The Future of Oil

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It’s a Fossil-Fueled World

BP Statistical Review 2008
Crude Oil Price

The Future?

1. Production and reserves. How much oil is there, and how long will it last?
2. Technology. How can we produce more of the oil in place?
3. Manpower. Who will work on these problems?
1. Production and Reserves

- How much do we have?
- How long will it last?

- Peak oil
- Business as usual

Peak Oil

Peak Oil

World, outside of swing producers - Saudi Arabia, Kuwait, Iran, Iraq, UAE

Peak Oil

World, excluding extra-heavy oil


World Proven Oil Reserves

- Oil and Oil Sands
- Alberta oil sands added
- OPEC restates reserves

Technical vs. Political Reserves

- Including tarsands +175 Gb
- OPEC fight for quotas +300 Gb
- Technical = 2P = proven + probable: backdated mean excluding extra-heavy
- Political = 1P = current proved

World Oil (+NGL) Production


World Oil (+NGL) Production

EIA and BP Statistical Review 2008

11

12
World Oil (+NGL) Production

How Good Are Forecasts?

2. Technology

- The “third trillion”:
  - (a) Discovering the undiscovered.
  - (b) Producing the unproductive.
  - (c) Unconventional sources.
- New discoveries.
- Enhanced oil recovery (EOR).
- Oil sands and oil shale.
(a) World Oil Reserves and Resources

![Graph showing world oil reserves and resources](image)

International Energy Agency, Resources to Reserves 2005
© OECD/IEA, 2005: Figure ES1, page 17, used with permission.

World Oil Production by Source

![Graph showing world oil production by source](image)

International Energy Agency, Resources to Reserves 2005
© OECD/IEA, 2005: Figure 2.1, page 41, used with permission.
**Top World Oil Producers, 2006** (thousand barrels per day)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>Production (thousand barrels per day)</th>
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<tbody>
<tr>
<td>1</td>
<td>Saudi Arabia</td>
<td>10,665</td>
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<tr>
<td>2</td>
<td>Russia</td>
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<td>Iraq</td>
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</tbody>
</table>

Source: EIA
Saudi Arabia Oil Production

Source: EIA June 2008 International Petroleum Monthly

Working Harder to Find Oil

Stuart Staniford, March 2, 2007 http://www.theoildrum.com
Effectiveness of Wildcat Drilling

Total Upstream Costs per Barrel

Notes: Costs are the quotient of costs and reserve additions for each three-year period. BOE = Barrels of oil equivalent.
Source: Energy Information Administration, Form EIA-339 (Financial Reporting System)

http://www.eia.doe.gov/neic/infosheets/crudeproduction.html

(b) Enhanced Oil Recovery

- Increasing recovery factor by recovering left-behind oil.
- 10% of US oil production for more than 10 years.
  - Thermal methods.
  - CO₂ methods.
  - Chemical methods.
Recovery Factor

Thermal Enhanced Oil Recovery


http://www.ccop.or.th/ppm/document/INWS4/INWS4DOC02a_Indonesia_Abdul_Muin.pdf
CO₂ Enhanced Oil Recovery

- US since 1980.
- 80 projects.
- > 230,000 b/d
- Sequestration too.

http://www.encana.com/operations/canada/weyburn/index.htm

ASP Enhanced Oil Recovery

Alkaline Surfactant Polymer (ASP)

Additional 20% of STOOIP

(c) Oil Sands

http://ostseis.anl.gov/guide/photos/index.cfm

www.energy.gov.ab.ca/OilSands/pdfs
Oil Sands

http://ostseis.anl.gov/guide/photos/index.cfm

Portion of a Large-Scale Commercial Tar Sands Processing Plant near Fort McMurray, Alberta, Canada (Image courtesy of Suncor Energy, Inc.)

Oil Sands - SAGD

www.opticanada.com/technology/bitumen_extraction/
Oil Sands - SAGD

http://www.longlake.ca/project/photo_gallery.asp

Oil Sands – Gas Consumption

• 2004 consumption 0.7 Bcf/d (Canada 7.7 Bcf/d).
• Producing 142 Gb of oil would need 200 Tcf of gas (Canada total reserves = 58 Tcf).
• 2006 carbon emissions = 45 Mt/year.
• Water and environmental concerns.

Söderbergh et al. (2007)

US imports 8.2 Bcf/d 2006 (14% of US consumption)

IEA World Energy Outlook 2006

30 Bcm/y = 2.9 Bcf/d (~1 Tcf/y)
3. Manpower and Womanpower

• Who will do the work?
Age Distribution
3.5 The More Distant Future

- Peak oil
- Peak gas
- Peak coal
- Peak uranium

- Ultimately, the fossil-fuel era will end, and the world must operate on renewable energy sources.
Futures for Graduates

• Develop skills in fundamentals.
• Foreign language skills allow mobility.
• Flexibility to address new problems.
• **Petroleum engineers today will be energy engineers in the future.**

Conclusions

• “Easy” oil has been consumed.
• Plenty of “difficult” oil still, but demand will soon surpass supply.
• Technologies to improve recovery require advanced skills.
• Shortages of professionals in many places.
• Excellent opportunities for young people to enter professional careers with large challenges, great responsibility and substantial rewards.