Challenges and Opportunities of the North American Petroleum Renaissance

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Chatham House
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EPRINC Overview

- Established in 1944
- Publishes original research on oil and gas developments
- Routinely testifies before Congress, consults with U.S. and other Gov’t officials
- Brief policymakers, Hill staff on relevant energy topics
- Presents finding through industry and public forums, universities and think tanks
- Engagement with Washington Diplomatic Community – EPRINC Embassy Series

EPRINC’s PRIMARY MISSION IS TO EVALUATE THE INTERACTION OF PETROLEUM ECONOMICS AND PUBLIC POLICY
Importance of the North American Lens

Source: Wood Mackenzie (includes NGLs)
U.S. Imports of Crude Oil and Petroleum Products as a Percent of GNP

Source: EIA, EPRINC Calculations
Major Global Challenge: Managing OPEC Spare Capacity

millions of barrels/day

Regional Rivalries and Downside Price Risk

Tight oil and Iraq are wild cards here
North American Oil Production

August U.S. Oil Production: 7.5 mbd
June Canadian Oil Production: 3.7 mbd

Source: EIA
EPRINC’s Forecast for Major U.S. Shale Plays

EPRINC forecasts an additional 1.5 mbd by 2022

Source: HPDI data with EPRINC forecast estimates
U.S. Total Imports, U.S. Production, U.S. Canadian Imports

- U.S. Imports: 7.8 mbd
- U.S. Production: 7.5 mbd
- Canadian Imports: 2.6 mbd

Source: EIA
U.S. Activity
Permit Activity

Source: HPDI September 2013, Past 90 Days
U.S. Rig Count

Source: Baker Hughes
Williston Basin Production

North Dakota accounts for almost 10% of US Production. Almost all new production is from the Bakken/Three Forks.

Source: NDIC
Permian Basin Production 1.3 mbd

Source: HPDI Oct 2013
Eagle Ford Production

Source: HPDI Nov 2013
Infrastructure Challenges and Pricing Impacts
**Pipeline Choke Points**

Source: EPRINC Choke Point Map using Hart ArcGIS Mapping software

- **Canadian Crude**
  - WCS-Heavy
  - Syncrude-Synthetic

- **Bakken Crude**
  - Light Sweet

- **Guernsey Choke Point**

- **Niobrara Crude**
  - Light Sweet

- **Clearbrook/Superior Choke Point**

- **Cushing Choke Point**
  - Over the past few years more and more domestic and Canadian crude has been pushed into Cushing without efficient outlets to the coasts.

- **Permian Crude**
  - Light Sweet

- **Eagle Ford Crude**
  - Light Sweet

- **Gulf Coast Choke Point**
  - Recent pipeline projects and expansions have begun opening Cushing to the Gulf and sending Permian crude to the Gulf. With an onslaught of Eagle Ford, Permian, and now Cushing crude, the Cushing bottleneck is moving to the Gulf Coast.

- **California refineries are a natural fit for heavy Canadian crude, but there are currently no pipeline options available. Both Washington and California have begun taking some volumes of Bakken crude over the past few years.**

- **East coast refineries are the natural home for Bakken light sweet crude, but there is currently no pipeline access to receive this oil. Rail is currently transporting both Bakken and Canadian crude to these refineries.**
All Canadian Pipeline Export Options Are Full

Source: Canadian Energy Pipeline Association
Market Saturation

Source: CAPP Crude Oil Forecast June 2013
Where light sweet Bakken and heavy (blended bitumen) needs to go…

Source: AFPM map, EIA data for graph
Regional Pricing Disparities

- Western Canadian Select -$41 to WTI

Source: Flint Hills, EIA, CME Group, and estimates
The Rise of Rail
Daily Crude by Rail Shipment in U.S. and Canada

Source: AAR; Crude and petroleum product includes liquefied gases, asphalt, fuel oil, lubricating oil, jet fuel, etc. U.S. operations exclude U.S. operations of CN and CP. Canadian operations include CN and CP and their U.S. operations. One carload holds 30,000 gallons (or 714.3 barrels).
North Dakota Crude Oil Transport

January 2012 Estimates

- Pipeline Export: 58%
- Tesoro Refinery: 10%
- Truck to Canadian Pipelines: 25%
- Estimated Rail: 7%

August 2013 Estimates

- Estimated Pipeline Export: 61%
- Tesoro Refinery: 31%
- Truck to Canadian Pipelines: 7%
- Estimated Rail: 1%

Source: North Dakota Pipeline Authority
Pipeline and Rail

- Severely limited due to lack of Keystone XL and lack of historical build out to the coasts – system designed to import into the Gulf and move up
- New markets
- Diversification
- Nimble - Quickly adjustable
- Optionality for Canadian and U.S. crude, NGLS, and other petroleum products

Source: EPRINC Maps using Hart Energy data and ArcGIS Mapping software
Refineries
Benefit
Refinery Acquisition Cost of Crude Oil

Source: EIA
Refinery Utilization by PADD

Source: EIA

East Coast (PADD 1) Percent Utilization of Refinery Operable Capacity %

Midwest (PADD 2) Percent Utilization of Refinery Operable Capacity %

Gulf Coast (PADD 3) Percent Utilization of Refinery Operable Capacity %

Rocky Mountains (PADD 4) Percent Utilization of Refinery Operable Capacity %

West Coast (PADD 5) Percent Utilization of Refinery Operable Capacity %

Aug PADD 4 99%
Regulatory Concerns and Conclusions
Potential Issues, Hurdles, and Regulatory Concerns

- Oil prices
- Water Usage – Fracking and Recycling
- Oil spills (rail and pipeline)
- Environmental Concerns
- Regs on Federal Land-Fracking
- Infrastructure Delays-PERMITTING
- Lack of prudent policy making: failing to connect what is happening on the ground to what is understood in Washington
- Costs incurred
Conclusions

• Since 2008 the U.S. and Canada have added over 3 mbd of crude to global production, helping offset issues in Libya and the Middle East.
• Pipelines are being built, but right now their is tightness in the system and an increasing need for Gateway, XL, and other Coastal options for US and Canadian crude.
• Bakken crude has to get to the U.S. East and West Coasts (via rail) and heavy Canadian needs to get to the Gulf and West Coast (via pipeline and rail).
• Roughly 7.7 mbd of new capacity (as estimated by EPRINC) is comprised of pipeline reversals, expansions, twinning, repurposing, and retrofitting. There are serious regulatory and permitting hurdles which deserve consideration.
• Even with a narrowing spread, rail is a serious option for US producers distanced from refining centers, especially Bakken and Canadian crude—markets exist where pipelines do not (especially with XL delay and Gateway uncertainty).
• Market has changes for producers and refiners with optionality, market and regulatory uncertainty
• Rail will be here in the long term, the question is simply how much and where.
• Refineries are going to play a vital role in this renaissance as they adapt to high volumes of light sweet and heavy crude oils.
APPENDIX
## Reserve Estimates

<table>
<thead>
<tr>
<th>Bakken Reserve Estimates</th>
<th>Barrels</th>
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<tbody>
<tr>
<td>1995 USGS</td>
<td>151 million</td>
</tr>
<tr>
<td>2008 USGS</td>
<td>4.3 billion</td>
</tr>
<tr>
<td>2010 NDIC</td>
<td>Add 1.9 billion (Three-Forks Addition)</td>
</tr>
<tr>
<td>January 2011 ND State Officials</td>
<td>11 billion (North Dakota alone)</td>
</tr>
<tr>
<td>Continental Resources</td>
<td>20 billion</td>
</tr>
<tr>
<td>....Pending USGS Update</td>
<td>???? billion</td>
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</table>

Source: EPRINC
CAPP 2013 Updated Production Forecast

Source: CAPP

Over 3 mbd increase by 2030

Thousands of Barrels per Day

- Mining
- In Situ
- Conventional Light
- Conventional Heavy

Source: CAPP
U.S. Federal Land Map

Source: NationalAtlas.gov
Horizontal Drilling and Hydraulic Fracturing

- **24" conductor casing (10-60 feet)** cemented to surface
- **20" casing (200-500 feet)** cemented to surface
- **13 3/8" casing** (up to 1,000 feet) cemented to surface
- **9 5/8" casing**, if necessary to seal off shallow oil, gas or brine-bearing zones
- **5 1/2" casing**, 500 feet above Marcellus

**Hydraulic Fracturing**

Hydraulic fracturing, or "fracking," involves the injection of more than a million gallons of water, sand and chemicals at high pressure down and across into horizontally drilled wells as far as 10,000 feet below the surface. The pressurized mixture causes the rock layer, in this case the Marcellus Shale, to crack. These fissures are held open by the sand particles so that natural gas from the shale can flow up the well.

Roughly 200 tanker trucks deliver water for the fracturing process. A pumper truck injects a mix of sand, water and chemicals into the well. Recovered water is stored in open pits, then taken to a treatment plant.

Storage tanks
Natural gas is trucked to a pipeline for delivery

Graphic by Al Granberg
Fracking Concerns

Source: http://www.makingitmagazine.net/?p=7084
Natural Gas Flaring

In North Dakota, Flames of Wasted Natural Gas Light the Prairie

Source: NDPA
Why?

**Simple Terms**
- **GREEN** – Gas is sold to consumers
- **Orange** – Challenges on existing infrastructure
- **Blue** – Lack of pipelines

**Legend**
- **GREEN** – % of gas captured and sold
- **Orange** – % flared from wells with at least one mcf sold.
- **Blue** – % flared from zero sales wells

**Source:** NDPA
## Cost of Oil Sands Production

### Estimated Initial Capital Expenditure (CAPEX) and Threshold\(^{(a)}\) Prices for New Oil Sands Projects

<table>
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<tr>
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<th><strong>CAPEX</strong></th>
<th><strong>Economic Threshold</strong></th>
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</thead>
<tbody>
<tr>
<td>Mining, Extraction and Upgrading</td>
<td>$85,000-$105,000</td>
<td>$85-$95</td>
</tr>
<tr>
<td>Mining and Extraction Only (No upgrading)</td>
<td>$60,000-$75,000</td>
<td>$65-$75</td>
</tr>
<tr>
<td>Steam-assisted Gravity Drainage (SAGD)/Cyclic Steam Stimulation (CSS)</td>
<td>$25,000-$40,000</td>
<td>$50-$60</td>
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</table>

\(^{(a)}\) Includes a realistic after-tax rate of return, commonly in the order of 10 to 15%.


Source: PacWest Consulting
Shale Oil Play Break Even Costs

Source: ITG Investment Presentation Nov 2012
Issues and Regulations

http://northernrockiesrisingtide.wordpress.com/tar-sandkearl-module-faq/
Issues and Regulations
Decline Rates

Source: Lynn Helms, ND Dept. of Mineral Resources, NDPC
Meeting Sept. 2011 Medora ND
Exports of Petroleum Product

Source: EIA
Estimated Ultimate Recovery

Source: Brigham Exploration via World Oil
Completion Best Practices

- Studies have shown that **permeability of the rock**, **completion best practices**, and **type of fracking fluids** and components all matter in increasing production (Oil and Gas Investor).

Source: Bakken Breakout Bismark Tribune Summer 2011
Need Sand, Water, and Fracs

- Three million gallons of water per well...Need FRESH water for fracking.... (6 billion gallons per year-2000 wells per year)

- 2-3 million pounds of sand per well (ceramics, natural sand, resin coated sand)

- 6 billion pounds of sand used in 2011 = 30,000 railcars of sand

Source: Superior Well Services, Bakken Investor Conference, June 2011, Minot, ND
Drilling Then and Now

Source: From PIECE Course Workbook, Mark J Kaiser, Houston, July 2008, “Introduction to USA Petroleum Industry”
North American Potential...Shale Oil Plays
Shifting Crude Flows

Source: EIA, EPRINC

New Capacity 2013-2015 (mbd)

<table>
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<tr>
<th>Inbound: Cushing, Ok</th>
<th>1.97</th>
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<tbody>
<tr>
<td>Outbound: Cushing, OK</td>
<td>1.55</td>
</tr>
<tr>
<td>Inbound: Gulf Coast</td>
<td>3.52</td>
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Midwest (PADD 2) Receipts by Pipeline from Gulf Coast (PADD 3)

Gulf Coast (PADD 3) Receipts by Pipeline from Midwest (PADD 2)
Pipelines and Proposed Projects

The majority of this new pipeline capacity, roughly 7.7 mbd (as estimated by EPRINC), is composed of pipeline reversals, expansions, twinning, repurposing, and retrofitting.

Source: CAPP Crude Oil Forecast June 2013
Bakken Drilling

- Original dual-zone development plan
  - 8 wells per 1,280 acres – 4MB, 4TF
  - 603,000 Boe EUR per well (avg. 24.5 stages/completions)
  - ECO-Pad® design: 2 wells south, 2 wells north
- Additional Three Forks potential

Source: Continental Resources Inc., Corporate Presentation, 2012.
Source: Triangle Petroleum Corporation, Presentation Bakken Product Markets and Take-Away Denver Jan 31-Feb 1 2012
Canadian vs. Total Foreign Imports by PADD

Source: EIA Data
In 2012 CAPP estimated the costs to the Canadian economy were $40 million/day.

Source: Canadian Energy Pipeline Association