Changing US Crude Oil Imports are Driving Refinery Upgrades, Creating Opportunities

Christopher Buehler, Ph.D., P.E.
Praveen Gunaseelan, Ph.D.

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Overview

- US Crude Oil Imports: Trends & Drivers
- Infrastructure Developments
- Impact on US Refining
- Opportunities for Gasification
- Summary
US Crude Oil Imports: Trends & Drivers
US Consumption, Production & Import Trends

Chart based on Energy Information Administration (EIA) data. Petroleum products supplied is used as an approximation for consumption.
US Crude Oil Import Trends by Country of Origin

Chart based on EIA data.
Origin of US Crude Oil Imports

Average import flows for Nov. 2007 in thousands of barrels per day

Figure from vesseltrax.com, Dec. 2007.
Historical US Imports of Crude Oil by Area of Entry

Chart based on EIA data.
US Crude Oil Imports in 2007 by Area of Entry

Figure based on EIA data, July 2008.
Lower Quality of Crude Oil Feedstock

- Crude oil becoming:
  - Heavier
  - More sour
- Increasingly stringent sulfur specifications for refined fuels
- Refining heavy sour crude oils consumes more energy and hydrogen

Chart based on EIA data.
Drivers for Increasing Crude Oil Imports to US

- Declining domestic oil production
- Long-term US demand growth for products
- Foreign producers looking to monetize reserves
- Heavy-light price differentials
- Expanding infrastructure for imports
- US refinery expansions
Infrastructure Developments
Key Infrastructure for Canadian Crude Imports
Existing, Under Construction & Planned

- Existing (2.3 MBPD)
  - Enbridge System (1.7 MBPD)
  - KM Trans Mountain (300 KBPD)
  - KM Express (280 KBPD)

- Ongoing Projects (+1.1 MBPD)
  - TCPL Keystone (435 KBPD, 2009)
  - TCPL Keystone Ext. (155 KBPD, 2010)
  - Enbridge Clipper (450 KBPD, 2010)

- Proposed Projects
  - Enbridge Southern Access Extension
  - Enbridge Southern Lights (Diluent)
  - Enbridge Gateway

Project data from Canadian Association of Petroleum Producers (CAPP) Forecast, June 2009. Figure from Alberta Energy Resources Conservation Board, June 2009.
Existing and Planned Infrastructure for Crude Imports into US Gulf Coast

Gulf Coast
Crude Oil Imports Nov. 2007
(thousands of barrels per day)

Figure adapted vesseltrax.com, Dec. 2007.
Impact on US Refining
Crude Oil Price Comparison

Chart based on EIA data.
Western Canada Oil Sands & Conventional Crude Oil Production

* Bitumen Blend includes some volumes of upgraded heavy sour crude oil and bitumen blended with diluent or upgraded crude oil.

Chart from CAPP Forecast, June 2009.
Major Ongoing and Proposed US Refinery Expansion Projects based on Heavy Crude

BP, Whiting
- $3.8B, On-stream 2011
- (+) 260 Kbpd bitumen capacity
- 102 Kbpd Coker
- 2x100 MMSCFD H₂ Plants
- Gas-Oil Hydrotreater
- Sulfur Recovery

Marathon, Detroit HOUPL $2.2B, On-stream 2012 Q3
- (+) 115 Kbpd (+80 Kbpd bitumen)
- 28 Kbpd Coker
- 12 Kbpd Coker NHT
- 33 Kbpd DHT
- 35 MMSCFD H₂
- 2x140 Sulfur Plant

BP, Husky JV – Toledo Refinery $2.5B, On-stream 2015
- (+) 170 Kbpd (+120 Kbpd heavy)
- Coker Expansion

Hyperion, South Dakota $8-10B
- 400 Kbpd Greenfield Refinery

COP/Encana JV, Wood River
- Phase 1, $1.9B, 2010
- (+) 60 Kbpd bitumen capacity
- 65 Kbpd Coker
- Phase 2, $2B, 2013
- (+) 100 Kbpd bitumen
- Crude, Coker Expansion

Marathon, Garyville $3.5B, On-stream 2009 Q4
- (+) 180 Kbpd heavy crude
- CDU, Coker, Hydrocracker
- Kero HT, Naphtha HT, Sulfur Plant

COP/Encana JV, Borger
- 3 Phases, $1.4B, 2012
- (+) 75 Kbpd bitumen capacity
- 25 Kbpd Coker
- Debottlenecking
- Crude Expansion

Motiva, Port Arthur $7B, On-stream 2010
- 325 KBPD Refinery Expansion
Refinery Configuration Changes required for Processing of DilBit

- New Capacity Required
  - Diluent Recovery
  - Crude Distillation (Atmospheric/Vacuum)
  - Bitumen Upgrading
    - Delayed Coking / Resid Hydroprocessing
    - Hydrocracking / Solvent Deasphalting
  - Sulfur Plants

- Expanded Capacity Required
  - Naphtha Hydrotreating
  - Distillate Hydrotreating

- Optional Capacity
  - Gasification of Residuals (Petroleum Coke or Asphaltenes)
Typical Refinery Configuration Changes Required for Processing DilBit

- DilBit Recovery
- Crude Distillation
- Vacuum Distillation
- Naphtha Hydrotreater
- Catalytic Reformer
- Gasoline Hydrotreater
- FCC Unit
- Distillate Hydrotreater
- Hydrocracker
- Sulfur Plant
- Gasifier
- Power, Steam

Legend:
- Recovered Diluent
- Naphtha Hydrotreater
- Catalytic Reformer
- Gasoline Hydrotreater
- FCC Unit
- Distillate Hydrotreater
- Hydrocracker
- Sulfur Plant
- Gasifier
- Power, Steam
- H₂
- Pet-Coke
Opportunities for Integrated Gasification Units

**Drivers**
- Increased volume of residuals (pet-coke, asphaltenes)
- Increasing requirements for Hydrogen, Power, Steam, Heat
- Favorable economics vs. NG
- Efficiency, waste reduction
- Refinery integration synergies
- Potential for CO₂ capture

**Process**
- Residual oxidation to Syngas
- Syngas → H₂, power
- Heat Recovery → Steam → Power

**Major Technology Providers**
- Shell
- GE
- ConocoPhillips
- Sasol/Lurgi

**Examples of Integrated Gasifiers at US Refineries**
- Valero, Delaware City, DE
- ExxonMobil, Baytown, TX
- Frontier, El Dorado, KS
Summary

- **Increasing US reliance on foreign crude oil**
  - Domestic declines, long-term product demand growth, discounts for heavy crude, infrastructure developments

- **Decreasing quality of crude imports**

- **Canada is leading exporter of crude to US**
  - Investments in oil sands production, pipelines
  - US refinery expansions based on heavy Canadian crude

- **Extensive refinery modifications needed**
  - Crude distillation capacity
  - Bitumen upgrading capacity: primary, secondary
  - Hydrotreating, sulfur recovery, etc.

- **Opportunities for integrated gasification of residuals**
Questions?

Christopher Buehler, Ph.D., P.E.
Phone: (832) 325 5721
buehler@exponent.com

Praveen Gunaseelan, Ph.D.
Phone: (713) 784 4653
Praveen@vantagepoint-energy.com
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