Will the Challenges Facing Oil Sands Projects Curtail Industry Growth?

Canadian Society for Engineering Management

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Strategy West Inc.
Calgary, Alberta
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Presentation Outline

- Oil Sands Industry Resources, Reserves and Historical Production
- Industry Outlook - Unconstrained Case
  - Crude bitumen production
  - Synthetic crude oil and non-upgraded crude bitumen supply
- Industry Challenges
  - Greenhouse gas emissions
  - Energy supply and costs
  - Project costs and economics
- Industry Outlook – Constrained Case
- Conclusions
Resources and Reserves

- Initial volume in place (bitumen): 1,694 billion barrels
- Initial established reserves: 178.7 billion barrels
- Cumulative production: 5.0 billion barrels
- Remaining established reserves: 173.7 billion barrels
- Remaining established reserves under active development: 10.2 billion barrels


Mineable and In Situ Resources and Reserves

Mineable Resources/Reserves
- < 75m (250 ft) to top of oil sands
- Athabasca Oil Sands Area only
- 6% of initial volume in place
- 20% of initial established reserves
- 68% of cumulative production to year-end 2005

In Situ Resources/Reserves
- > 75m (250 ft) to top of oil sands
- Athabasca, Cold Lake and Peace River Oil Sands Areas
- 94% of initial volume in place
- 80% of initial established reserves
- 32% of cumulative production to year-end 2005

Preliminary estimates indicate that Alberta’s Oil Sands will provide 43% of Canada’s “crude oil” production in 2006 (total 2,655 kb/d)

Source: National Energy Board; November 11, 2006

Bitumen Production Outlook – Unconstrained Case

Source: Strategy West Inc.
SCO and Non-Upgraded Bitumen Supply - Unconstrained Case

CAPEX - Unconstrained Case

<table>
<thead>
<tr>
<th>Incremental Bitumen 2005-2020 (million b/d)</th>
<th>Initial CAPEX ($ per b/d)</th>
<th>Average Annual Initial CAPEX 2005-2020 ($ billions)</th>
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<tbody>
<tr>
<td>Mining &amp; Extraction</td>
<td>2.2</td>
<td>$35,000 (Bitumen)</td>
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<td>In Situ</td>
<td>2.4</td>
<td>$25,000 (Bitumen)</td>
</tr>
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<td>Incremental Production</td>
<td>4.6</td>
<td></td>
</tr>
<tr>
<td>Upgrading</td>
<td>2.8</td>
<td>$50,000 (SCO)</td>
</tr>
<tr>
<td>Total CAPEX</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: does not include sustaining capital

Source: Strategy West Inc.
Will the Challenges Facing Oil Sands Curtail Industry Growth?

Oil Sands Historical CAPEX

Capital Spending ($ billions)

- 1998
- 1999
- 2000
- 2001
- 2002
- 2003
- 2004
- 2005

Includes Sustaining Capital

Source: Canadian Association of Petroleum Producers (CAPP)

Oil Sands Industry Challenges and Sustainability

The “Triple Bottom Line”

- Healthy Environment
- Strong Economy
- Sustainable Development
- Social Well-Being

People

Planet
Oil Sands Industry
Environmental Challenges

- Air Emissions
  - Greenhouse Gases
  - Criteria Air Contaminants (SOx, NOx, PM, VOCs, CO, NH3)

- Water Use
  - Consumption
  - Recycle

- Waste Disposal
  - Tailings
  - Other Solid and Liquid Wastes

- Reclamation and Abandonment

- Cumulative Effects

Oil Sands Industry
Economic Challenges

- Capital Costs
  - Labour Availability and Productivity
  - Services and Materials
  - Project Management

- Energy Consumption, Supply and Costs
  - Internal Energy Use
  - External Energy Options

- Non-Energy Operating Costs

- Product Prices
  - Light Sweet Crude (WTI/MSW)
  - Heavy-Light Differentials

- Markets
  - Final Product (Bitumen, SCO, RPPs or Petrochemicals)?
  - Integration?

- Market Access
  - Pipeline Infrastructure

- Gas-over-Bitumen
Oil Sands Industry
Societal Challenges

- Public Services
  - Health
  - Education
  - Other
- Public Infrastructure
  - Road
  - Water & Sewer
  - Rail
  - Other
- Regulatory Issues
  - Royalties and Taxes (Economic Rent)
  - Regulatory Agencies
    - Staffing
    - Workload
    - Funding
- Pace of Development

Canada’s GHG Emissions

Source: Environment Canada
Canada’s Top GHG Emitters

Top 10 carbon dioxide emitters in Canada

1. Syncrude Generating Plant, Tar Sands Utilities Corporation
2. Nanticoke Generating Station, Ontario Power Generation
4. Bow River Generating Station, Fort McMurray
5. Lambton Generating Station/Detroit Power Generation
6. EPCOR Lasqueti Thiessen Generating Station, Akl.
7. Sites Development/Lambton Generating Station, Alberta Power Ltd., Fort McMurray
8. Nanticoke Dam/Power Station, Sault Ste. Marie (Ontario)
10. Fort McMuray Generating Station, Alberta Power Ltd.

Assumes no reduction in GHG emission intensities from 2006 levels

Source: CanWest News Services

Oil Sands GHG Emission Potential - Unconstrained Case

Assumes no reduction in GHG emission intensities from 2006 levels

Source: Strategy West Inc.
## Oil Sands Energy and Hydrogen Requirements

<table>
<thead>
<tr>
<th><strong>Energy</strong></th>
<th><strong>Hydrogen</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>In situ steam and process heat</td>
<td>Hydro-conversion processes (upgrading)</td>
</tr>
<tr>
<td>Mining/extraction process heat</td>
<td></td>
</tr>
<tr>
<td>Upgrading process heat</td>
<td></td>
</tr>
<tr>
<td>Electricity</td>
<td></td>
</tr>
</tbody>
</table>

## Current Sources of Thermal Energy, Hydrogen and Electricity

<table>
<thead>
<tr>
<th><strong>Thermal Energy</strong></th>
<th><strong>Hydrogen</strong></th>
<th><strong>Electricity</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas</td>
<td>Steam Methane Reforming (natural gas)</td>
<td>On-site Cogeneration</td>
</tr>
<tr>
<td>Produced Gases (in situ projects)</td>
<td></td>
<td>Purchased Electricity</td>
</tr>
<tr>
<td>Process Gases (upgraders)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coke (upgraders)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liquid Hydrocarbon Fuels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crude Bitumen</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Oil Sands External Natural Gas Requirements

- Thermal in situ projects are very large energy consumers – Gas use depends on the performance of the in situ recovery process (i.e., steam oil ratio)
- Gas use for upgrading is higher for production of higher quality synthetic crude oil

Gas Demand for Bitumen Recovery and Upgrading

Total oil sands gas requirements increase to 880 Bcf/a by 2015 (490 Bcf/a is purchased gas)
Total Alberta Marketable Gas Production and Demand

Oil sands purchased gas (490 Bcf/a) represents 27% of total Alberta marketable gas demand in 2015. Alberta gas removals in 2015 (2,560 Bcf/a) drop to 70% of 2005 levels.

Potential Future Sources of Thermal Energy, Hydrogen and Electricity

- **Bitumen Combustion**: Yes, Yes
- **Gasification**: Yes, Yes, Yes
- **Nuclear**: Yes, Yes, Yes

It is also expected that oil sands industry energy intensity will be reduced through efficiency improvements and application of new technologies.
Oil Sands Gasification Projects

<table>
<thead>
<tr>
<th>Project</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPTI/Nexen Long Lake</td>
<td>Under Construction</td>
</tr>
<tr>
<td>Suncor Voyageur 2</td>
<td>Application</td>
</tr>
<tr>
<td>North West Upgrading</td>
<td>Application</td>
</tr>
<tr>
<td>Synenco Northern Lights</td>
<td>Application</td>
</tr>
<tr>
<td>CNRL Horizon</td>
<td>Under Consideration</td>
</tr>
<tr>
<td>CNRL Primrose</td>
<td>Under Consideration</td>
</tr>
<tr>
<td>Petro-Canada</td>
<td>Under Consideration</td>
</tr>
<tr>
<td>NAOS Kai Kos Dehseh</td>
<td>Under Consideration</td>
</tr>
<tr>
<td>Others?</td>
<td></td>
</tr>
</tbody>
</table>

Initial CAPEX - Selected Non-Integrated Projects

**Steam Assisted Gravity Drainage (SAGD)**

<table>
<thead>
<tr>
<th>Operator</th>
<th>Project</th>
<th>CAPEX ($ millions)</th>
<th>Capacity (b/d bitumen)</th>
<th>Unit CAPEX ($ per b/d)</th>
<th>Startup</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suncor</td>
<td>Firebag 2</td>
<td>$540</td>
<td>35,000</td>
<td>$15,400</td>
<td>Q1 2006</td>
</tr>
<tr>
<td>Husky</td>
<td>Tucker</td>
<td>$470</td>
<td>30,000</td>
<td>$15,700</td>
<td>Q4 2006</td>
</tr>
<tr>
<td>Connacher</td>
<td>Great Divide</td>
<td>$240</td>
<td>10,000</td>
<td>$24,000</td>
<td>Q3 2007</td>
</tr>
<tr>
<td>Petro-Canada</td>
<td>MacKay River 2</td>
<td>$800 - $1,200</td>
<td>40,000</td>
<td>$20,000 - $30,000</td>
<td>2010</td>
</tr>
</tbody>
</table>

**Mining and Extraction**

<table>
<thead>
<tr>
<th>Operator</th>
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<th>CAPEX ($ millions)</th>
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<th>Unit CAPEX ($ per b/d)</th>
<th>Startup</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synenco</td>
<td>Northern Lights</td>
<td>$4,400 - $5,500</td>
<td>114,500</td>
<td>$38,400 - $48,900</td>
<td>2011</td>
</tr>
</tbody>
</table>

Source: Company Press Releases and Investor Presentations
### Initial CAPEX - Selected Integrated Projects

Steam Assisted Gravity Drainage (SAGD) with Integrated Upgrading

<table>
<thead>
<tr>
<th>Operator</th>
<th>Project</th>
<th>CAPEX ($ millions)</th>
<th>Capacity (b/d SCO)</th>
<th>Unit CAPEX ($ per b/d)</th>
<th>Startup</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPTI/Nexen</td>
<td>Long Lake 1</td>
<td>$4,600</td>
<td>58,500</td>
<td>$78,600</td>
<td>Q1/Q3 2007</td>
</tr>
</tbody>
</table>

**Mining and Extraction with Integrated Upgrading**

<table>
<thead>
<tr>
<th>Operator</th>
<th>Project</th>
<th>CAPEX ($ millions)</th>
<th>Capacity (b/d SCO)</th>
<th>Unit CAPEX ($ per b/d)</th>
<th>Startup</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNRL</td>
<td>Horizon 1</td>
<td>$6,800</td>
<td>114,500</td>
<td>$59,600</td>
<td>Q3 2008</td>
</tr>
<tr>
<td>Petro-Canada</td>
<td>Fort Hills 1</td>
<td>$12,600</td>
<td>140,000</td>
<td>$90,000</td>
<td>2011</td>
</tr>
<tr>
<td>Petro-Canada</td>
<td>Fort Hills 2</td>
<td>$8,000</td>
<td>100,000</td>
<td>$80,000</td>
<td>2014</td>
</tr>
<tr>
<td>Shell</td>
<td>AOSP Expansion 1</td>
<td>$10,000 - $12,000</td>
<td>100,000</td>
<td>$100,000 - $120,000</td>
<td>2010</td>
</tr>
</tbody>
</table>

Source: Company Press Releases and Investor Presentations; Fort Hills Figures from UTS Energy Oct 12, 2006

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### Hypothetical Oil Sands Projects - Cost Assumptions

<table>
<thead>
<tr>
<th>Product</th>
<th>SAGD</th>
<th>Mining &amp; Extraction</th>
<th>Upgrading (Coker)</th>
</tr>
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<tbody>
<tr>
<td>Initial CAPEX (Real 2006 C$ per b/d)</td>
<td>$25,000 (Bitumen)</td>
<td>$35,000 (Bitumen)</td>
<td>$50,000 (SCO)</td>
</tr>
<tr>
<td>Non-energy OPEX (Real 2006 C$/b)</td>
<td>$4.00</td>
<td>$8.00</td>
<td>$4.00</td>
</tr>
<tr>
<td>Purchased Natural Gas (GJ/b)</td>
<td>1.10</td>
<td>0.20</td>
<td>0.50</td>
</tr>
<tr>
<td>Purchased Electricity (kWh/b)</td>
<td>9</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SCO Yield</td>
<td>-</td>
<td>-</td>
<td>85%</td>
</tr>
<tr>
<td>GHG Emission Penalty ($/t)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
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</table>

Source: Strategy West Inc.
Economic Implications

- Escalating costs have raised the oil sands project investment threshold to US$50-60/b (WTI at Cushing)
- Others have expressed similar views:
  - Charlie Fischer (Nexen): New projects will need crude prices of about US$45/b to break even (October 2006)
  - Murray Edwards (CNRL): “These projects, long term, need prices higher than $50 [US$/b]”; (October 2006)
Oil Sands Industry Outlooks

- Unconstrained Outlook
  - Assumes all existing and proposed projects are developed and meet their scheduled startup dates
- Constrained Outlook
  - Project-by-project timing adjustments
  - Project-by-project probability assessment

Project-by-Project Timing Adjustments and Probabilities

- Project Timing
  - Lease Evaluation
  - Disclosure
  - Application Preparation and EIA
  - Application Review and Approval
  - Detailed Engineering
  - Internal Approval
  - Construction
  - Phasing

- Project Probabilities
  - Project Status
  - Owners
    - Operating experience
    - Financial capacity
    - Technical capability
    - Other factors
  - Technology
  - Existing Operations
  - Integration
  - Timing

Source: Strategy West Inc.
Bitumen Production Outlook – Constrained Case

SCO and Non-Upgraded Bitumen Supply – Constrained Case
**CAPEX – Constrained Case**

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<td>Incremental Production</td>
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<tr>
<td>Upgrading</td>
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<td>$50,000 (SCO)</td>
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<tr>
<td>Total CAPEX</td>
<td></td>
<td>$10.4</td>
</tr>
</tbody>
</table>

Note: does not include sustaining capital

Source: Strategy West Inc.

**Comparative Industry Outlooks**

[Graph showing SCO and Non-Upgraded Bitumen Supply from 2005 to 2020]

- CAPP 2006 06
- EUB 2006 06
- NEB 2006 06
- NRCan 2006 10
- SW 2006 10

Source: Strategy West Inc.
Conclusions

- Canada’s oil sands are one of the world’s largest hydrocarbon accumulations
- The industry is well developed and making a significant contribution to North American oil supply
- Oil sands projects are experiencing cost pressures but are economically attractive at current high oil prices
- The industry faces many challenges but will overcome them and continue to grow

Thank You

Questions?

Please visit www.strategywest.com for oil sands project lists and other detailed oil sands industry information