Crude Stream/Grade Competition in the North American Shale Fairway Refining Market

Selected Extracts from EAI, Inc. ‘s North American Crude Study, Crudehub and Deep Dive Product Series

for

Crude Oil Quality Association
Denver, Colorado

May 23, 2017
Crude Stream/Grade Competition in the North American Shale Fairway Refining Market

- Overall North American Supply, Demand & Logistics Pulse
- Western Canada Update from EAI, Inc. Canada Deep Dive Study
- North American Shale Fairway Update: Activity, Production, Streams-Grades and EAI, Inc. Basin Deep Dive Insights
- North American Shale Fairway Highway Insights & Outlooks
  - Import shift
  - Refining Crude Slates: A very Dynamic Environment
  - Exports-Gulf Coast Gateway for Clearing Hydrocarbons
    - Hydrocarbon Resources – It isn’t just crude
    - Refined Products with Mexico Reform

- Closing Remarks
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EAI, Inc. North American Shale Fairway Regions

- Western Canada
- Rocky Mountain
- Northern Tier
- Midcon
- Western Gulf
- Midwest
- Eastern Gulf
The North American Shale Fairway (NASF): Key Interregional Dynamics Across the Crude-Light Product Spectrum

Key Supply-Demand-Pricing Trigger Points Occurring in 2017-2018

- USCC transitioning from being short to long (by balance-LM grades)
- Overall NASF supply (non-waterborne) will exceed refinery runs (LM grades)

* NASF Network Balance Forecast Boundary is USCC & GC with Western Canada, Eastern Rockies and East / West Coast markets net crude interactions
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Canada’s Crude Oil Production Basins

- Western Canadian Sedimentary Basin (WCSB)
- Hudson Bay Basin
- Appalachian Basin
- Orphan Basin
- Flemish Pass Basin
- Jeanne d’Arc Basin
- Michigan Basin
- Appalachian Basin

Abbreviations:
- BC: British Columbia
- AB: Alberta
- SK: Saskatchewan
- MB: Manitoba
- ON: Ontario
- QC: Quebec
- NS: Nova Scotia
- NB: New Brunswick
- NT: Northwest Territories
- YT: Yukon
- NWT: Nunavut
Western Canada Production Outlook by Major Stream

- **Total Canadian production is likely to exceed 4.7 MMBPD in 2018, with growth leveling to 5000 MBPD by 2021.**
- **Incremental Growth Streams/Grades 2017-2018:**
  - **SAGD Bitumen:** Dil-Bit, Rail-Bit, Raw Bitumen
  - **Oil Sands Mining Projects:** Kearl and Fort Hills
  - **Unconventional Plays:** Montney, Duvernay and Others

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**Base Bitumen Production**

Actual production through 201712

- **Suncor Fort Hills**
- **Kearl Blend (Post 12-2017)**
- **New Projects > 2017**
- **Heavy Conventional**
- **Light Conventional/Tight Oil**
- **Synthetic Crude Plus Some Intermediates**
- **Diluent for Bitumen Blend**
- **Fort Hills**
- **Heavy Conventional**
- **New In-Situ Projects Under Construction and Likely to Proceed**
The characterization of the various Canadian unconventional plays is typically less detailed than in the U.S. Many Canadian plays have differing names for formations of the same geologic age. Additionally basin names, field names, formation names, group names and member names may be used to reference the same plays.

- **VIKING**
  - Primarily located in Eastern AB and Western SK.
  - Typical crude is heavier than other unconventional production.

- **SHAUNAVON**
  - Produced from a small area in Southern SK.

- **BAKKEN**
  - Canadian Bakken production is largely sourced from the Northern Williston Basin.
  - Additional production is from the new AB Bakken play.

- **CARDIUM**
  - Production is sourced primarily from the AB Foothills.
  - This play is one of the most developed unconventional plays in Canada.

- **MONTNEY**
  - This unconventional play stretches through AB and BC and primarily produces gas and condensates.

- **DUVERNAY**
  - Development has just started in this condensate rich play with early wells located around the Peace River Arch.
Western Canadian Light/Medium Crude Outlook
Conventional Base Decline with Unconventional Growth

- Production from Canada’s unconventional resource plays will support growth over the forecast period primarily from the Duvernay and Montney plays.
- The light/medium conventional production stream is expected to continue to decline at traditional rates.
Canadian Crude Oil Production and Pipeline Export Capacity
Focus on Pipeline Project Timelines

- Major export pipelines, which compete with rail for crude oil capacity, all face some delays.
- The three major incremental projects (Line 3 Replacement, Trans Mountain, Keystone) are projected to begin operating between 2019-2022 timeframe.

- ALCL Expansion Phase 1 (450→570 MBPD) in 3Q-2014 and Phase 2 (570→800 MBPD) in 3Q-2015
- Current Approximate Production Level
- TMX faces huge public opposition hurdles in B.C.
- Line 3 Expansion could be delayed due to Route Permitting in Minnesota
- KXL earliest construction in 2019, startup in 2021

Capacity build up of pipeline projects at effective utilization capacity (94% full capacity). All projects listed have inherent risks to become delayed or cancelled. The risk for delays versus on-time are shown in the slashed areas. Pipelines are stacked in order of estimated likelihood to actually come online.
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<table>
<thead>
<tr>
<th>North America Shale Fairway Production Outlook</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ EAI, Inc.'s annual production across the NASF averaged 13.4 MMBPD in 2017 (inclusive of AK, CA and Canada)</td>
</tr>
<tr>
<td>▪ Will likely reach 14.7 MMBPD in 2018</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Growth in Producer Capital Expenditures</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Across NASF operators have grown capital expenditure by an average of 15% from 2017 – 2018.</td>
</tr>
<tr>
<td>▪ This is lower than the 2016 – 2017 recovery period which had gains of 25% plus.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rig Count and Drilling Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ U.S. rig count grew 7% during 1Q 2018 from 924 to 993 and exceeded 1000 through April which is the highest level in 2 years</td>
</tr>
</tbody>
</table>
EAI, Inc. North American Shale Fairway (NASF) Production Update

- Most unconventional basins across the NASF have grown considerably from 4Q 2016 – 4Q 2017
- Overall net growth 1365 with Permian Basin representing 49 percent of this total
- West Canada (primarily heavy), Bakken, Colorado/DJ and Eagle Ford most of the balance at 650
- Large fraction of this incremental is moving south to Gulf Coast refining or export markets

Represents growth from 4Q 2016 - 4Q 2017, (omitted December 2017 data sets because they are not yet complete.

* Gulf of Mexico production was adjusted to account for significant hurricane related production impacts in 2017.
<table>
<thead>
<tr>
<th>Basin/Play</th>
<th>2017 Prd (MBPD)</th>
<th>Regional Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Canada Heavy/Oil Sands</strong></td>
<td>2840</td>
<td>Production growth: Fort Hills mine and incremental production from existing and some greenfield in-situ projects. Exxon’s Kearl project is undergoing some expansion. Longer term (post 2019-2020) lag in new project development slows oil sands growth.</td>
</tr>
<tr>
<td><strong>Canada Light/Medium</strong></td>
<td>1470</td>
<td>The light/medium conventional streams continue to decline. New light oil production primarily from Duvernay and Montney will provide some production growth over the outlook period.</td>
</tr>
<tr>
<td><strong>Bakken</strong></td>
<td>1060</td>
<td>Through early 2018, investment has been picking up as well as permitting &amp; drilling. Supported by drilling in the core led by pure play operators. Restrictions on gas flaring may limit the potential for off-core expansion longer term.</td>
</tr>
<tr>
<td><strong>Powder River</strong></td>
<td>94</td>
<td>The Powder River Basin in Wyoming remains an economical target for the Niobrara play. However, high geologic complexity and strong returns in competing U.S. shale plays tend to prioritize investment away from this basin.</td>
</tr>
<tr>
<td><strong>Denver Julesburg</strong></td>
<td>331</td>
<td>The condensate rich Wattenberg field remains a key drilling target through 2018 supported by strong economics in the core of the basin. However, investments in off-core areas such as the Northwest Mineral Belt remained challenged.</td>
</tr>
</tbody>
</table>
### EAI, Inc. North American Crude Production Synopsis

**Regional Production, Rig Count Trends and Current Activity Overview**

<table>
<thead>
<tr>
<th>Basin/Play</th>
<th>2017 Prd (MBPD)</th>
<th>Regional Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid West / Utica</td>
<td>99</td>
<td>Overall drilling activity in the Mid West remains focused on the Utica condensate core. Regional economics (especially for associated gas) tend to limit the play’s potential.</td>
</tr>
<tr>
<td>Mid Continent (OK Uncon.)</td>
<td>473</td>
<td>Within Oklahoma operators continue to drill in the stacked Woodford plays (STACK, SCOOP, etc.) which are economic in early 2018. Likely the 3rd most desirable basin target.</td>
</tr>
<tr>
<td>Permian (Delaware)</td>
<td>997</td>
<td>The Delaware Sub Basin is the largest source of incremental production growth in the NASF through 2018. Driven by investment /drilling activity in the Wolfcamp play. Many operators diverting resources away from competing NASF shale plays to invest in this basin.</td>
</tr>
<tr>
<td>Permian (Midland)</td>
<td>1423</td>
<td>Not as strong as the neighboring Delaware Basin, the Midland Basin is still undergoing significant production growth through 2018. The Wolfcamp economics are very supportive in the massive Spraberry field under the current price environment.</td>
</tr>
<tr>
<td>Eagle Ford</td>
<td>1200</td>
<td>The Eagle Ford is expected pickup/grow this year (2018), although the region competes heavily with the Permian Basin for capital and drilling resources. The LaSalle/McMullen condensate trend is likely to support much of the 2018 growth.</td>
</tr>
<tr>
<td>Gulf of Mexico</td>
<td>1634</td>
<td>Overall production growth peaks over the next 3 years limited much like the Oil Sands projects within Canada. Recent capital expenditure in the region has not been sufficient enough to generate enough new projects to offset older production declines.</td>
</tr>
</tbody>
</table>
Crude Production Outlook by Stream

**EAI, Inc. CrudeHub Output: North American Shale Fairway (NASF)**

- **Permian Delaware Basin, Eagle Ford, DJ and West Canada Duvernay/Montney-Condensate Drivers**
- **Western Canada dil-bit major growth stream driven by SAGD projects that were started a number of years ago as well as major oil sands mining projects: Fort Hills (ramping up) and Kearl (expanding capacity)**
Crude Production Outlook: Condensate (From Lease/Wells)

- Condensate generally has most favorable production economics. Permian Delaware, Eagle Ford and DJ-Wattenberg condensate logistics and market access moving in a direction where it can all be segregated.
- Most U.S. condensate is in the 45-55 API range; Montney/Duvernay produce lighter streams which is advantageous for diluent market but most shipped to U.S. market as dil-bit, i.e. U.S. refineries still receive.
- Note: Montney-Duvernay production outlook detailed in another slide and not included in these totals.

Includes Bakken, Rockies, Midcontinent, Midwest, Gulf Coast (but not Western Canada Unconventional which is broken out in another chart)
Permian Basin Production
(EAI, Inc. P Area) Characterization

Map showing the various regions of the Permian Basin, including:
- Delaware Basin
- Southeastern Shelf
- Ouachita Structural Belt
- Matador Arch
- Midland Basin
- Val Verde Basin
- Northwest Shelf
- Eastern Shelf

Legend:
- P1
- P2
- P3
- P4
- P5
- P6
- P7
- P8
- P9
- P10
- P11
The lightest oil production in the Permian Basin is sourced from the Delaware Sub Basin in the West.

EAI, Inc.’s base price scenario indicates a growth rate of roughly 26% from 924 MBPD in 2017 to 1163 MBPD in 2018 for the Delaware Sub Basin production area.

The top 5 producing fields in the Delaware Sub Basin have an average crude oil gravity of roughly 45° API.

The most important field to monitor in the area is the Ford (West): production growth of 100% from 2015 – 2017 and has the highest average API gravity in the Delaware and expected to increase as more production comes online.

Well locations for the top fields measured by liquid production in the Delaware basin through Q3 2017. *Indicates primarily WTI/WTS conventional production
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- Closing Remarks
- U.S. heavy crude imports increasing since 2013 and reached over 4000 MPBD in 2017 led by Canadian supply.
- Most other sources have declined or flattened over the last few years with Venezuela averaging 543 MBPD to the U.S. in 2017
Latin America Production and Export Summary

- 2017 Overall LAM crude production averaged 9.2 MMBPD and roughly 2.0 MMBPD was exported to the U.S.
- The most noticeable changes to the Latin America exports includes the loss of Venezuela production which is averaging around 1.5 MBPD in early 2018. While all Venezuela grades have been affected by national turmoil the heaviest grades which require diluent for transport have been impacted the most.

<table>
<thead>
<tr>
<th>Subarea</th>
<th>Country</th>
<th>Production</th>
<th>Export U.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCST</td>
<td>Venezuela</td>
<td>1753</td>
<td>618</td>
</tr>
<tr>
<td>MXCO</td>
<td>Mexico</td>
<td>2156</td>
<td>607</td>
</tr>
<tr>
<td>WCST</td>
<td>Colombia</td>
<td>1037</td>
<td>333</td>
</tr>
<tr>
<td>WCST</td>
<td>Ecuador</td>
<td>509</td>
<td>206</td>
</tr>
<tr>
<td>ECST</td>
<td>Brazil</td>
<td>2647</td>
<td>198</td>
</tr>
<tr>
<td>ECST</td>
<td>Argentina</td>
<td>816</td>
<td>0</td>
</tr>
<tr>
<td>CRBN</td>
<td>Trinidad/Tobago</td>
<td>74</td>
<td>8</td>
</tr>
<tr>
<td>WCST</td>
<td>Peru</td>
<td>43</td>
<td>2</td>
</tr>
<tr>
<td>CNAM</td>
<td>Guatemala</td>
<td>10</td>
<td>8</td>
</tr>
</tbody>
</table>

The table shows annual average crude oil production with exports to U.S. Based on EAI, Inc. petroleum balance tables. Volumes may not match other tables/slides due to handling of petroleum liquids (other).

Supply Regions Shown by Color and Representation
- MX – A Subset of North America
- CNAM – A Subset Of Latin America
- WCST – South American West Coast
- NCST – South America North Coast
- ECST – South America East Coast
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Foreign crude summarized by grade category. Domestic crude consists primarily of light sweet and light sour crude with the exception of GOM-Mars medium sour, OK-Velma heavy, CA – heavy/AK ANS, and Wyoming heavy crude streams. EAI, Inc. tracks and analyzes all plants; Shale Fairway consists of 23 refinery hubs and 88 plants.
Refining Expansion & Crude Slate Shift: U.S Shale Fairway (USSF)

- Refineries in USSF have expanded by 684 MBPD plus have increased utilization
- Total runs across the NASF have increased by 1880 MBPD after adjusting for Harvey
- Heavy crude runs grew over 500 MBPD and domestic light/med by 1790 -some of this growth is displacement of foreign light and medium sour
- Heavy crude runs hit 3800 MBPD in 2017Q2 and fell off a bit with Harvey-likely supply constrained with Canada – US pipeline constraints and Venezuelan production collapse

![Graph showing refining capacity and crude runs](image-url)
Refining Crude Slate Fractions by Foreign Grade and Domestic: U.S. Shale Fairway

- Domestic crude percent of total runs increasing support by utilization increases & expansions
- Heavy crude represents 30-34 percent of the overall crude slate has grown until recently
- Foreign grades fairly steady with some drop off of light and medium sour
- Ramp-up of US GOM medium sour and OPEC cuts contributing to Medium Sour fall off

![Diagram showing crude slate fractions over time]
Refining Expansion & Crude Slate Shift: U.S. Gulf Coast

- Refineries in Gulf Coast have expanded by 425 MBPD plus have increased utilization
- Utilization increases and expansions appear to be driven by predominately by domestic light/med crude runs
- Heavy crude runs running at 1700-2000 MBPD fairly steady.
- Increasing Canadian was replacing southern waterborne (LAM) but limited by pipeline and recent rail constraints. Incremental rail key to fill heavy crude gap.
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- Thank you!
U.S. Gulf Coast Crude Exports by Port West to East: Brownsville/Corpus Christi to Pascagoula

- Addresses 18 distinct port areas from Brownsville/Corpus Christi to Pascagoula
- Exports through Gulf Coast ranged from 1200-1400 (1Q-2018) MBPD with Corpus Christi,
- In recent weeks total U.S. crude exports have ranged from 1.8 to 2.6 MBPD (into May 2018) Beaumont and Houston having the largest crude export levels
**Crude Exports by Grade: U.S. Gulf Coast**

- **Light Sweet and very light sweet crude/condensate exports out of the U.S. GC at 800-1100 MBPD (1Q-2018)**
- **Heavy sour exports running 60 to 200 MBPD**
- **Medium Sour grades at 15 to 170 MBPD**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Exports, MBPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Sweet</td>
<td>0-55</td>
</tr>
<tr>
<td>Very Light Sweet</td>
<td>20-112</td>
</tr>
<tr>
<td>Light Sour</td>
<td>0-20</td>
</tr>
<tr>
<td>Medium Sour 1-2</td>
<td>0-17</td>
</tr>
<tr>
<td>Heavy Sour</td>
<td>147-200</td>
</tr>
</tbody>
</table>

Note: The exports data are for 2016-2018, with specific months and values for each grade.
Gulf Coast Deep Dive Downstream Subareas

Key External Market-Supply Hub Interactions/Dynamics

WTX - NM growing longer supply push to Phoenix (pipeline limited)

Midcontinent seeking market outlets such as Dallas – Fort Worth to clear lengthening gasoline supply.

Midcontinent is in the most dire need of market outlets. Push to Little Rock/Memphis via Magellan pipeline is at the expense of Gulf Coast supply.

Gulf Coast experiencing Plantation/Colonial bottlenecks, but East Coast demand decline will open up Colonial to NYH over time.

Jones Act vessel availability growing with lower crude demand and significant vessel new builds coming online. Gulf Coast with opportunities to increase supply to coastal marine markets opening up some Colonial pipeline capacity to the Northeast.

Gulf Coast very dependent on foreign markets to clear lengthening supply both locally and in the Midcontinent/Midwest markets. Export of gasoline and diesel expected to grow significantly over the next 10 years.

Maintain movements to E. Colorado as Suncor and Midcontinent will compete to keep/ increase market share in CO.

Pipeline and rail projects to move refined product to N. Mexico where demand is expected to grow and refineries continue to have operational issues.
EAI, Inc. Micro-Market Boundaries and Supply Structure

Mexican Downstream Business (2016/2017 MBPD Gasoline, diesel, jet fuel)

**Pacific Coastal Imports**
- U.S. Gulf Coast: 99 / 106
- U.S. West Coast: 53 / 52
- Asia-Euro-LAM: 5 / 45

**Mexico Domestic**
- Pemex Refining: 584 / 452
- Implied Demand: 1333 / 1289

**Cross Border Imports**
- U.S. Gulf Coast: 102 / 136

**South Coastal Imports**
- U.S. Gulf Coast: 420 / 439
- Euro-LAM: 70 / 59
Port Level Imports and Exports by Major Liquid Hydrocarbon Commodity

- EAI, Inc. assessing future export load across all hydrocarbon liquid commodities to assess infrastructure needs and investment opportunities in terminals/tankage, docks, ports/channels and supply infrastructure feeding export hubs that often share capacity with non-export destinations.
- Metrics below capture all significant Gulf Coast ports and export-import loadings across all major ports with Houston, Corpus Christi and Port Arthur the top ports in terms of volume moved through their jurisdiction.

![Graph showing cumulative volume exports and imports across Gulf Coast ports](image_url)

Metrics represent 2017 through July before Hurricane Harvey impact.
CrudeHub is EAI, Inc.’s web based information portal which provides its North American Crude retainer clients with ongoing updates of the various components that comprise the North American Crude study as well as tools and data access to facilitate a client’s internal information, business development and analytical needs. CrudeHub is being used by major Gulf Coast refiners, crude producers, investors, traders, etc. to provide dynamic tracking of key metrics and analytics including:

- **Timing of Critical Events & Milestones**
- **Extended EAI, Inc. Insights & Analysis**
- **Curated News Feeds and Commentary**
- **Production Outlooks & Forecasts (Monthly & Annual)**
- **Midstream Infrastructure Project Tracking Database**
  - Up-to-date tracking of construction, planned, and newly operating crude pipeline projects
  - Up-to-date tracking of construction, planned, and newly operating crude-by-rail projects
  - Metrics and analysis of all infrastructure projects presented in a series of interactive charts and tables
  - Live mapping of all crude infrastructure projects and newly commissioned assets
  - Coverage of logistics sector and logistics-specific news, projects, and status changes
- **U.S. Refining Sector Coverage**
  - 133 Refinery Profiles
  - Configurable crude run profiles by region, refining hub, and crude grade
  - Crude Slate Profile by Region, Hub, Individual Plant, and Crude Grade (2012 through current)
  - Crude Throughput Trend by Region, Hub, Individual Plant, and Crude Grade (2012 through current)
  - Breakout of foreign versus domestic runs
  - Processing Capability Summary by Plant
  - Coverage of refining sector and refinery-specific news, projects, and status changes
- **Crude Network Balances Trends & Outlooks**
  - Regional balance summary and outlook (at least 5-year history and 8-year forecast period)
  - Crude import trend configurable by origin, destination region, and crude grade
  - U.S. Crude Inventory Report
- **Crude Pricing & Economics**
How do we deliver value?

EAI, Inc. Global Resources Group

Industry Studies

Client Services
Enhancement & Outsourcing

Client Specific Consulting & Value Building
EAI, Inc. Business Components and Product/Consulting Process

- Global Resources
- Resource Logistics
- Manufacturing
- Product Logistics
- Markets & Retail

- Trends
- Information Resources
- Business Component Integration
- Analytics & Modeling
- Opportunities
- Competition
- Insights

- Industry Studies
- Strategy and Planning Consulting
- Project Opportunities & Evaluation
- Asset – Business Acquisition/Sale Support
- Optimization & IT Solutions and Products
EAI, Inc. Integrated Business Components, Bottom-Up Information Resources and Proven Processes
Insights, Outlooks, Opportunities, Strategy

Global / Macro Factors

Regional Supply-Demand Network

Resources
- Crude Oil / Other Feedstock Production

Feedstock Blend Stock Transportation and Distribution
- Logistics
- Configuration / Capacity

Refining
- Capacity
- Yields

Product Transportation and Distribution
- Costs

Refined Product Markets
- Market Access
- Market Growth
- Product Pricing

Regional, Asset, Resource & Company Specific Factors
Bottom-Up Perspective
EAI, Inc. Value Chain
Creating different products and services drawing on the same information and process
Contact

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