher than in 2002 and this is reflected in a new oil price assumption for the projections. But world economic growth has remained robust, as the

⁶⁷ DOE EIA. “Long Term World Oil Supply.” April 18, 2000.

⁶⁸ Hirsch, R.L., Bezdek, R., Wendling, R. Peaking of World Oil Production: Impacts, Mitigation & Risk Management. DOE NETL. February 2005.

⁶⁹ Wood, J. H., Long, G.R., Morehouse, D.F. Long-Term World Oil Supply Scenarios. DOE EIA. Posted: August 18, 2004.

⁷⁰ Morehouse, D. Private communication. June 1, 2006.

⁷¹ Strahan, A. Global Petroleum Capacity to Rise 25 Percent by 2015. Bloomberg. 2006-08-08.

⁷² Jackson, P.M., Esser, R.W. Expansion Set to Continue - Global Liquids Capacity to 2015. CERA. August 2006.

⁷³ The World Energy Outlook 2006 Maps Out a Cleaner, Cleverer and More Competitive Energy Future. International Energy Agency. News Release - November 7, 2006.

recessionary effects of higher energy prices have been more than offset by other factors.”

“WEO 2006 identifies under-investment in new energy supply as a real risk’, said Mr. Mandil, (Claude Mandil, IEA Executive Director). To quench the world's thirst for energy, the Reference Scenario projection calls for a cumulative investment in energy-supply infrastructure of over \$20 trillion in real terms over 2005-2030 - substantially more than was previously estimated. It is far from certain that all this investment will actually occur. There has been an apparent surge in oil and gas investment in recent years, but it is, to a large extent, illusory. Drilling, material and personnel costs in the industry have soared, so that in real terms investment in 2005 was barely higher than that in 2000.”

In interviews associated with the WEO 2006 release, IEA executives further affirmed the impending difficulties: "This energy future is not only unsustainable, it is doomed to failure," because of, "underinvestment in basic energy infrastructure," "...In short, we are on course for an energy system that will evolve from crisis to crisis," according to Mandil.⁷⁴

“Mr. Birol, the IEA economist, said in an interview that he expects the oil industry's production capacity will slightly outstrip demand through the end of this decade ‘if all the projects see the light of day.’”⁷⁵

Another recent warning comes from the prestigious Aspen Institute:⁷⁶ “It is not a question of what exists below the ground, but the adequacy of the investment environment above ground and the progress made on demand reduction that will lead to wise choices. As access to resources increasingly is taken out of the control of market forces and placed under the control of governments and government-controlled entities, the ability to supply energy markets increasingly becomes a government decision rather than a market decision. Unfortunately, government decisions often are swayed less by what is best for the market and consumers than by what is in the best interests of individual nations or political ideologies. As politics intrude more and more into future energy decision making, the collective security of consumers and producers erodes and can fall prey to political whims and disruptive policies based on non-energy goals. Bold steps to alter course are required.”

⁷⁴ IEA says demands on OPEC crude to increase 'substantially': IEA. Platts--7Nov2006

⁷⁵ Bahree, B. Investment by Oil Industry Stalls. WSJ. November 8, 2006.

⁷⁶ Johnston, J.B., Forum Chair. ENERGY MARKETS AND GLOBAL POLITICS. The Aspen Institute. 2006.

VII. Summary and Concluding Remarks

It is especially noteworthy that a number of industry insiders have now expressed the view that the era of easy, low-cost oil is past. This in itself heralds a fundamental change in the world oil outlook.

Over the past year and a half, a number of individuals and organizations have provided forecasts for when world conventional oil production might reach a peak. Some forecasts use similar geological estimates, while others use very different ones. The range of conventional oil peaking year forecasts extends from last year (Deffeyes) to a denial that it will happen (OPEC); others have affirmed or modified their previous positions. Some of the forecasters with the greatest concerns believe that peak oil may happen sooner than they had previously stated, while some of the optimists have revised their peaking forecasts further into the future. It is clear that there is no consensus among the forecasters, which is not surprising because of the use of different methodologies and the fact that oil reserves estimates are open to considerable question.

Because of the large uncertainties, it is difficult to define an overriding geological basis for accepting or rejecting any of these forecasts. Some commentators suggest that self-interest may have impacted some of the forecasts; others speak of over-optimism, over-pessimism, political pressure, lack of understanding of petroleum geology, etc. Some forecasters explicitly discuss the issue of underinvestment in exploration and production, which could lead to markedly different future world oil production, while others do not. None of the forecasts take explicit account of terrorism or resource nationalism, both of which are very uncertain but could have profound impact.⁷⁷

The recent IEA and Aspen warnings about worldwide underinvestment in upstream oil development is a matter of deep concern. Indeed, it is one thing to estimate what might be available underground, but it is quite another for the needed investment and skills to be brought to bear on a timely basis to overcome existing oil field depletion as well as to provide the additional production growth that the world demands.

The wide range of peak oil forecasts makes peak oil decision-making particularly difficult. One option would be to await a consensus of peak oil forecasters, but that is very unlikely in light of their strongly held divergent views. Another option is to wait until the problem is obvious before taking action, particularly since there seem to be so many other public policy problems demanding immediate attention.

⁷⁷ Resource nationalism refers to countries appropriating oil fields developed by institutions based outside of their borders. Examples include Venezuela, Bolivia, Algeria, Ecuador, Russia, etc.

In the final analysis, peak oil presents the world with a risk management problem of tremendous complexity and enormity. From our earlier report:⁷⁸

It is possible that peaking may not occur for several decades, but it is also possible that peaking may occur in the near future. We are thus faced with a daunting risk management problem:

- *On the one hand, mitigation initiated soon would be premature if peaking is still several decades away.*
- *On the other hand, if peaking is imminent, failure to initiate mitigation quickly will have significant economic and social costs to the U.S. and the world.*

The two risks are asymmetric:

- *Mitigation actions initiated prematurely will be costly and could result in a poor use of resources.*
- *Late initiation of mitigation may result in severe consequences.*

Mitigation will require an intense effort over decades. This inescapable conclusion is based on the time required to replace vast numbers of liquid fuel consuming vehicles and the time required to build a substantial number of substitute fuel production facilities. Our scenarios analysis shows:

- *Waiting until world oil production peaks before taking crash program action would leave the world with a significant liquid fuel deficit for more than two decades.*
- *Initiating a mitigation crash program 10 years before world oil peaking helps considerably but still leaves a liquid fuels shortfall roughly a decade after the time that oil would have peaked.*
- *Initiating a mitigation crash program 20 years before peaking appears to offer the possibility of avoiding a world liquid fuels shortfall for the forecast period.*

⁷⁸ Hirsch, R.L., Bezdek, R., Wendling, R. Peaking of World Oil Production: Impacts, Mitigation & Risk Management. DOE NETL. February 2005.

The obvious conclusion ... is that with adequate, timely mitigation, the economic costs to the world can be minimized. If mitigation were to be too little, too late, world supply/demand balance will be achieved through massive demand destruction (shortages), which would translate to significant economic hardship.

There will be no quick fixes. Even crash programs will require more than a decade to yield substantial relief.

It is our sincere hope that readers will look beyond the conflicting forecasts and focus on the consequences of underestimating the enormity of the peak oil problem. Effective mitigation means taking decisive action well before the problem is obvious.