Global Petroleum Supply and Pricing: Is the World Really Running Out of Oil?

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Presentation Outline

- Introduction
  - Two Classic Schools of Thought Debate
    - Is the petroleum era about to end?

- Global Oil Resources and Supply Outlook
  - Reserve growth & capacity expansion
  - E&P industry performance Indicators

- Future Global Oil Supply and Pricing Outlook
  - What are the major determinants?
  - Understanding the role of the key players

- Concluding Remarks
Presentation Objectives

- Discuss the two schools of thought on the physical limit of petroleum availability.
- Analyze E&P industry performance indicators with respect to global supply sustainability.
- Evaluate how global E&P key players influence petroleum supply & pricing outlook.
- Demonstrate that the world is awash with oil and that it is conjectural to suggest otherwise in the nearest future.
Petroleum Resource Availability Fundamentals:

--- The Underlying Issues in the debate are... 

- **Resources**—the stock of oil deemed extractable in an undefined future.
- **Reserves**—resources presumed recoverable under currently known technology, operating, and economic conditions.
- **Production capacity**—a measure of the sustainable flow of petroleum as a result of discovery, investment, and infrastructures installed.
Schematic of Petroleum Resource Taxonomy

- **Production**:
  - Reserves
    - 1P: Proved
    - 2P: Probable
    - 3P: Possible
  - Contingent Resources
    - 1C
    - 2C
    - 3C
- **Total Petroleum Initially-In-Place (PIP)**
- **Discovered PIP**
- **Undiscovered PIP**

Increasing Chance of Commerciality

Range of Uncertainty

Not to scale
Conventional Oil Resources: Size & Locations

Mean Estimates, 3,577 Billion Barrels (IEA, 2008)

<table>
<thead>
<tr>
<th>Region</th>
<th>Initial Reserves</th>
<th>Reserves Growth</th>
<th>Undiscovered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>206</td>
<td>40</td>
<td>85</td>
</tr>
<tr>
<td>Asia Pacific</td>
<td>147</td>
<td>22</td>
<td>40</td>
</tr>
<tr>
<td>EU &amp; Eurasia</td>
<td>433</td>
<td>70</td>
<td>220</td>
</tr>
<tr>
<td>Latin America</td>
<td>229</td>
<td>44</td>
<td>108</td>
</tr>
<tr>
<td>Middle East</td>
<td>986</td>
<td>204</td>
<td>257</td>
</tr>
<tr>
<td>North America</td>
<td>368</td>
<td>22</td>
<td>95</td>
</tr>
</tbody>
</table>
Conventional Oil Resources: Distribution by Geographic Region?

Above Ground Reserves, 1.1 Trillion Barrels

- Middle East: 40%
- North America: 14%
- Europe & Eurasia: 20%
- South & Central America: 11%
- Africa: 9%
- Asia Pacific: 6%

Mean Estimates, 3,577 Billion Barrels (IEA, 2008)
Conventional Oil Reserves: Countries with Largest Reserves (www.wikipedia.com)

Above Ground Reserves, 1.1 Trillion Barrels (IEA 2008)

COUNTRIES WITH LARGEST OIL RESERVES
## Conventional Oil Reserves: Top 10 Countries as of January 1, 2008

<table>
<thead>
<tr>
<th>Country</th>
<th>Reserves (bbl)</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>20,970,000,000</td>
<td>1.54%</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>266,800,000,000</td>
<td>19.66%</td>
</tr>
<tr>
<td>Canada</td>
<td>178,600,000,000</td>
<td>13.16%</td>
</tr>
<tr>
<td>Iran</td>
<td>140,000,000,000+</td>
<td>10.20%</td>
</tr>
<tr>
<td>Iraq</td>
<td>115,000,000,000</td>
<td>8.47%</td>
</tr>
<tr>
<td>Kuwait</td>
<td>104,000,000,000</td>
<td>7.66%</td>
</tr>
<tr>
<td>United Arab Emirate</td>
<td>97,800,000,000</td>
<td>7.21%</td>
</tr>
<tr>
<td>Venezuela</td>
<td>87,040,000,000</td>
<td>6.41%</td>
</tr>
<tr>
<td>Russia</td>
<td>79,000,000,000</td>
<td>5.82%</td>
</tr>
<tr>
<td>Libya</td>
<td>41,460,000,000</td>
<td>3.05%</td>
</tr>
<tr>
<td>Nigeria</td>
<td>36,220,000,000</td>
<td>2.67%</td>
</tr>
</tbody>
</table>
Global Oil Resources and Supply Outlook: Pessimistic School of Thought—There is a Wolf at the Door!

- Resources are fixed, capacity growth cannot meet future demand growth, and supply outlook is bleak.

- Hubbert modeling framework (HMF) underlies the resource stock and flow pessimism.

- Global oil production has peaked or will peak soon and shortages are bound to occur.

- The end of the era of petroleum as the driver of the global economy is in the nearest and not the distant future.
Global Oil Resources and Supply Outlook: Pessimistic School of Thought—Hubbert 1956 Original Model

- Proven reserves: $250 \times 10^9$ bbls
- Cumulative production: $90 \times 10^9$ bbls
- Future discoveries: $910 \times 10^9$ bbls
We have been told before that the end of the petroleum era is here!

<table>
<thead>
<tr>
<th>Date of Forecast</th>
<th>Source</th>
<th>Forecast Date of Conventional Peak</th>
<th>Assumed Ultimate* Billion Barrels</th>
</tr>
</thead>
<tbody>
<tr>
<td>1972</td>
<td>ESSO</td>
<td>&quot;Oil to become increasingly scarce from about the year 2000.&quot;</td>
<td>2100</td>
</tr>
<tr>
<td>1972</td>
<td>Report for the UN Con. On Human Environment</td>
<td>&quot;Likely that peak production will have been reached by the year 2000.&quot;</td>
<td>2500</td>
</tr>
<tr>
<td>1977</td>
<td>Ehrlich et al.</td>
<td>Peak: 2000</td>
<td>1900</td>
</tr>
<tr>
<td>1981</td>
<td>World Bank</td>
<td>&quot;..plateau around the turn of the century.&quot;</td>
<td>1900</td>
</tr>
<tr>
<td>1995</td>
<td>Petroconsultants</td>
<td>Peak: 2005</td>
<td>1800</td>
</tr>
<tr>
<td>1997</td>
<td>Edwards</td>
<td>Peak: 2020</td>
<td>2836</td>
</tr>
<tr>
<td>1999</td>
<td>Campbell</td>
<td>Peak: ~2010</td>
<td>2000</td>
</tr>
<tr>
<td>2000</td>
<td>Bartlett</td>
<td>Peak: 2004, or 2019</td>
<td>2000, or 3000</td>
</tr>
<tr>
<td>2000</td>
<td>US EIA</td>
<td>Peak: 2016-2037</td>
<td>3003 (from USGS)</td>
</tr>
<tr>
<td>2002</td>
<td>Smith</td>
<td>Peak: 2011-2016</td>
<td>2180</td>
</tr>
</tbody>
</table>

Source: www.oildepletion.org
Worldwide Reserves & Extraction - Regional Trends: Evidence suggests, if there is a Wolf, it is not at the door ...!
Proportion of Recoverable Reserves Extracted Since 1970: the end of petroleum era is no way near!

<table>
<thead>
<tr>
<th>Year</th>
<th>North America</th>
<th>S. &amp; Cent. America</th>
<th>Europe &amp; Eurasia</th>
<th>Middle East</th>
<th>Africa</th>
<th>Asia Pacific</th>
<th>World</th>
</tr>
</thead>
<tbody>
<tr>
<td>1979</td>
<td>41.30%</td>
<td>37.67%</td>
<td>30.51%</td>
<td>16.76%</td>
<td>27.54%</td>
<td>25.58%</td>
<td>24.73%</td>
</tr>
<tr>
<td>1989</td>
<td>50.87%</td>
<td>29.57%</td>
<td>54.49%</td>
<td>15.85%</td>
<td>41.28%</td>
<td>49.60%</td>
<td>30.00%</td>
</tr>
<tr>
<td>1999</td>
<td>68.68%</td>
<td>33.75%</td>
<td>57.27%</td>
<td>22.65%</td>
<td>44.48%</td>
<td>58.90%</td>
<td>38.45%</td>
</tr>
<tr>
<td>2008</td>
<td>73.60%</td>
<td>36.88%</td>
<td>59.34%</td>
<td>26.87%</td>
<td>43.77%</td>
<td>67.40%</td>
<td>42.74%</td>
</tr>
</tbody>
</table>
Global Oil Resources and Supply Outlook:
Trends since 1970 show reserves growth despite rising extraction…

World Oil Reserves, 1970-2008

World Oil Extraction, 1970-2008
Global Oil Resources and Supply Outlook: Optimistic School of Thought – Research & Development Matter

- Recoverable resource growth is assured but the extent of the size of growth may be imprecise.
- Technology does not just hasten or enhance extraction from existing resources but it equally facilitates growth in reserves.
- Economics and fiscal policy do affect resource discovery and production, just as geology does.
- HMF though statistically robust for describing the U.S. pre Alaska peak in the 1970s, is not significantly scientific to explain the global depletion process completely.
Periodic Worldwide Reserves Added & Extracted: More Reserves Added than Extracted Since 1970

- Reserves added
- Reserves extracted

### Periodic Worldwide Reserves Added & Extracted:

<table>
<thead>
<tr>
<th>Period</th>
<th>Reserves Added</th>
<th>Reserves Extracted</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970-1979</td>
<td>222</td>
<td>211</td>
</tr>
<tr>
<td>1980-1989</td>
<td>582</td>
<td>219</td>
</tr>
<tr>
<td>1990-1999</td>
<td>336</td>
<td>250</td>
</tr>
<tr>
<td>2000-2008</td>
<td>427</td>
<td>258</td>
</tr>
</tbody>
</table>

**Note:** The graph represents the comparison of reserves added and extracted over the specified periods. The data shows that more reserves were added than extracted since 1970.
Global Oil Resources and Supply Outlook:
Is depletion since 1970 faster than expansion...?

Annual Depletion & Growth Rates

- **World**: 0.027 (Depletion) 0.034 (Growth)
- **Asia Pacific**: 0.014 (Depletion) 0.036 (Growth)
- **Africa**: 0.034 (Depletion) 0.063 (Growth)
- **Middle East**: 0.030 (Depletion) 0.053 (Growth)
- **Europe & Eurasia**: 0.033 (Depletion) 0.059 (Growth)
- **S. & Cent. America**: 0.035 (Depletion) 0.071 (Growth)
- **North America**: 0.043 (Depletion) 0.059 (Growth)

- **Annual Depletion & Growth Rates**
Global Oil Resources and Supply Outlook:
Is the World Replacing Extracted Reserves Adequately?

- High replacement rate delays imminent exhaustion of petroleum resources.

- Reflects the robust state of the global exploration and production (E&P) business.

- Supports sustainability of E&P business in several producing regions.
Global Oil Resources and Supply Outlook:
Is Estimated Proved Reserves Adequate to Sustain Projected Demand Growth?

- Periodic Reserves-production (R-P) ratio:
  - Shows less tightness in oil market over space and time.
  - But, is a low R-P preferred to a high R-P?
- Global average R-P was above 30 years in the 1970s.
  - It’s above 40 years currently.
Global Oil Resources and Supply Outlook: Is Estimated Proved Reserves Adequate to Sustain Projected Demand Growth?


- R-P shows verifiable sustainability of reserves at moderate growth in extraction rate.

- Worldwide sustainability premium is about 15 years in comparison to the 1970s.
Future Global Oil Supply & Pricing Outlook: The Role of the Market Systems

- Physical market fundamentals:
  - Non OPEC supply responsiveness
  - Energy demand in the emerging economies
  - Access to petroleum resources
  - Investment constraints
  - Technological innovation
- Paper market conduct:
  - Exploitation of oil market volatility by commodity traders.
  - The laws of unintended consequences.
Future Global Oil Supply & Pricing: Role of Research & Development

- Technology facilitates generational equity issues.
- Reserve growth and production enhancement.
- Limits rapid increase in price growth at lower than the rate of interest.
  - Finding and development costs are expected to decrease, ceteris paribus.
  - The rate of increase in marginal extraction cost will fall and hence price falls, ceteris paribus.
Future Global Oil Supply & Pricing: Role of International Oil Companies (IOCs)

- Return on investments: is long-run preferred to short-run?
- Restructuring mood to promote efficiency, but must keep in perspective equity, effectiveness, and ethical issues.
- Grow inventories of oil reserves to sustain business outlook.
- Curtail finding costs drifting upward through discovery surprises and technical progress.
- Direct E&P investment flow to where resources are abundantly located with significant cost advantage.
  - Inevitability of IOC, OFS & NOC partnership.
Diversification of supply sources and strategic petroleum reserves/inventory as a policy strategy

Energy policy objectives to promote easy access to cheap, clean and secure energy worldwide.

Lift the ban or restricted access to resources to minimize supply uncertainty and hence global oil pricing.

Make environmental policies pragmatic and keep in perspective any unintended consequences of barrier to access available petroleum resources.
Future Global Oil Supply & Pricing: the Role of OPEC & National Oil Companies (NOCs)

- OPEC’s objective to maximize the intergenerational social well being of their citizens will influence global oil supply decisions.
- Rate of reinvestment in production capacity and level of spare capacity are important features to watch.
- Depletion policies in OPEC countries extremely critical to investment flows.
- IOC, OFS, & NOC partnership is inevitable for market stability.
  - IOC & OFS own E&P technology, significant access to funds, and experience.
  - NOCs have ownership of significant resources but limited technology and access to skilled workers and funding.
Summary and Conclusions

- The idea of a geologically induced end to the petroleum era worldwide is not about to happen.
  - Over 150 percent of worldwide produced conventional oil reserves was replaced over the last 38 years in the aggregate.
  - Global reserves production ratio remains above 35 years over the last 25+ years despite extraction growth.
  - There is a premium of about 15 years over where the global petroleum status was in 1970.
- The conventional wisdom is that technology has not peaked and the intelligence of human mind remains astounding.
- The path to IOC, NOC and OFS partnership is less fuzzy than in the past, making the imminent end to the petroleum era quite nebulous.
Summary and Conclusions

- Perhaps, we may be running out of subsidized petroleum not because of geological exhaustibility but:
  - Restricted easy access to global petroleum resources.
  - Limited capital investment flow to resource rich nations because of uncertainty and insecurity of investment.
  - E&P industry restructuring driven possibly by short term planning horizon and performance priority.
  - The “law of unintended consequences” that tends to make the call for transparency in crude commodity market trading, touchy!
Global Petroleum Supply and Pricing: Is the World Really Running Out of Oil?

Thank you for your Attention!