Challenges and Opportunities of the North American Petroleum Renaissance

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About EPRINC

• Founded in 1944

• Not-for-profit organization that studies intersection of energy economics and public policy, with emphasis on oil, natural gas, and petroleum product markets

• Institutional support from private sector and project support from US Government

• www.eprinc.org
EPRINC Embassy Series

• Engagement with Washington’s energy policy community

• Collaboration among the diplomatic community to provide both an interesting venue and constructive policy discussion

• The series offers an opportunity to gain a greater understanding of U.S. energy policy in an era of expanding U.S. supplies of oil and gas
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
Regional Propane Prices

Source: KBC Advanced Technologies

Significant Export Incentives
Average Projected Relative Manufacturing Costs for 2015

Manufacturing cost index (U.S. = 100)

Note: Cost structures were calculated as a weighted average across all industries. No difference was assumed in “other” costs (e.g., raw materials inputs and machine and tool depreciation). Differences in values are a function of the industry mix of each exporting country.

1U.S. figures represent costs in a set of select lower-cost states specified in previous publications.
2Chinese figures represent the Yangtze River Delta region.
Major Global Challenge: Managing OPEC Spare Capacity

Million barrels/day

Regional Rivalries and Downside Price Risk

Tight oil and Iraq are wild cards here
Outline

1. Breakdown of U.S. and Canadian Oil Production

2. Infrastructure Challenges in Moving Rising Volumes of North American Crude Oil

3. Regulatory Concerns and Conclusions


Source: EIA
EPRINC forecasts an additional 2.5 mbd by 2020.
U.S. Total Imports, U.S. Production, U.S. Canadian Imports

U.S. Imports 7.8 mbd
U.S. Production 7.7 mbd

Canadian Imports 2.6 mbd

Source: EIA
U.S. Activity
Permit Activity

Source: HPDI January 18 2014, Past 90 Days
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
So how much oil is there...?

<table>
<thead>
<tr>
<th>Bakken Reserve Estimates</th>
<th>Barrels</th>
</tr>
</thead>
<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>
</tr>
</tbody>
</table>

Source: EPRINC
State Production Trends

Source: EIA
U.S. Rig Count

Source: Baker Hughes
Part of the U.S. story

Source: NationalAtlas.gov
The Soaring Eagle Ford
Eagle Ford Wells

Source: HPDI Nov 2013
Eagle Ford Production

Source: HPDI Nov 2013
The Prolific Permian Basin
Permian Basin Production 1.38 mbd

Source: HPDI Oct 2013
EPRINC November Revised Permian Forecast

Source: EPRINC
Bakken
Williston Basin Production

Source: NDIC
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
Decline Rates

Source: HPDI, Bakken
Infrastructure Challenges
Pipeline Choke Points

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

- **Bakken Crude-Light Sweet**

- **Guernsey Choke Point**
  - 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.

- **Niobrara Crude-Light Sweet**

- **Clearbrook/Superior 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**

- **Cushing Choke Point**

- **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.

- **Eagle Ford Crude-Light Sweet**

Source: EPRINC Choke Point Map using Hart ArcGIS Mapping software
All Canadian Pipeline Export Options are Full

- **Kinder Morgan’s** Transmountain line off BC coast - currently 300,000 b/d capacity-recent announcements to expand up to 800,000 b/d (early 2017)

- **(Now Spectra)** Platte line to Wood River 280,000 b/d-full

- **Enbridge** mainline system currently transporting over 1.5 mbd with potential capacity around 2.5 mbd—Northern Gateway off BC coast planned 525,000 b/d, several other planned expansions, light oil access +400,000 b/d

- **TransCanada’s** Keystone 581,000 b/d-full—XL would add 700,000 b/d, Energy East Pipeline Project 500 to 800k
Market Saturation

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

Total Coking Capacity vs. Atmospheric Crude Distillation Capacity by PADD

Cokers = Heavy refining capability

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

- Western Canadian Select -$18.50 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).
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
- Neat Barrels
- 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
North Dakota Crude Oil Transport

January 2012 Estimates

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

November 2013 Estimates

- Estimated Pipeline Export: 71%
- Tesoro Refinery: 1%
- Truck to Canadian Pipelines: 22%
- Estimated Rail: 6%

Source: North Dakota Pipeline Authority
Crude by Rail Accidents

- July 6, 2013, a run-away train crashed and exploded in Lac-Mégantic, Quebec, killing 47 people and destroying parts of the town.
- November 8, 2013, about 12 cars derailed in a unit train of 90 cars carrying crude oil near Aliceville, Alabama (45 miles SW Tuscaloosa). Nobody was injured, but three of the cars exploded.
- December 30, 2013, a train hauling grain derailed near Casselton, (SE) ND hitting a 106 car unit train of crude oil which caused 18 crude tank cars to derail causing a massive explosion and fireball.
- January 7, 2014, a Canadian National train jumped tracks in Plaster Rock, New Brunswick. 15 cars derailed and caught fire. The train was carrying propane and crude oil from Western Canada.
- January 20, 2014, a CSX train derailed in Pennsylvania on a railroad bridge and close a busy expressway (Schuylkill), but did not leak any crude oil.

Refineries Benefit
Refinery Acquisition Cost of Crude Oil

Source: EIA

$/Barrel

- East Coast (PADD 1) Crude Oil Composite Acquisition Cost by Refiners $/bbl
- Midwest (PADD 2) Crude Oil Composite Acquisition Cost by Refiners $/bbl
- Rocky Mountain (PADD 4) Crude Oil Composite Acquisition Cost by Refiners $/bbl
- West Coast (PADD 5) Crude Oil Composite Acquisition Cost by Refiners $/bbl
- Gulf Coast (PADD 3) Crude Oil Composite Acquisition Cost by Refiners $/bbl
- Brent

Source: EIA
Refinery Utilization by PADD

Source: EIA
Regulatory Concerns
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
- Exports
Natural Gas Flaring

Source: NDPA
APPENDIX
US LNG Export Scenario

Source: Bentek
Value of an Oil Well in North Dakota

Typical 2012 North Dakota Bakken well will produce for 29 years (enhanced oil recovery efforts could extend the life of the well)

In those 29 years the average Bakken well:

• Produces approximately 580,000 barrels of oil
• Generates over $22 million net profit
• Cost $8,500,000 to drill and complete (up from 7.3 last year)

• Pays approximately $4,610,000 in taxes
  • $2,200,000 gross production taxes
  • $2,000,000 extraction tax
  • $410,000 sales tax
  • Pays royalties of $7,925,000 to mineral owners
  • Pays salaries and wages of $1,500,000
  • Pays operating expenses of $2,300,000

Source: ND Department of Mineral Resources 2012 Presentation