Evolution of Heavy Oil Mining and In-Situ Extraction Techniques from Alberta’s Oil Sands

Presentation to;
Mining Institute of Scotland
December 12th, 2007
Agenda

- The Case for Oil Sands
- Historical Perspective
- Oil Sands by Definition
- Extraction Methods
- Drivers for Success
- The Issues / The Future
- Questions
The Case for Oil Sands Development or Why Is Industry Excited?

**WORLD OIL RESERVES**

*billions of barrels*

- **Canadian Oil Sands** 163.5
- **Canadian Conventional** 17.1
- **Rest of World** 285.6
- **Saudi Arabia** 264.3
- **Rest of OPEC** 641.2

Source NEB
Heavy Oil & Bitumen Production

Oil Sands & Conventional Production Moderate Growth Case

Actual vs. Forecast

- Conventional Heavy
- Conventional Light
- Bitumen
- East Coast
- In Situ
- Mining

2006 Forecast

Chart showing production trends from 2002 to 2020.
Heavy Oil and Oil Sands Resources

Province of Alberta

Edmonton

Calgary

Fort McMurray

Canada
Heavy Oil and Oil Sands Comparison
Early exploration

Scottish Heritage

At about 24 miles from the fork (of the Athabasca and Clearwater Rivers) are some bituminous fountains into which a pole of 20 feet long may be inserted without the least resistance.

The bitumen is in a fluid state when mixed with gum, the resinous substance collected from the spruce fir, it serves to gum the Indians' canoes. In its heated state it emits a smell that of sea coal.

In 1788, Alexander MacKenzie wrote in his journal:
Surface Mining

- **<150 feet deep cutoff**

### Mining Projects

<table>
<thead>
<tr>
<th>Company</th>
<th>Project</th>
<th>Size (bbl/d)</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albian/Shell</td>
<td>Muskeg/Jackpine</td>
<td>150,000</td>
<td>now</td>
</tr>
<tr>
<td>Suncor</td>
<td>BasePlant</td>
<td>280,000</td>
<td>now</td>
</tr>
<tr>
<td>Syncrude</td>
<td>BasePlant</td>
<td>300,000</td>
<td>now</td>
</tr>
<tr>
<td>CNRL</td>
<td>Horizon</td>
<td>110,000</td>
<td>2008</td>
</tr>
<tr>
<td>Imperial</td>
<td>KearlLike</td>
<td>100,000</td>
<td>2010</td>
</tr>
<tr>
<td>Synenco</td>
<td>NorthernLights</td>
<td>50,000</td>
<td>2010</td>
</tr>
<tr>
<td>PetroCan</td>
<td>FortHills</td>
<td>50,000</td>
<td>2011</td>
</tr>
</tbody>
</table>
## In Situ SAGD Projects

<table>
<thead>
<tr>
<th>Company</th>
<th>Project</th>
<th>Size (bbl/d)</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>ConocoPhillips</td>
<td>Surmont</td>
<td>100,000</td>
<td>2006 - 2012</td>
</tr>
<tr>
<td>Total</td>
<td>Joslyn</td>
<td>45,000</td>
<td>2010</td>
</tr>
<tr>
<td>Devon</td>
<td>Jackfish</td>
<td>35,000</td>
<td>2008</td>
</tr>
<tr>
<td>Encana</td>
<td>Christina Lake</td>
<td>18,000</td>
<td>2008</td>
</tr>
<tr>
<td>Encana</td>
<td>Foster Creek</td>
<td>40,000 – 60,000</td>
<td>now</td>
</tr>
<tr>
<td>Husky</td>
<td>Sunrise</td>
<td>50,000 – 200,000</td>
<td>2008</td>
</tr>
<tr>
<td>Husky</td>
<td>Tucker Lake</td>
<td>30,000</td>
<td>2006</td>
</tr>
<tr>
<td>JACOS</td>
<td>Hangingstone</td>
<td>10,000</td>
<td>now</td>
</tr>
<tr>
<td>MEG Energy</td>
<td>Christina Lake</td>
<td>25,000</td>
<td>2008</td>
</tr>
<tr>
<td>North American</td>
<td>Kai Kos Dehseh</td>
<td>10,000</td>
<td>2008</td>
</tr>
<tr>
<td>PetroCanada</td>
<td>MacKay River</td>
<td>30,000 – 74,000</td>
<td>now - 2010</td>
</tr>
<tr>
<td>OPTI/Nexen</td>
<td>Long Lake</td>
<td>72,000</td>
<td>2007</td>
</tr>
<tr>
<td>Suncor</td>
<td>Firebag I&amp;2</td>
<td>70,000</td>
<td>now</td>
</tr>
</tbody>
</table>
Early History

Unlocking the sands

First steps

Initial development
Commercialization

Early commercialization

A giant undertaking

Early operations
Athabasca Oil Sand

- A mixture of bitumen, water, solids and fine clays
- The average composition
  - 11% bitumen
  - 5% water
  - 84% solids
Mineralogy and Characteristics

- Primarily quartz (>84%)
- Processibility concerns
  - Fines (< 44 µm)
  - Presence of clay
  - Aromatics, asphaltenes
- Viscosity range
- Sulphur, heavy metals
Geology

Devonian

Producer

Injector
Stacked Channels

100 Feet

SHALE PLUG

CHANNEL

IHS
Oil Sands Recovery Technologies
Mining and In-Situ (SAGD)

Athabasca Bitumen, Canada (8.6°API)

Steam Plant
Oil Treating & Tanks

Production Well

Steam Chamber

Graph:
- X-axis: Temperature (°C)
- Y-axis: Oil Viscosity (cP)
- Data points showing the decrease in viscosity with increasing temperature.
Pad 02 Well Pair 01

**Well Pair Architecture**

- **508mm Surface Hole**
  - Surface Casing: 406.4mm H-40, 96.73 kg/m, Tenaris ER
- **374.7mm Intermediate Hole**
  - Intermediate Casing: 296.5mm, K-55, 80.36 kg/m, Tenaris Blue
  - Heel Inj. String: 177.8mm, K-55, R2, 34.23 kg/m, Tenaris ER SC SB landed at 393.31 mKB
- **406mm Surface Hole**
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SAGD Pads
Concurrent Operations
Challenges
Syncrude operates mining, extraction, upgrading and utilities plants in order to produce synthetic crude from oil sand.
Oil Sands Mining

Syncrude

Athabasca Oil sands

Edmonton

Calgary

B.C.

Alberta

Sask.
Surface Mining is a Material Management Operation
Nexen’s – Oil Sands Insitu Assets – Long Lake

Long Lake Project (Phase 1)
Start of Site Construction Q2, 2005
30,000 bbls/d by 2008
Nexen Long Lake

Lime Sludge Ponds
North Camp
Water Treatment Area
Admin Building & Warehouse
Water & Bitumen Storage Area
Drilling Camp
Well Pad 9
Well Pad 2
Hydro-Cracker Unit
Gasifier Unit
Or crude Unit
Emulsion Treating Area
Phase 2 Upgrader Site
Phase 3 Upgrader Site
Product Storage Area
Steam Generation Unit
Air Separation Unit
Rail Spur
Future Steam Expansion (to 3.3 SOR)
Well Pads 6, 7, & 8
Security Gate
Upgrading
## Comparison of Bitumen and Synthetic Crude

<table>
<thead>
<tr>
<th></th>
<th>Raw Bitumen</th>
<th>Synthetic Crude Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.P.I. Gravity</td>
<td>9-10</td>
<td>35</td>
</tr>
<tr>
<td>Boiling Range</td>
<td>400°-1100°F</td>
<td>80°-900°F</td>
</tr>
<tr>
<td></td>
<td>(204°-593°C)</td>
<td>(27°-482°C)</td>
</tr>
<tr>
<td>Sulfur</td>
<td>4.5-5%</td>
<td>0.2%</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>0.5-1%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Vanadium</td>
<td>150 ppm</td>
<td>Nil</td>
</tr>
<tr>
<td>Nickel</td>
<td>50 ppm</td>
<td>Nil</td>
</tr>
<tr>
<td>Colour</td>
<td>Black</td>
<td>Straw</td>
</tr>
<tr>
<td>Ash</td>
<td>1%</td>
<td>Nil</td>
</tr>
</tbody>
</table>
Converting Dirt to Dollars

- 1000 million tons of oil sands mined
- 44.9%
- 449 million tons of oil sands processed
Converting Dirt to Dollars

- 11.3%
- 51 tons of crude bitumen in mined oil sands
- 90%
Converting Dirt to Dollars

- 260 million bbls of crude bitumen production
- 85%
- 220 million bbls of synthetic production
- 30% -60% of WTI
- 95%-105% of WTI
Economic Drivers of Oil Sands Development
Integrated Solution Required

- Cost of Natural Gas
- Product Quality
- Successful Project Execution
What are the Challenges

Leaders in reclamation

Continuous innovation

Community development
The Future?

Looking ahead