Global Hydrocarbon Reserves

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WORLD GLOBAL ENERGY SUPPLY

Source – International Energy Agency
World oil production by source in million barrels per day

Source: WEO-2004, IEA.
RESERVE ESTIMATION

History:

• 1920  US Geological Survey announced peak oil
• 1939  US Department of Interior: Oil reserves for 13 more years
• 1972  Club of Rome: Limits of growth
• 1977  US President Jimmy Carter: „We are running out of oil

• Reserves = f ( Price, world economics, availability, cost, salaries, technical or fiscal measures, political boundaries, speculations etc.)
Reserves:

Reserves are the estimated quantities of hydrocarbons that are claimed to be recoverable under existing economic and operating conditions. The total estimated amount of hydrocarbons in an reservoir, including both producible and non-producible hydrocarbons, is called oil/gas in place.

Resources:

Resources are those quantities of hydrocarbons estimated, as of a given date, to be potentially recoverable from accumulations, but the applied project(s) are not yet considered mature enough for commercial development.
Oil Recovery Factors:

1979: 20%
2000: 35%
> 2000: 50%

Average increase of the RF: 0.2 – 1% / year
1% Increase = Annual consumption
IEA “Resources to Reserves” 2005

Available oil in Billion Barrels

- Already Produced
- OPEC ME
- Other Conv.
- EOR
- Heavy oil Bitumen
- Oil Shales
- Deep Water
- Super Deep

Economic price 2004 US $

- WEO required Cumulative 2030
- Arctic

WORLD GLOBAL ENERGY SUPPLY
LARGEST OIL RESERVES

World Proved Oil Reserves by Geographic Region as of January 1, 2007

- Middle East: 739 Billion Barrels
- North America: 213 Billion Barrels
- Africa: 114 Billion Barrels
- Central and South America: 103 Billion Barrels
- Europe: 100 Billion Barrels
- Asia: 33 Billion Barrels
- World Total: 1,317 Billion Barrels

World proven reserves of natural gas in trillion cubic metres

World total: 180 tcm as of 1 January 2004

Source: WEO-2004, IEA.
OIL AND GAS RESERVES

Years

Oil

Gas
WORLD OIL SPARE CAPACITY

Source – International Energy Agency; SWP
FROM A WOODEN PIPELINE ....

Photo courtesy of S.T. Peas, Meadville, PA, USA, with thanks to Syracuse University and Onondaga Historical Society, Syracuse, NY, USA.
IMPACT OF TECHNOLOGY ON NORTH SEA PRODUCTION

Source: European Network for Research in Geo-Energy - ENeRG - courtesy of Shell.
CONVENTIONAL vs. EXPANDABLE TECHNOLOGY

MonoDiameter Well Plan

- 14" Riser
- 12" BOP
- 11¾" Casing
- Drive Pipe
- 9¾" SET
- 9¾" SET
- 9¾" SET
- 9¾" SET
- 9¾" SET
- 9½ at TD

MonoDiameter

Casing sizes:
- 36 inches
- 26 inches
- 20 inches
- 16 inches
- 13¾ inches
- 11¾ inches
- 9¾ inches
- 7½ inches
- 5½-inches tubing

Courtesy of Schlumberger.
Sketch of casing (blue) being expanded by an expanding tool pulled from bottom to top
EVOLUTION OF DEEPWATER TECHNOLOGY

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<thead>
<tr>
<th>Year</th>
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<tr>
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Courtesy of Shell.
FUTURE OIL AND GAS DEEPWATER POTENTIAL UN THE WORLD

150-200 billion boe estimated resource potential
80 billion boe discovered
20 billion boe on production
7 billion boe produced

“Mature” DW Basins
Developing DW Basins

Source: Wood Mackenzie; courtesy of Shell.
EVOLUTION OF DRILLING TECHNOLOGY

- Vertical wells
- Deviated wells
- Horizontal wells
3D SEISMIC
Water, in blue, has swept out the oil but left some channels still containing oil (high concentration in yellow and red, lower concentration in green). The oil may have been left behind because, for example, the channels have lower permeability.

This illustration, not based on factual data, is reproduced from Yeten 2002, courtesy of Fikri Kuchuk, Schlumberger.
HEAVY OIL
Reproduced with kind permission from the Energy Institute, originally published in Modern Petroleum Technology (www.energyinstpubs.org.uk), with thanks also to Maurice Dusseault, University of Waterloo, Canada, for pointing out this figure.
United States coal bed methane resources - 20 trillion cubic metres

Figure 4.2

Courtesy of Gas Technology Institute, United States.
The distribution of oil shales totals 1,060 billion barrels of recoverable oil.

- USA: 620 Bbbl
- Brazil: 300
- Russia: 40
- Congo: 40
- Australia: 15
- Canada: 15
- Europe: 15
- China: 10
- Rest of the World: 5

*After Encyclopaedia Britannica 2005.*
GAS HYDRATES

*Hydrates existence domain as a function of pressure and temperature*

*Courtesy of S. Dalimore, National Resources Canada.*
MAP OF CONFIRMED METHANE HYDRATE PRESENCE

Courtesy of S. Dallimore, National Resources Canada.
Based on USGS and IEA data.
CRUDE OIL IMPORT AUSTRIA 2007

Import: 7.60 Mio to
Domestic: 0.85 Mio to
Total: 8.45 Mio to
NATURAL GAS IMPORT 2006

Import: 7.0 Mrd. Nm³
Domestic: 1.8 Mrd. Nm³
Total: 8.8 Mrd. Nm³

- Russia: 71.0%
- Norway: 6.0%
- Germany: 5.0%
- Domestic: 18.0%
GAS FROM RUSSIA FOR EU – 2008

Gas pipelines
- existing
- Under construction

Liquefied Natural Gas Terminal
- existing
- under construction

Stand: 2008
Oil flows and major chokepoints, 2003

Source: WEO-2004, IEA.

- US Refinery Bottlenecks
- US Hurricanes
- Venezuela Resource Nationalism
- Iraq: Sabotage
- Iran Nuclear Ambition
- Russia Policy
- China Demand Increase
- Nigeria Civil Unrest
- Indonesia LNG Exports
- Strait of Malacca Piracy
More than 50% of the work force will leave the Industry within 10 years.

.... and then it gets awfully quiet.
CONCLUSION

- The problems with hydrocarbons is nowadays rather capacity than reserves.

- Geopolitical development is the highest risk for security of supply with hydrocarbons.

- European security of supply with fossil energy is a big issue.

- Lack of skilled engineers and geoscientists (outrunning on resources).

- High potential in usage of new technologies to increase the recovery factor.