Kjell Aleklett

Global Energy Systems, Uppsala University, Sweden
Kjell.aleklett@fysast.uu.se, www.fysast.uu.se/ges

President of ASPO International
www.peakoil.net

Blog: aleklett.wordpress.com

December 16, 2010
Perth, Australia
“A World Addicted to Oil”

“Australians are boozing more than ever – at least 10.2 litres a year each – placing the nation among some of the world’s heaviest drinkers.”

But this Australian is drinking oil !!!
How much energy is bound in oil?

100 ml of oil contains 1 kWh

What can you do with 1 kWh?

You can move a small car to the top of the Eiffel Tower!

A day’s work for a man is 0.5 kWh

Filling you car with 50 liter is equal to the energy you need to move 500 cars to top of the Tower

or having 1000 slaves pushing your car.
50 liter gasoline is equal to the work of 1000 persons during one day.
"The term Peak Oil refers the maximum rate of the production of oil in any area under consideration, recognizing that it is a finite natural resource, subject to depletion."
The Historical “Peak Oil” Endgame

Oct 23rd 2003
Leaders from The Economist printed edition

The end of the Oil Age

On a time scale starting at year 0 and ending 4000 years later everyone agree that there will be a peak in the oil production between 2000 and 2100.
When was oil produced?
Filling the global barrel
US Lower 48, the states below Canada
Peak Oil in Australia

Source: Peak oil & the advent of demand destruction, Zeibots & Bell, Australian Planner, December 2010, (forthcoming)
Guards of the future
WEO 2008 was released on November 12th. On page 51 the IEA states that

“the results of these analyses [prospects for oil and gas production] are intended to provide policy makers, investors and end users with a rigorous quantitative framework for assessing likely future trends in energy markets”.

Giant oil field decline rates and their influence on world oil production

Mikael Höök¹,*, Robert Hirsch², Kjell Aleklett³
Depletion rate of remaining recoverable reserves

$$d_{\delta t} = \frac{q_t}{(R_0 - Q_t)}$$

$d_{\delta t}$ = depletion rate of remaining reserves, $q_t$ = production at time $t$, $R_0$ = Initially present reserves or ultimate recoverable resources, and $Q_t$ = Cumulative up to time $t$. 

[Graph showing depletion rate behavior in the North Sea with a peak in 2000.]
New field developments in WEO 2008

Production from New Field Developments in WEO 2008 Reference Scenario

- OPEC Onshore
- OPEC Offshore
- Non-OPEC onshore
- Non-OPEC Offshore
Depletion ($d_\delta$) for fields to be developed in WEO 2008
Production for fields to be developed with physical depletion ($d_\delta$) limits

Realistic Production Outlook from New Field Developments

- Annual production [Mb/d]
- Years: 2005 to 2030
- Categories: OPEC Land, OPEC Offshore, Non-OPEC Land, Non-OPEC Offshore, IEA Forecast
Historical crude oil discovery
114 billion barrels is OK

2010 -2030:
121 bb (WEO 114 bb)
Production from Yet-to-find fields in WEO 2008, economical limits

IEA production forecast for yet-to-find fields

- Daily production [Mb/d]
- Year: 2005 to 2030
- OPEC Onshore
- OPEC Offshore
- Non-OPEC Onshore
- Non-OPEC Offshore
Depletion ($d_\delta$) for fields Yet-To-Find in WEO 2008

Production WEO2008: 19 Mb/d
Our production in 2030: 9 Mb/d
IEA - World Energy Outlook, 2008

- Natural gas liquids
- Non-conventional oil
- Crude oil - additional EOR
- Crude oil - fields yet to be found
- Crude oil - fields yet to be developed
- Crude oil - currently producing fields
Oil sands and crude oil

[Saudi Arabia, Iran, Iraq, United Arab Emirates, Kuwait, Venezuela, Russia, Libya, Nigeria, U.S., Canada’s Oil Sands]
Oil from oil sands in Canada, (Energy Policy, 2007)
NGL – Natural Gas liquids

WEO 2008: NGL is a fraction of natural gas production - OK
WEO 2008: Natural gas production will increase by 47% - OK for this work
WEO 2008: NGL production will increase by 90% - not OK, should be 47%
WEO 2008: NGL given as barrels and not as oil equivalents
K. Aleklett, M. Höök, K. Jakobsson, M. Lardelli, S. Snowden, B. Söderbergh

The Peak of the Oil Age
- analyzing the world oil production Reference Scenario in World Energy Outlook 2008,
Published in: Energy Policy, Volume 38, Issue 3, March 2010, Pages 1398-1414
K. Aleklett, M. Höök, K. Jakobsson, M. Lardelli, S. Snowden, B. Söderbergh

The Peak of the Oil Age
- analyzing the world oil production Reference Scenario in World Energy Outlook 2008,
Published in: Energy Policy, Volume 38, Issue 3, March 2010, Pages 1398-1414
Risks – Import and Export of Oil

Import of oil
- USA
- Japan
- China
- Germany
- South Korea
- France
- India
- Italy
- Spain
- Netherlands
- Taiwan
- Singapore
- Belgium & Lux.
- Thailand
- Turkey
- South Africa
- Poland
- Greece
- Pakistan
- Australia

Export of oil
- Saudi Arabia
- Russian Fed.
- Norway
- Nigeria
- UAE
- Kuwait
- Iran
- Iraq
- Mexico
- Algeria
- Libya
- Angola
- Kazakhstan
- Qatar
- Canada
- Oman
- Syria
- Yemen
- Vietnam

2005
Peak Oil in Australia

Source: Peak oil & the advent of demand destruction, Zeibots & Bell, Australian Planner, December 2010, (forthcoming)
The Peak Oil End Game in USA

By 2030 the likely production in USA will be 2 million barrels per year.
The Peak Oil End Game in USA

By 2030 the likely production in USA will be 2 million barrels per year.
Future imports in the USA and China
The world needs to increase the import with 30 Mbpd by 2030 - from 48 Mbpd to 78 Mbpd
Figure 7.10: Production from the Orinoco belt in million barrels per day (Mbpd), both historic and a forecast up to 2030. Note it is only the Hamaca, Cerro Negro, Petrozueta and Sincor that is actually on production.
Oil produktion in SSA
The Norwegian Oil End Game

A field by field analysis with maximum discovery potential. As Norway uses 0.2 Mbpd the export in 2030 will be around 0.2 Mbpd
Future export of oil from Russia

Figure 38. Mean export comparison between the reference policy and the alternative policy for 70, 120 and 170 Gb oil left estimates.

We cannot count on more then 3 Mbd in export from Russia in year 2030.
Future oil production in Saudi Arabia

Reported reserves (2p), Developed reserves (1P) and Cumulative production for Saudi Arabia

Extrapolated curves are for 17.5, 12.0, 10.0 respectively 7.7 Mbpd
Exports + and – in 2030

Export of oil

Million barrels per day (mbpd)

- Saudi Arabia
- Russian Fed.
- Norway
- Nigeria
- Venezuela
- Iran
- UAE
- Kuwait
- Iraq
- Mexico
- Algeria
- Libya
- Angola
- Kazakhstan
- Qatar
- Canada
- Oman
- Syria
- Yemen
- Vietnam

2005
What does it mean for Australia and WA?
Australia’s oil supply shortfall - an increasing financial burden

Source: Peak oil & the advent of demand destruction, Zeibots & Bell, Australian Planner, December 2010, (forthcoming)
Transport Fuels from Oil

Distribution of world refinery production by product in 2006

- Tonnage
- Percentage

<table>
<thead>
<tr>
<th>Product</th>
<th>Million Tones</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPG, Ethane, Naphtha</td>
<td>300</td>
<td>10%</td>
</tr>
<tr>
<td>Motor gasoline</td>
<td>600</td>
<td>20%</td>
</tr>
<tr>
<td>Aviation fuel</td>
<td>150</td>
<td>5%</td>
</tr>
<tr>
<td>Middle distillates</td>
<td>1200</td>
<td>35%</td>
</tr>
<tr>
<td>Heavy fuel oil</td>
<td>600</td>
<td>20%</td>
</tr>
<tr>
<td>Other products</td>
<td>400</td>
<td>13%</td>
</tr>
</tbody>
</table>
“Business as Usual” for the Aviation Industry
Future Aviation Fuel Demand and Production

Aviation fuel demand, 3% growth, and 3 supply scenarios

Aviation fuel and future oil production scenarios, Emma Nygren, Kjell Aleklett, Mikael Höök, Accepted by Energy Policy
Oil fields in Iraq
Oil fields in Iraq

Let us squeeze in 100 Gb of oil into one bottle of Champagne.
"We are drinking oil!"

If 100 Gb of oil is squeezed into one bottle of Champagne we have spent 11 bottles.
The global reserve of crude oil is 8 bottles of Champagne
Where to find the crude oil or the 8 bottles of Champagne
The global consumption per year is 30 billion barrels of oil.

One bottle of Champagne is equal to the consumption in three years and four months.
The USA is addicted to oil

President Bush, Capitol Hill, 2006: “We have a serious problem. America is addicted to oil”

From the beginning the nature had put two bottles in the ground in USA. They are just now sipping on the last glass.
The global reserve of crude oil is 8 bottles of Champagne.

We will discover three more bottles of Champagne.

We also have three more bottles “sparkling wine” in Canada and Venezuela.
The global reserve of crude oil is 8 bottles of Champagne

We have in total 10 bottles (8+2) to empty and 3 more to find, in total 13 bottles. If it takes 3 1/3 years to empty one bottle everyone should be aware of that the party is over and that we need to sobering up!
And therefore to the peakists I say, You can declare victory. You are no longer the beleagured small minority of voices crying in the wilderness. You are now main streams. You must learn to take yes for an answer and be gracious in victory.”

Cork, Ireland, 2007 September 17
We Have to Build a "Crash Mat"
Global Energy Systems

UPPSALA HYDROCARBON DEPLETION STUDY GROUP

Web page: www.fysast.uu.se/ges
Peeking at Peak Oil

Kjell Aleklett
Illustrations: Olle Qvennerstedt