Managing Midstream Mayhem: 
Mixing New Oil with Old Infrastructure

Peter Whitman*
International Association of Energy Economists
June 17, 2014

* US Department of Energy. This presentation is the sole responsibility of the author and does not necessarily reflect the views of the US Government or the Department of Energy
Outline

Objectives
• Changing oil landscape will require additional infrastructure
• Examine effect of lifting stylized oil export ban on flows

Methodology
• Least-cost production and transportation flow model of Atlantic Basin crude oil supply and consumption at refining centers
• Develop representative refining model configurations and types
• Derive refinery costs for changing crude slates by each refinery configuration
• Detailed domestic crude infrastructure model with individual transportation routes. Reduced form international nodes and routes

Indicative Results and Conclusions
• Describe change in flows with increased domestic production
• Methodology for change in refinery margins
The Problem
Refinery Conversion Capability by Type 2012 Crude Utilization
Imports of Crude by PADD 2007 and 2012
Infrastructure Model

Methodology

• Least-cost model:
  o Refinery economics modeling with Argonne National Laboratory and Jacobs Consulting
  o Refinery aggregations by refinery processing type (31 distinct refinery nodes)
  o Domestic infrastructure modeling with Oak Ridge National Laboratory
  o Tariffs and tanker rates

• Develop representative refining model configurations and types
  o Unit characteristics derived from commercial applications
  o Gulf Coast heavy coking refinery
  o Gulf Coast light cracking refinery
  o Midwest heavy coking refinery
  o European representation

• Aggregate refinery groups by throughput bottoms percent
  o Fraction of crude running through secondary processing units
  o Reflects amount of processing available to create high value products
  o Heavy crudes have higher bottoms percent; require more processing
Detailed Methodology

Methodology (continued)

• Detailed domestic crude infrastructure model with individual transportation routes. Reduced form international nodes and routes
  o Significant individual pipelines
  o Domestic barge and rail routes
  o Reduced form international nodes and routes
  o Key crude transportation routes: Africa, Europe, Latin America
  o EU refining node

• Derive refinery costs and margin impacts for changing crude slates for each refinery configuration
  o Crude oil supply based on EIA’s Annual Energy Outlook
  o Domestic supply modeled by crude type: 5 crude streams by region (17 domestic regions)
  o International crudes relevant to the Atlantic Basin
  o Pooling, non-linear representation of blends, other standard refinery modeling techniques
  o Incorporate results of detailed refinery modeling through quantification of refining costs due to changing crude slate
  o Constraints on bottoms percent by refinery aggregate
Key Design Metrics

Crude Specifications

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Hvy Sour</th>
<th>Med Sour</th>
<th>Light Sour</th>
<th>Hvy Med Sweet</th>
<th>Lt Sweet</th>
</tr>
</thead>
<tbody>
<tr>
<td>API</td>
<td>API&lt;28</td>
<td>API 28-32</td>
<td>API&gt;32</td>
<td>API&lt;35</td>
<td>API&gt;=35</td>
</tr>
<tr>
<td>Sulfur</td>
<td>Sul &gt;.5</td>
<td>Sul &gt;.5</td>
<td>Sul &lt; .5</td>
<td>Sul &lt; .5</td>
<td>Sul &lt; .5</td>
</tr>
</tbody>
</table>

Refinery Groups

<table>
<thead>
<tr>
<th>PADD</th>
<th>Number of Refinery Groups</th>
<th>Average Bottoms Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>3</td>
<td>16.23</td>
</tr>
<tr>
<td>P2</td>
<td>12</td>
<td>17.18</td>
</tr>
<tr>
<td>P3</td>
<td>8</td>
<td>20.32</td>
</tr>
<tr>
<td>P4</td>
<td>3</td>
<td>18.42</td>
</tr>
<tr>
<td>P5</td>
<td>3</td>
<td>24.24</td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
<td>-</td>
</tr>
</tbody>
</table>

Base Domestic Production

<table>
<thead>
<tr>
<th>2012 Crude Production (MB/D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PADD</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>
Reference Case

Crude Quality Consumption by Year

**PADD III Crude Types**

- Hvy Sour
- Med Sour
- Light Sour
- Hvy Med Sweet
- Lt Sweet

**PADD II Crude Types**

- Hvy Sour
- Med Sour
- Light Sour
- Hvy Med Sweet
- Lt Sweet
Reference Case Results

Waterborne imports

![Bar chart showing waterborne imports for different categories and years: 2012, 2015, 2020. The chart indicates the flow in thousands of barrels per day for categories such as Heavy Sour, Medium Sour, Light Sour, Heavy Medium Sweet, Light Sweet, and Total Flow.]
High Resource Case Crude Quality

Lifted Export Ban

Export Ban

Legend:
- 2012
- 2015
- 2020
High Resource Case Waterborne Imports

![Bar Chart: Lifted Export Ban](chart1)

- **Hvy_Sour**
- **Med_Sour**
- **Light_Sour**
- **Hvy_Med_Sweet**
- **Lt_Sweet**

- **Thousands of Barrels per Day**
- **2012**
- **2015**
- **2020**

![Bar Chart: Export Ban](chart2)

- **Hvy_Sour**
- **Med_Sour**
- **Light_Sour**
- **Hvy_Med_Sweet**
- **Lt_Sweet**

- **Thousands of Barrels per Day**
- **2012**
- **2015**
- **2020**
## Indicative Marginal Values

**No Price Feedback**  
**No Product Response**  
**Brent at $110**

### Selected Marginal Prices: No Feedback

<table>
<thead>
<tr>
<th>Refinery</th>
<th>No Export</th>
<th>Export</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicago_Refineries_Coking</td>
<td>$90</td>
<td>$96</td>
</tr>
<tr>
<td>Ohio_Refineries</td>
<td>$96</td>
<td>$107</td>
</tr>
<tr>
<td>Texas_3_Refineries_Bottoms_Conversion</td>
<td>$94</td>
<td>$103</td>
</tr>
<tr>
<td>Texas_3_Refineries_Without_Bottoms_Conversion</td>
<td>$96</td>
<td>$112</td>
</tr>
<tr>
<td>EC_Light_Refineries</td>
<td>$110</td>
<td>$111</td>
</tr>
<tr>
<td>EC_Heavy_Refineries</td>
<td>$104</td>
<td>$102</td>
</tr>
<tr>
<td>LA_AL_Bottoms_Conversion</td>
<td>$95</td>
<td>$103</td>
</tr>
<tr>
<td>LA_AL_Without_Bottoms_Conversion</td>
<td>$96</td>
<td>$110</td>
</tr>
</tbody>
</table>
Conclusions

- Model shows increasing US production of light crudes, along with increased Canadian production of heavy crudes could have a modest impact on US refining.

- Currently planned infrastructure along with rail could accommodate changing crude flows under reference conditions

- The potential exists for exports to influence refinery economics and producer wealth distribution

- Model shows relatively modest changes in refinery operations will likely be necessary to accommodate a changed crude slate under reference forecasts, though profitability may very well be impacted.