Update on Canadian Oil Sands Crude

BOARD OF DIRECTORS SPECIAL MEETING
November 19, 2018

Victor Douglas
Manager, Rule Development and Strategic Policy
Overview

• Background
  o What are Oil Sands
  o Where are they found?
  o Extraction and Processing

• Site Visits
  o In-Situ
  o Processing and Aerial Tour
  o Edmonton and Vancouver Meetings

• Summary and Conclusion
What are Oil Sands

Also called “tar Sands” or “bituminous sands”

Mixture of

- bitumen (10% up to 20%)
- sand / clay (85%) and
- water (5%)
Where do “Oil Sands” Come From?

Alberta, Canada

- 3 primary areas
  - Athabasca
  - Cold Lake
  - Peace River
- 10% of World’s proven reserves
  - Third largest reserve
  - 170 billion barrels
- Covers area the size of New York State
- Two types of extraction processes
  - Surface Mining
  - In Situ

Adapted from Oil Sands Magazine
Oil Sands Extraction Processes
In-Situ & Surface Mining

80%* In-Situ (Wells/Steam)

20%* Surface Mining

Accessible Material

IN-SITU EXTRACTION

SURFACE MINING (OPEN-PIT)

OIL Sands 101: Surface Mining vs. In-Situ Bitumen Extraction
Oil Sands Production: In-Situ

~40%*
In-Situ

In-Situ Bitumen Extraction: Steam-Assisted Gravity Drainage (SAGD)

www.oilsandsmagazine.com
In-Situ Extraction Operations

Adapted from *Oil Sands Magazine*
Steam Injection and Extraction Wells

Adapted from *Oil Sands Magazine*
Steam Generation

Adapted from *Oil Sands Magazine*
Oil / Water Separation

Adapted from *Oil Sands Magazine*
Bitumen Upgrading Operations

Adapted from Oil Sands Magazine

In-Situ Extraction Operations
Tailings Pond

In-Situ Extraction Operations

Adapted from Oil Sands Magazine
Oil Sands Production: Surface Mining

~50%* Surface Mining

Adapted from Oil Sands Magazine
Oil Sands Production: Surface Mining
Oil Sands Production: Surface Mining

Surface Mining Equipment
Oil Sands Production: Surface Mining

Adapted from *Oil Sands Magazine*
Extraction Equipment

Adapted from Oil Sands Magazine
Oil Sands Production: Surface Mining

Material Handling Plant (OPP-Dry)

- Dump Hopper
- Apron Feeder
- Double-Roll Crusher or Sizer
- Surge Bin or Storage Pile

Slurry Preparation Plant (OPP-Wet)

- Hot/warm water + caustic soda
- Mix Box or Rotating Vessel
- Slurry to Extraction
- Hydro-Transport Pipeline

Surge Feed Conveyor

MSE Wall

loose oil sands

www.oilsandsmagazine.com
Oil Sands Production: Surface Mining

Crushing
Oil Sands Production: Surface Mining

Crushing and Separation
Froth Gravity Separation

Adapted from *Oil Sands Magazine*
Oil Sands Production: Surface Mining

Froth Gravity Separation

Adapted from Oil Sands Magazine
Oil Sands Production: Surface Mining

Froth Treatment and Upgrading
Restoration Efforts
Oil Sands Production: Surface Mining
Oil Sands Production: Surface Mining
Canadian Perspectives

- Stand.Earth
- Tsleil Waututh Nation
- Responsible Fossil Fuels – Pembina Institute, Edmonton
- City of Vancouver
- West Coast Environmental Law
- Union of BC Indian Chiefs
- Squamish Nation
- Kwikwasut’inuxw Haxwa’mis First Nation
- City of Burnaby
Alberta and Canadian Government Efforts

• Environmental and Community-led Monitoring
• Carbon Emissions Pricing
• Capping oil sands greenhouse gas (GHG) emissions at 100 megatonnes (Mt) per year
• Reducing methane emissions province-wide by 45 per cent by 2025
Climate and Bay Area Environmental Concerns

Local Toxics

Oil Sands processing may impact toxic risk from refineries.

Global GHGs

Oil Sands extraction and processing are very “carbon intensive” requiring more energy than conventional crudes, increasing GHG emissions.

Water

Increased ship traffic increases the potential for oil spills.

$\text{H}_2\text{S}$
Oil Sands vs California Crude Oil: Carbon Intensity

Life Cycle Greenhouse Gas Emissions

Source: IHS ENERGY, Comparing GHG Intensity of the Oil Sands and Average US Crude Oil, May 2014
Oil Sands vs California Crude Oil: API Gravity

Adapted from Oil Sands Magazine
Oil Sands vs California Crude Oil: Sulfur v. Density

Line: imported Canadian crude oil with properties similar to Oil Sands
Bars: total imported Canadian crude oil

Source:
District analysis of U.S. EIA Imports Data

\[
\% \text{ of Operable Capacity} = \frac{\text{Canadian Imports with Oil Sands Properties}}{\text{Operable Capacity} \times 365}
\]

\[
\% \text{ of Operable Capacity} = \frac{\text{Total Canadian Imports}}{\text{Operable Capacity} \times 365}
\]
Mitigating Bay Area Environmental Concerns

Local Toxics

- Track Emissions with Crude Slates (Regulation 12, Rule 15)
- Reduce Significant Health Risks (Regulation 11, Rule 18)
- Control Technology for Toxics (Regulation 2, Rule 5)
- AB 617 Community Health Protection Programs

Global GHGs

- Low Carbon Fuel Standard
- Cap and Trade
- Rule 13-1: Significant Methane Releases

Water

- Office of Spill Prevention and Response
Conclusion

In Summary:

- Oil Sands extraction has significant local environmental impacts
- Oil Sands crude similar to composition and impacts from California Crude
- Approximately 4% of crude refined in the Bay Area comes from Canada
- Significant regulatory framework in place in the Bay Area; we will need to continue monitoring crude imports
- Regulatory changes may be necessary if emissions increase
- Continued use of fossil fuels in California will impact climate change
Canadian Tar Sands: Issues for BAAQMD to consider

AGENDA: 13

Tzeporah Berman, BA MES LLD
Adjunct Professor York University
International Campaigns Director
Surface Mining

Deposits less than 100 m from surface

Total oilsands region = 142,200 km$^2$
Surface mineable area = 4,800 km$^2$
Tailings ponds volume reached 1,271,000,000 cubic metres in 2016

Source: Government of Alberta

pembina.org/oil-sands/tailings-ponds
250 Million Litres per day
Toxic compounds present in tailings waste

- Contain residual bitumen, cyanide, napthenic acids, heavy metals

- Possible contamination of surface water and groundwater systems – seeping 2.9 million USG per day

- Toxic air pollutants such as methane, VOCs and H$_2$S emissions
In situ
Steam drilling for deep oilsands deposits
80% of total oilsands region is suitable for in situ developments
In situ produces a dirtier barrel
Almost 20 per cent of Canada’s entire natural gas production is used solely to extract oil from the tar sands. Enough is burned every day to heat six million homes or almost every single house in Alberta, Saskatchewan and Manitoba.

2.38 Billion cubic feet per day
Oil sands production emits 3 to 4 times more greenhouse gases than producing conventional crude oil. This makes it one of the world’s dirtiest forms of fuel.
The boreal forest is a crucial habitat for wolves, grizzly bear, lynx and moose. Woodland caribou populations in the region have declined by 50 per cent over the past 10 years and studies predict caribou will become extinct if approved tar sands projects are implemented.
One square represents the area of 100 hectares (ha) of land

Active area of the land mined for oilsands (94,095 ha)

Area of the land mined for oilsands certified as reclaimed and returned to the province (104 ha)
Air quality
Sulphur dioxide and nitrogen oxides are major contributors to acid rain formation.
HAPPENING NOW

Fort McMurray Wildfire
GHGs from oil and gas increase by 13% between 2015 and 2030 (but +62% for oil sands).

Emissions from oil and gas production will represent 42% (215 Mt) of Canada’s carbon budget in 2030 (517 Mt).

Oilsands emissions are the core of the issue.

Source: Environment and Climate Change Canada
GHGs for Canada and the Oil Sands for 2015 (actual) and 2030, 2050 (projected)
The graph shows the emissions intensity (kg CO₂e/barrel of bitumen) from 2004 to 2015 for different processes:

- **In situ**: The emissions intensity for in situ processes shows a slight decrease over time, with a peak in 2007.

- **OVERALL**: The overall emissions intensity trends are represented by a red line, which shows a slight increase from 2004 to 2015, reaching a 9% increase.

- **Mining**: The mining emissions intensity, represented by a blue line, remains relatively stable with minor fluctuations.

The graph indicates that while emissions intensity varies across different processes, the overall emissions show a noticeable increase, potentially highlighting areas for improvement in environmental sustainability.
FIGURE 12
Total GHG Emissions for 30 Phase 1 OCI Test Oils

Source: Authors’ calculations

Note: Unlike the other OCI test oils, Cold Lake dilbit is not composed of a full barrel of oil.

Source: Carnegie Endowment
Carbon-intensive source of oil

North American weighted average: 541

- U.S. Bakken (No Flare): 471 kg CO₂e/barrel of crude
- U.S. Texas Eagle Ford Black Oil Zone: 477 kg CO₂e/barrel of crude
- Mexico Cantarell: 504 kg CO₂e/barrel of crude
- U.S. Bakken (Flare): 532 kg CO₂e/barrel of crude
- U.S. Alaska North Slope: 564 kg CO₂e/barrel of crude
- Canada oilsands: 709 kg CO₂e/barrel of crude

Source: Carnegie Endowment
Low grade crude = lesser value

Extra heavy oil, contains higher levels of sulphur

Source: PRELIM
# Summary of Ozone Seasons

<table>
<thead>
<tr>
<th>Year</th>
<th>National 8-Hour</th>
<th>State 1-Hour</th>
<th>State 8-Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015*</td>
<td>5</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td>2016</td>
<td>15</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>2017</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>2018</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Spare the Air Alerts: 6/22/18, 6/23/18, 6/30/18, 7/26/18, 8/8/18, 8/9/18, 8/18/18, 8/19/18, 8/23/18, 8/24/18, 9/3/18, 9/5/18, 9/26/18

Days > 0.070 ppm 8-hour NAAQS: 8/3/18, 8/9/18, 8/18/18

*Based on NAAQS of 0.075 ppm that was in place during that year
## Winter PM$_{2.5}$ Seasons

<table>
<thead>
<tr>
<th>Year</th>
<th>Days $&gt; 35$ µg/m$^3$</th>
<th>Winter Spare the Air Alerts</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015/2016</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>2016/2017</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>2017/2018</td>
<td>8</td>
<td>19</td>
</tr>
<tr>
<td>2018/2019</td>
<td>11</td>
<td>11</td>
</tr>
</tbody>
</table>

- Spare the Air Alert Called for: 11/8/18 – 11/18/18
- Days $> 35$ µg/m$^3$ 24-hr NAAQS: 11/8/18 – 11/18/18
<table>
<thead>
<tr>
<th>Year</th>
<th>National Ozone Exceedances</th>
<th>Days &gt; 35 µg/m³ due to Wildfires (PM₂.₅)</th>
<th>Total Days &gt; 35 µg/m³ (PM₂.₅)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>5*</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2015</td>
<td>5*</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>2016</td>
<td>15</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2017</td>
<td>6</td>
<td>14</td>
<td>18</td>
</tr>
<tr>
<td>2018</td>
<td>3</td>
<td>13</td>
<td>17</td>
</tr>
</tbody>
</table>

For Ozone - Days > 0.070 ppm 8-hour NAAQS: 08/03/18, 8/9/18, 8/18/18

* Based on NAAQS of 0.075 ppm that was in place during those years

For Wintertime - Days > 35 µg/m³ 24-hr NAAQS: 12/15/17, 12/24/17, 12/30/17, 12/31/17, 1/1/18, 1/2/18, 1/3/18, 1/4/18, 11/8/18 – 11/18/18

(Other exceedances occurred due to wildfires)