Market Development for Western Canadian Crude Oil

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Steve Fekete
Senior Principal
Calgary
Purvin & Gertz and Oil Sands

- International Energy Consultancy
  - Private and Independent
- Firm established in 1947
  - Headquartered in Houston
  - Maintained office in Calgary since 1973
- 30 years in oil sands (Canada and Venezuela)
- Maintain short-term and long-term forecasts
  - Supply / Demand
  - Pricing
- Refining and upgrading
  - Technologies, Costs / Economics
- Independent Engineer for banks/investors
  - Initial project reviews and project reports
  - Project monitoring and certification of progress
Topics

- Oils Sands Supply Outlook
  - Bitumen
  - SCO
- Markets for Oil Sands Products
  - Canada
  - PADD II (US Midwest / Midcontinent)
  - PADD III (USGC)
  - PADD I (US East Coast)
- Netback Outlook
Current markets include Canada/U.S. Midwest, Rocky Mountains and PNW.

Developing and potential markets for incremental exports include Midcontinent, USGC, Pacific Rim, US East Coast.
Despite Challenges, Oil Sands Production Growth to 2015 will Offset Conventional Decline

Thousand Barrels per Day

- East Coast
- SCO
- Bitumen
- Conventional Heavy
- Conventional Light & C5s

Total Western Canada
Gross Bitumen Production

Thousand Barrel per Day

- **Gross bitumen (not diluted)**
- Does not include mining projects with an integrated upgrader
Bitumen Processing Options...

- **Bitumen**: 50% Resid, 32% Gas Oil, 18% Distillate & Lighter
  - 8 API, 4.8% Sulfur

- **Upgrading**: Synthetic Crude (no Resid)
  - 20% Naphtha & Lighter
  - 45% Distillate
  - 35%+ Gas Oil
  - 33 API, 0.2% Sulfur

- **Refining**: Refined Products
  - 57% Gasoline
  - 35% Diesel / Jet Fuel
  - 8% RFO, Asphalt
  - >50 API, <0.003% Sulfur

- **Coking Refinery**: Significant conversion and refining needed to reduce C:H ratio
Market Development For Bitumen Blends

- USGC is a very large market with high complexity. Need pipeline.
- Midwest (PADD II) has large coking. Main market for Canadian heavy crude.
- For West Coast (PADD V or Asia) need new or expanded pipeline and marine terminal.
Many Announced Refinery Projects Focus on Bitumen

Projects Targeting Bitumen
Petro-Canada, Edmonton
Petro-Canada, Montreal
BP - Whiting, IN
BP/Husky – Toledo, OH
ConocoPhillips/EnCana – Wood River, IL
ConocoPhillips/EnCana – Borger, TX
Flint Hills - Pine Bend, MN
Husky – Lima, OH
Marathon - Detroit, MI
Marathon – Catlettsburg, KY
Marathon – Robinson, IL
Coffeyville Refining – Coffeyville, KS
Frontier – El Dorado, KS
Sinclair – Tulsa, OK
At present, most heavy crude blends go to the US Midwest (PADD II)
- Continued growth expected in supply and PADD II use

Runs in Canada will increase

Large increase in heavy crude demand in PADD II could consume most of incremental supply
Most SCO production growth to come from integrated oil sands projects

Thousand Barrel per Day

- Midstream Upgrading
- Integrated Production
- Announced Capacity

Distillation Comparison – Light Sweet Crude

Note: Missing fraction is light ends
Non-Coking Refineries with High VGO Conversion Ideal for SCO Processing

**Western Canada:** Small and saturated

**Midwest (PADD II):** Large market but needs hydrocracking

**USGC (PADD III):** Has hydrocracking capacity; mostly coking refineries

**West Coast (PADD V):** Large market (hydrocracking, mostly with coking)

**East Coast (PADD I):** High concentration of cracking (FCCU) capacity
Downstream VGO Conversion Capacity Required

- VGO conversion capacity additions required in traditional markets to process incremental SCO

- Estimated capacity requirements in excess of creep additions
  - Requirements exceed 1% annually

- Access to USGC may provide some relief
  - Large VGO market, active trade

![Graph showing Thousand Barrels per Day over years 2005 to 2020 with different capacities and supply levels.](image-url)
Conversion Capacity Focus on SCO Projects is Limited to Date…

**Projects Targeting Bitumen**
- Petro-Canada, Edmonton
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- BP - Whiting, IN
- BP/Husky – Toledo, OH
- ConocoPhillips/EnCana – Wood River, IL
- ConocoPhillips/EnCana – Borger, TX
- Flint Hills - Pine Bend, MN
- Husky – Lima, OH
- Marathon - Detroit, MI
- Marathon – Catlettsburg, KY
- Marathon – Robinson, IL
- Coffeyville Refining – Coffeyville, KS
- Frontier – El Dorado, KS
- Sinclair – Tulsa, OK

**Projects Targeting SCO**
- Sun – Toledo, OH
- Suncor – Denver, CO
- Suncor – Sarnia, ON
- Flint Hills - Pine Bend, MN (combined with bitumen)
Most SCO has historically been processed in Canada.

Most future SCO growth will go to the US Midwest / Mid-continent.

New markets required to absorb incremental SCO.
Sour, Heavy SCO Expected to Increase…

- Lower capital requirements for the upgrader
  - Refiner assumes the “load” of hydrotreating product to meet specs
- Potentially unique processing / transport issues
  - Olefins, nitrogen, sulfur, gravity
  - Issues with traditional processing
  - Pipeline limitations

![Graph showing the increase in Thousand Barrels per Day from 2000 to 2020 for Sour / Heavy SCO and Sweet SCO.](image)
Considerations in screening potential markets for oil sands crudes

Initial screening based on capacity, complexity

Other considerations:
- Future heavy crude supply to large, complex USGC market
- Strong growth in Asia suggests current and new-build opportunities
- California will need more heavy imports
- Impact of regulatory constraints on market development
Canadian Markets for Western Crude

<table>
<thead>
<tr>
<th>Refinery Capacity (Thousand B/D)</th>
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<tbody>
<tr>
<td>West</td>
<td>627</td>
</tr>
<tr>
<td>Ontario</td>
<td>468</td>
</tr>
<tr>
<td>Montreal</td>
<td>255</td>
</tr>
<tr>
<td>Total</td>
<td>1,350</td>
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- West is fully supplied
- Ontario receives crude
  - ≈ 225 MB/D from west
  - ≈ 150 MB/D from east*
- Montreal receives all crude from east*

*Newfoundland and imports

Uncertain Projects

- Reversal of Enbridge Line 9 from Sarnia to Montreal
  - could increase western crude delivery by ≈ 250 MB/D
  - or more if one of Portland pipelines also reversed from Montreal to Maine
  - displaced crudes are mostly light

- Petro-Canada coker at Montreal to use heavy crude

- Shell grassroots refinery at Sarnia for oil sands crudes
  - would add more than 80 MB/D to Ontario
PADD II Markets for Canadian Crude Oil

CRUDE TYPES
- Lt Swt: 25%
- Lt Sour: 44%
- Hvy Sour: 31%
- High Tan: 2%

REFINERY CONFIGURATION
- Coking: 67%
- Cracking: 31%
- HydroSkim: 2%

SOURCE
- Domestic: 53%
- Foreign: 34%
- Canadian: 13%
PADD II is the largest market for Canadian crude.

- Canadian crude runs forecast to rise strongly.
- More pipeline capacity needed.
PADD III Markets for Canadian Crude Oil

CRUDE TYPES
- Lt Swt: 34%
- Lt Sour: 32%
- Hvy Sour: 2%
- High Tan: 2%

REFINERY CONFIGURATION
- Coking: 79%
- Cracking: 20%
- HydroSkim: 1%

SOURCE
- Domestic: 42%
- Other: 32%
- Foreign: 25%
- Canada: 1%
- Mexico / Venezuela: 1%

8.4 million Barrel per Day (design)
Most production from Venezuela is heavy sour.

Four Orinoco upgraders upgrade extra heavy Orinoco production to produce about 700 KBPD synthetic crudes, which vary from 16 to 30+ °API.

Crude production is declining in current political environment and the inflection point is uncertain.

New fiscal and operating terms delaying development of new Orinoco projects, despite a new group of participants.

Resource base is huge.

Venezuela production adding a high degree of uncertainty to heavy crude balances.
Heavy Crude Production From Mexico

- Maya produced from Cantarell offshore field has peaked
- Other heavy production from Ku-Maloob-Zaap is increasing
- New production may come from exploration and production further offshore and in deeper water - eventually

Mexico production could resume growth or go into long-term decline adding further uncertainty
PADD I refiners process significant volumes of imported sweet crude, and should continue.

**Thousand Barrels per Day**

- Heavy Sour Crude Runs
- Light Sour Crude Runs
- Sweet Crude Runs

**Thousand Barrels per Day**

- Other Imported Crude
- Canadian Crude
- Domestic Crude
Oil sands crudes have similar distillation characteristics to selected PADD I imports.
PADD I imported crude sources are varied (Barrels per Day, 2007)

- Europe 51
- CIS 43
- Middle East 167
- North Africa 127
- Canada 256
- Latin America 192
- West Africa 652

Average Quality: 31.2 API, 1.05 wt% Sulfur
Potential target refineries in Philadelphia region (capacity in MB/D):

- Sunoco Marcus Hook 175
- Sunoco Philadelphia 335
- Sunoco Eagle Point 150
- ConocoPhillips Trainer 185
- Valero Paulsboro 160

Several proposals:

- Inland pipeline
- Line 9/Portland/marine

No cost information available
Impact of Market Clearing Location

SCO – MSW, Edmonton (2008 $/BBL)

- Parity Location
  - Sarnia
  - Chicago
  - Wood River
  - Cushing
  - USGC

SCO Price Forecast

- PADD I parity likely established by Bonny Light at Philadelphia
- Edmonton netback will depend on pipeline tolls
Light/heavy differentials will drop as resid destruction capacity comes on-stream.

**Forecast in Constant 2008 Dollars per Barrel**

**USGC Light Products minus Fuel Oil**

**Crude Differential**

- Lt Products - HSFO
- WTI - Maya
- MSW - CLB

Note: Light Products = ½ (Gasoline + Distillate)
Moderation is forecast as conversion capacity is added . . .
Rapid expansion of Western Canadian Oil Sands will require new markets

- Markets required for SCO, especially with diluent alternatives becoming reality

Downstream conversion capacity required

- PADD II cooker capacity announcements appear sufficient to consume bitumen
- VGO conversion capacity required for incremental SCO

Disposition of SCO in more distant markets will likely reduce netbacks

- SCO discounts may create the economic incentive for investment
Production and marketability of Oil Sands bitumen blends and synthetic crude oil, crude price differentials, economics of upgrading and diluent issues are analyzed in Purvin & Gertz’ multi-client service, *Crude Oil & Oil Sands Market Outlook*.

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