Canada’s Oil Sands Resources and its Future Impact on Global Oil Supply

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Bengt Söderbergh
M.Sc. in Business and Economics with International Specialization
M.Sc. In Sociotechnical Systems Engineering (September 2005)
Comparison Between Different Countries’ Proven Conventional Oil Reserves

In January 2003, Canada’s proven oil reserves increased from 5 to 180 billion barrels.

Why? Canada’s reserves of non-conventional oil became included.
Comparison Between Different Regions’ Oil Production

- Saudi Arabia
- Russia
- U.S.
- North Sea
- Iran
- China
- Iraq
- Conventional Canadian Oil
- Canadian Oil Sands

Oil Production (in Thousand Bbls Per Day)
Unconventional Oil Production is Supposed to Bridge the Coming Gap!

**Low Resource Case**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remaining ultimately recoverable resources base for conventional oil,</td>
<td>1700</td>
</tr>
<tr>
<td>as of 1/1/1996 (billion barrels)</td>
<td></td>
</tr>
<tr>
<td>Peak period of conventional oil production</td>
<td>2013-2017</td>
</tr>
<tr>
<td>Global demand at peak of conventional oil (mb/d)</td>
<td>96</td>
</tr>
<tr>
<td>Non-conventional oil production in 2030 (mb/d)</td>
<td>37</td>
</tr>
</tbody>
</table>

Source: World Energy Outlook 2004
Definitions of Oil Sands and Heavy Oils

Oil Sands

Quartz sand, silt and clay, water and bitumen. Also, minor amounts of mineral, titanium, zirconium, tourmaline and pyrite

Typical composition:
- 75 – 80% inorganic material (90% quartz sand)
- 3 – 5% water
- 10 – 12% bitumen

Bitumen/Heavy Oil

Thick black, tar like substance that pours extremely slowly.

7 – 14° API

Bitumen > 10,000 cPo
The Canadian Oil Sands Deposits

Production Technologies

Mining and In situ thermal recovery

In situ, extraction accomplished by drilling wells and thereafter injecting hot steam.

Mining production 2004, about 600,000 bbls/d

In situ production 2004, about 400,000 bbls/d
Mining Extraction

About 20% of established reserves

Mining, huge open-pit mines combined with large extraction facilities to separate the bitumen from the sand.

Less than 75 meters overburden.
In Situ Recovery

About 80% of oil established reserves

In situ extraction removes the hydrocarbons, and leave the mineral behind.

Viscosity, permeability and reservoir thickness important.

Cyclic Steam Stimulation (CSS) Steam Assisted Gravity Drainage (SAGD)

Emerging technologies, VAPEX & THAI
**Cyclic Steam Simulation (CSS)**

(20 – 25% recovery rate)

**Steam Assisted Gravity Drainage (SAGD)**

(40 – 70% recovery rate)
Upgrading

Bitumen is deficient in hydrogen. Must be upgraded to synthetic crude oil (SCO) to acceptable feedstock for refineries.

Addition of hydrogen or the rejection of carbon, or both.

Upgrading uses natural gas as a source of heat and steam for processing and also as a source of hydrogen.
# Canadian Reserves of Crude Bitumen

<table>
<thead>
<tr>
<th>(Billion barrels)</th>
<th>Ultimate Volume In Place</th>
<th>Initial Volume In Place</th>
<th>Initial Established Reserves</th>
<th>Remaining Established Reserves</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mineable</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Athabasca</td>
<td>138.6</td>
<td>113.4</td>
<td>35.2</td>
<td>32.3</td>
</tr>
<tr>
<td><strong>In Situ</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Athabasca</td>
<td>n/a</td>
<td>1187</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Cold Lake</td>
<td>n/a</td>
<td>201.3</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Peace river</td>
<td>n/a</td>
<td>127</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Total In Situ</td>
<td>2381</td>
<td>1515.3</td>
<td>143.6</td>
<td>142.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2520</td>
<td>1628.7</td>
<td>178.8</td>
<td>174.7</td>
</tr>
</tbody>
</table>
Environmental Impact

Large water use (2.5 – 4 units of water per bitumen unit)

Large ponds of waste material.

Greenhouse gases, mainly CO$_2$, but also other air emissions such as SO$_2$, NO$_x$, H$_2$S, CO, O$_3$, VOCs PAH etc

Greenhouse gas emissions from the oil sands industry may exceed 130 mega-tonnes per year by 2020.

Canada has signed the Kyoto treaty!
Oil Production Investment Aspects

Oil sands mining projects demand enormous capital investments.

Shell has invested more than C$6 billion in the AOSP project.

Production costs between $15 – 24!

Already Made And Planned Investments In Oil Sands Production

1996 – 2002 $24 billion (Can.) investment in oil sands
2002 – 2006 $7 billion (Can) under construction.
2007 - $25 (Can) billion, new oil sands projects announced and under evaluation.

Oil Sands production - A Profitable Business Area!
Different Public Oil Sands Forecasts

![Graph showing different forecasts for total oil sands production from 2005 to 2030. The graph includes lines for Total Oil Sands Production, NEB, Total Oil Sands Production, CAPP, Total Oil Sands Production, AEUB, and Total Oil Sands Production, OSTRM. The x-axis represents years from 2005 to 2030, and the y-axis represents thousand bbls per day.]
Need of Natural Gas

Recovery and upgrading of bitumen from the oil sands consume large amounts of natural gas, electricity and hydrogen. Natural gas is the main source of energy and hydrogen. (historical origin)
**Increasing demand for Natural Gas**

In 2003, natural gas supplied about 30% of the total energy consumption in Canada.

About 50% of Canadian natural gas production is exported to the U.S..

U.S. gas demand will grow from today’s 60 Bcf/day to more than 90 Bcf per day by 2010.
Unsustainable Reliance on Natural Gas
All Projects Oil Sands Production Forecast

Assumes all currently planned and postponed projects completed.
– Not realistic! Assumes immediate action to increase production.
All Mining Projects Forecast

All currently planned and postponed mining projects completed.

The established mineable reserves of 32 Gb will have been produced!
In Situ Production – the Long Term Future

Extrapolated curve after 2030

Extrapolated curve after 2025
Canada’s Total Oil Sands Production May Peak

![Graph showing total oil sands production in Canada from 2005 to 2050. The graph indicates a peak in production around 2025, with a decline projected thereafter. The data is represented in thousands of barrels per day, with the x-axis showing years from 2005 to 2050, and the y-axis showing barrels per day from 0 to 7000.]
The Declining Conventional Oil Production from the North Sea and Canada

The North Sea

Canada
Resulting Oil Production from Canada’s Oil Sands, Canada’s Conventional oil and the North Sea

![Graph showing oil production from Canada's Oil Sands and conventional oil in comparison to the North Sea. The graph highlights a gap in oil production between 2015 and 2030.]
Conclusions

The natural gas supply situation and CO$_2$E emissions are development constraints for the oil sands industry.

??? In situ production - the big question mark ???

The Canadian oil sands industry cannot even compensate for the combined decline of conventional oil production in Canada + the North sea by 2030.

The Canadian oil sands will not prevent global peak oil!

Question to the IEA: Assuming Venezuela achieves a production of 6 million b/d of heavy oil by 2030, Canada 5 million barrels. Who will produce the remaining 26 million barrels per day of unconventional oil?
The Canadian oil sands will not prevent global peak oil, or meet future increase of demand.