EIA's Short Answer Is:

Not Soon … But Within the Present Century.
### 36 Estimates of the Time of Peak World Oil Production (There Are More)

<table>
<thead>
<tr>
<th>Published</th>
<th>By</th>
<th>Peak Year/Range</th>
<th>Published</th>
<th>By</th>
<th>Peak Year/Range</th>
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<tbody>
<tr>
<td>1972</td>
<td>ESSO</td>
<td>About 2000</td>
<td>1999</td>
<td>Parker</td>
<td>2040</td>
</tr>
<tr>
<td>1972</td>
<td>UN</td>
<td>By 2000</td>
<td>2000</td>
<td>Bartlett</td>
<td>2004 or 2019</td>
</tr>
<tr>
<td>1976</td>
<td>UKDOE</td>
<td>About 2000</td>
<td>2000</td>
<td>EIA</td>
<td>2021-2167; 2037 most likely</td>
</tr>
<tr>
<td>1985</td>
<td>Bookout</td>
<td>2020</td>
<td>2002</td>
<td>Campbell</td>
<td>2010</td>
</tr>
<tr>
<td>1989</td>
<td>Campbell</td>
<td>1989</td>
<td>2002</td>
<td>Cavallo</td>
<td>2025-2028</td>
</tr>
<tr>
<td>1997</td>
<td>Ivanhoe</td>
<td>2010</td>
<td>2003</td>
<td>Lynch</td>
<td>No visible peak</td>
</tr>
<tr>
<td>1997</td>
<td>Edwards</td>
<td>2020</td>
<td>2003</td>
<td>Shell</td>
<td>After 2025</td>
</tr>
<tr>
<td>1999</td>
<td>Campbell</td>
<td>2010</td>
<td>2004</td>
<td>CERA</td>
<td>After 2020</td>
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</tbody>
</table>
World Oil Production 1900-2003 and EIA's Forecasts to 2025

2004 International Energy Outlook Forecasts

- High Economic Growth
- Reference Case
- Low Economic Growth
- History
Published Estimates of World Ultimate Recovery

Trillions of Barrels

- USGS 5% 2000
- USGS Mean 2000
- USGS 95% 2000
- Campbell 1995
- Masters 1994
- Campbell 1992
- Bookout 1989
- Masters 1987
- Martin 1984
- Nehring 1982
- Halbouty 1981
- Meyerhoff 1979
- Nehring 1978
- Nelson 1977
- Folinsbee 1976
- Adams & Kirby 1975
- Linden 1973
- Moody 1972
- Moody 1970
- Shell 1968
- Weeks 1959
- MacNaughton 1953
- Weeks 1948
- Pratt 1942

Trillions of Barrels
M. King Hubbert’s 1956 Prediction of Peak U.S. Oil Production

\begin{equation}
Q_d = \frac{170 \times 10^9}{1 + 6.17e^{-0.0667(t-1930)}}
\end{equation}

\begin{equation}
Q_p = \frac{170 \times 10^9}{1 + 6.17e^{-0.0667(t-1941)}}
\end{equation}

\begin{equation}
Q_r = Q_d - Q_p
\end{equation}

Cumulative discovery
Cumulative production lags 11 years
Proved reserves

Time (years):
0 1860 1880 1900 1920 1940 1960 1980 2000 2020 2040 2060

Billions of Barrels:
0 25 50 75 100 125 150 175
EIA's Long-Term World Oil Supply Modeling Scenarios for Conventional Crude Oils
(>10° API Gravity Or <10,000 cP Viscosity)

Three Pre-Peak Production Growth Rates:

1, 2, and 3 percent per year

Combined with Three USGS / MMS / EIA-Sourced Technically Recoverable Resource Base Levels:

2.793 trillion barrels (95% chance of that much or more)
3.338 trillion barrels (expected value; statistical mean)
3.947 trillion barrels (5% chance of that much or more)

To Yield Nine Model Projections Spanning the Plausible Range of Outcomes.

*The central scenario combines the 2-percent growth rate and the expected value resource base estimate.*
EIA's Model For Conventional Oil Resources
(>10° API and <10,000 cP Viscosity)

**Exponential Growth Phase**
Assumes a constant percentage increase in production per year until the peak year is reached.

**Peak Year**
Assumed to be reached when reserves-to-production ratio declines to 10.

**Decline Phase**
R/P Ratio held constant at 10, production declines with reserves base.

Area under curve = recoverable resource
Comparative Advantages of the EIA Model

Explicitly and quantitatively considers both supply and demand.

Relies on the USGS WPA2000 resource estimates. They reflect the most modern, thorough, and detailed study of world petroleum resources ever made.

Assumes (as does the USGS) that proved ultimate recovery grows over time outside the borders of the United States, albeit not in every field.

Does not assume symmetry of the growth and decline phases of the world production path. There is no science-based reason why these phases should be symmetrical for a closed world-wide system.

Explicitly recognizes the primary uncertainties and their plausible bounds.
Conventional Oil Resources, Central Scenario

USGS Based Estimate of Ultimate Recovery

Ultimate Recovery

Probability

BBls

Mean (expected value) 3,338

Peak Year 2044
Reached when production out of the mean estimate of the resource base reaches an R/P ratio of 10 on a 2 percent per year growth curve.

2 Percent Growth per Year

- History
- Mean

Billion Barrels per Year

1900 1925 1950 1975 2000 2025 2050 2075 2100 2125

120
100
80
60
40
20
0

 (>10° API and <10000 cP Viscosity)
Conventional Oil Resources, All Nine Scenarios

(>10° API and <10000 cP Viscosity)

USGS Based Estimates of Ultimate Recovery

<table>
<thead>
<tr>
<th>Probability</th>
<th>Ultimate Recovery BBls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (95 %)</td>
<td>2,793</td>
</tr>
<tr>
<td>Mean (expected value)</td>
<td>3,338</td>
</tr>
<tr>
<td>High (5 %)</td>
<td>3,947</td>
</tr>
</tbody>
</table>

Peak Range 37 yrs

2031  ->  2068

Peak Year of Mean Estimate 2044

3 Percent Growth per Year

2 Percent Growth per Year

1 Percent Growth per Year
## Summary Table For Conventional Oil Resources

*(>10° API and <10000 cP Viscosity)*

<table>
<thead>
<tr>
<th>Resource Base</th>
<th>Ultimate Recovery BBbls</th>
<th>Annual Demand Growth, %</th>
<th>Peak Year</th>
<th>Peak Rate, MMBbls/yr</th>
<th>Peak Rate, MMBbls/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (95%)</td>
<td>2,793</td>
<td>1.0</td>
<td>2046</td>
<td>38,932</td>
<td>107</td>
</tr>
<tr>
<td></td>
<td>2,793</td>
<td>2.0</td>
<td>2037</td>
<td>50,389</td>
<td>138</td>
</tr>
<tr>
<td></td>
<td>2,793</td>
<td>3.0</td>
<td>2031</td>
<td>58,841</td>
<td>161</td>
</tr>
<tr>
<td>Mean (expected value)</td>
<td>3,338</td>
<td>1.0</td>
<td>2057</td>
<td>43,424</td>
<td>119</td>
</tr>
<tr>
<td></td>
<td>3,338</td>
<td>2.0</td>
<td>2044</td>
<td>57,069</td>
<td>156</td>
</tr>
<tr>
<td></td>
<td>3,338</td>
<td>3.0</td>
<td>2036</td>
<td>66,795</td>
<td>183</td>
</tr>
<tr>
<td>High (5%)</td>
<td>3,947</td>
<td>1.0</td>
<td>2068</td>
<td>48,446</td>
<td>133</td>
</tr>
<tr>
<td></td>
<td>3,947</td>
<td>2.0</td>
<td>2050</td>
<td>64,355</td>
<td>176</td>
</tr>
<tr>
<td></td>
<td>3,947</td>
<td>3.0</td>
<td>2040</td>
<td>78,475</td>
<td>215</td>
</tr>
</tbody>
</table>
The World's Primary Additional "Oil" Resources

**Canadian Bitumen (Alberta; "tar sands")**
≈80 percent of the world's in-place bitumen (< 10° API)

**Venezuelan Extra-Heavy Oil (Orinoco Belt)**
≈90 percent of the world's in-place extra-heavy oil (> 10000 cP)

For both:

There's no finding risk (or cost).

Commercial production is happening (and accelerating).

The achievable recovery factors and the production costs are mostly technology-driven.

**Oil Shales**
A huge in-place kerogen resource … but the technology to economically produce large quantities of synthetic oil from them does not exist and is not likely to in the next few decades.
## Canadian Bitumen

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated In-Place Resource</td>
<td>2.372 trillion barrels</td>
</tr>
<tr>
<td>API Gravity</td>
<td>7.5-9.0 degrees</td>
</tr>
<tr>
<td>Viscosity</td>
<td>Up to 1,000,000 centipoise</td>
</tr>
<tr>
<td>Host Formation Characteristics</td>
<td>Porosity 31 to 35 percent</td>
</tr>
<tr>
<td></td>
<td>Permeability 2.5 to 5.0 Darcies</td>
</tr>
<tr>
<td>Resource Drawbacks</td>
<td>High metallics content</td>
</tr>
<tr>
<td>Extraction/Processing Drawbacks</td>
<td>High energy requirements (and associated CO2 emissions); large volumes of light hydrocarbon diluent and freshwater are required.</td>
</tr>
</tbody>
</table>
Canadian Tar Sands (Bitumen)
2.37 Trillion Barrels In-Place
1.42 Trillion Barrels Recoverable
(60 percent recovery factor estimated)

2003 World Oil Production
25 Billion Barrels

20078 Canadian Bitumen
Production Estimate
41 Billion Barrels

6% Growth
6% Decline

Recoverable Resource = 1.42 Trillion Barrels

History
6.1% Avg. Growth
## Venezuelan Extra-Heavy Oil

<table>
<thead>
<tr>
<th>Estimated In-Place Resource</th>
<th>1.36 trillion barrels</th>
</tr>
</thead>
<tbody>
<tr>
<td>API Gravity</td>
<td>8-10 degrees</td>
</tr>
<tr>
<td>Viscosity</td>
<td>10,000+ centipoise</td>
</tr>
<tr>
<td>Host Formation Characteristics</td>
<td>Porosity 30 to 36 percent</td>
</tr>
<tr>
<td></td>
<td>Permeability 1 to 17 Darcies</td>
</tr>
<tr>
<td>Resource Drawbacks</td>
<td>2.0-3.5 percent sulfur content</td>
</tr>
<tr>
<td></td>
<td>High metallics content</td>
</tr>
<tr>
<td>Extraction/Processing Drawbacks</td>
<td>Requires large volumes of light hydrocarbon diluent and/or fresh water (for Orimulsion).</td>
</tr>
</tbody>
</table>
EIA Model Results Including Canadian Bitumen
And Orinoco Extra-Heavy Oil Resources

USGS Based Estimates of Ultimate Recovery
Including Heavy Oil

Ultimate Recovery BBls

Mean + 2.239 TBbls.  5,577
Mean + 1.120 TBbls.  4,458

2% Growth

Decline R/P = 10

History
## Summary of EIA Model Results Including Canadian Bitumen And Orinoco Extra-Heavy Oil Resources

<table>
<thead>
<tr>
<th>Resource Base</th>
<th>Ultimate Recovery BBbls</th>
<th>Annual Demand Growth, %</th>
<th>Peak Year</th>
<th>Peak Rate, MMBbls/yr</th>
<th>Peak Rate, MMBbls/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean + 1.120 TBbls</td>
<td>4,458</td>
<td>1.0</td>
<td>2077</td>
<td>52,985</td>
<td>145</td>
</tr>
<tr>
<td>(30% recovery)</td>
<td>4,458</td>
<td>2.0</td>
<td>2055</td>
<td>71,053</td>
<td>195</td>
</tr>
<tr>
<td></td>
<td>4,458</td>
<td>3.0</td>
<td>2043</td>
<td>82,768</td>
<td>227</td>
</tr>
<tr>
<td>Mean + 2.239 TBbls</td>
<td>5,577</td>
<td>1.0</td>
<td>2094</td>
<td>62,750</td>
<td>172</td>
</tr>
<tr>
<td>(60% recovery)</td>
<td>5,577</td>
<td>2.0</td>
<td>2065</td>
<td>87,677</td>
<td>240</td>
</tr>
<tr>
<td></td>
<td>5,577</td>
<td>3.0</td>
<td>2049</td>
<td>98,829</td>
<td>271</td>
</tr>
</tbody>
</table>
The Other Half of the Economic Equation: Demand Reduction

2094 @ 1% Growth
2065 @ 2% Growth
2049 @ 3% Growth

Decline
R/P = 10

History
Conclusions, Interpretations, and Implications

A peak in world oil production is decades away ... not years away.

Geopolitical factors may cause plateaus or even declines for considerable periods of time.

Oil production growth rates of 1 to 3 percent per year will not soon be constrained by the size of the technically recoverable resource base, particularly when extra-heavy oil and bitumen resources are included.

Primarily it's the size of the technically recoverable resource base that determines the peak year. Reasonable long term world oil supply models use the best available resource base estimates and include all economically producible petroleum resources.

However, complacency about both supply and demand side energy research, development, and analysis is risky given the involved scientific and technical challenges and the long lead times needed for significant market penetration of new energy technologies.