EAI, INC.
(Energy Analysts International)

Westminster, Colorado
EAI, Inc.’s U.S. North American Shale Fairway Crude Supply, Logistics, Refining and Pricing Outlook Study

Utica Shale Extract and Focus for Crude Oil Quality Association

By EAI, Inc.

November 8, 2012
EAI, Inc.'s New Study Release: North American Shale Fairway Crude Supply, Logistics, Refining & Pricing Outlook

Global Interactions

Western Canada
- Conventional Light
- Conventional Heavy
- Synthetic
- Bitumen Blends

Rocky Mountains
- Overall
- Niobrara / DJ
- Powder River
- Uinta Basin

Bakken / 4th US Central Corridor
- Overall
- Bakken
- Mississippian

Permian Basin
- Overall
- Wolfberry
- Avalon / Bone Spring

Eagle Ford
- Condensate
- Crude

Other Gulf Coast
- Granite Wash
- Other Inland
- Gulf of Mexico
- Foreign Imports

EAI, Inc. North American Crude Production, Supply, Logistics, Refining and Pricing Network Modeling

Crude routes & flows by price linking production to supply to refining. Basis for crude pricing relationships, production to supply relationships, refinery feed in crude opportunities, and refinery costs. etc.
Crude Supply, Distribution & Refining Outlook
Information and Modeling Process

Supporting EAI, Inc.’s North American Crude and Shale Fairway Studies other EAI, Inc. Resource Based Industry Studies & EAI’ Inc.’s Client Specific Consulting

- Outlook for Crude Pricing Relationships
- Incremental/Replacement Crude Oil vs Refined Product Outlook
- Transportation/Port Facility Outlook
- Feedstock Availability and Supply Strategy by Refining Area
- Outlook for Refining & Potential Closures

Study Basis
- Characterization of NA Crude Network
- Crude Price Forecast and Price Relationships

Component Analysis
- Crude Production Trends and Outlook by Area
- Regional Crude Balances
- Crude Transportation Network Capabilities and Flows
- Replacement / Incremental Crude Supply Outlook
- Crude Supply Economics
- EAI, Inc.'s Crude Oil Network Balance Forecast
- Environmental Regulation Outlook
- Regional Crude Balances
- Refinery Processing Capabilities and Feedstock Outlook
- Refinery Facility Outlook
- Product Supply Demand Trends and Outlook
- Refinery Feedstock and Blendstock Outlook

Integrated Network Analysis
- Environmental Regulation Outlook

Program Output
Integrated & Regional Approach to Analysis
Petroleum Supply - Demand Network

GLOBAL FACTORS
- Technology
- Economics
- Policy
- Company/Business

Regional Supply - Demand Network

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

Product Transportation and Distribution
- Logistics
- Costs
- Capacity

Refining
- Configuration/Capacity
- Yields
- Costs
- Network Links

Feedstock Blend Stock Transportation and Distribution
- Logistics
- Costs
- Capacity

Crude Oil/Other Feedstock Production
- Production Trends
- Production Economics
- Quality
- Price

Resources
- Resource/Base
- Geological/Reservoir Parameters
- Finding Costs

Regional - Facility Specific Factors
EAI, Inc.’s U.S. North American Shale Fairway Crude Supply, Logistics, Refining and Pricing Outlook Study

Utica Shale: Production Outlook
North American Resource Plays

The primary shale plays shown below extend from the Bakken to the Gulf Coast and up to Utica.

RIG COUNT 2012
HZ DRILLING IS
FOCUSED ON OIL WITH
WEST TEXAS & WILLISTON
HAVING TOP 2 PLAYS

Sources:
USGS: Intek Recoverable resource estimates; EUR Estimates: Operator Quarterly Reports and UGCenter.com; Rig count data: BAKER HUGES, CAODC
Midwest/Northeast Resource Plays

Most of the Midwest and Appalachia is dominated by natural gas with both coal and organic shale as source rocks. Higher liquid content is found in the western Marcellus and western Utica shale of Ohio and Pennsylvania. The southern portion of the Illinois Basin has produced light crude since 1860’s with peak output of 220 MBPD in the late 1950’s. The USGS and Ohio DNR indicate recoverable reserves ranging from 1.3 -5.0 billion barrels.
Midwest and Eastern Shale Plays

Utica Shale could replace the Marcellus as the leading source of new gas and liquids supply in the Northeast. Of the 30 wells completed in the Utica through Oct 2012, most of the liquids appear to be ultra-light crude-condensate range.
Midwest and Eastern Shale Plays
Marcellus and Utica

- **Ohio crude**: called “Pennsylvania Grade” crude which was produced from sandstone and limestone reservoirs at depths of 300-1600 feet. Wells typically produced less than 50 BOPD. Most of the liquids being recovered from the Marcellus have been NGL as derived from gas processing. The Utica has higher crude content with liquids increasing to the west of the Marcellus fairway in PA and Ohio.

- **Utica & Point Pleasant shales** (Orodivician) underlie the Marcellus (Devonian) and presents a much larger area for exploration. As with the Marcellus, the mature deep source rocks contain dry gas with wet gas, condensate and oil found in progressively shallower sediment. The Utica liquids play is most active in eastern Ohio.

- **Reserves Potential**: USGS 2011 assessment gives the Marcellus technically recoverable reserves of 84 TCF and 3.4 Billion barrels of NGL. This compares with 2.0 TCF and 0.01 Billion barrels NGL reported for the Marcellus in the Appalachian Basin in the 2002 assessment. The **2012 Utica Shale assessment cites technically recoverable reserves of 38 TCF, 208 million barrels NGL and 940 Million barrels oil**. Utica development could take as many as 110,000 wells in the Gas window and 17,500 wells would fit within the oil window.

- **Horizontal rig count**: 30 active in Ohio as of October 2012. Roughly 176 horizontal wells had been drilled out of 423 drilling permits issued for Utica in Ohio through June 2012. (Many of those Horizontal Permits target Marcellus oil along the OH-PA state line).

- **Completions**: Roughly 36 Utica-Point Pleasant Hz wells completed to date. Initial production tests available for less than 20 of these with most ranging from dry gas to very wet gas and condensate.
### U.S. Central Corridor

#### Midwest and North Eastern Resource Plays

- **Midwest**: comprised of IL, IN, OH, MI, produced 56 MBPD during 2011. Of these states, only Ohio has enough recent resource based completions to allow speculation of potential reserves. PA reserves are published.
  - Positive factors include well defined source rock, up to 450 feet thick, with estimated recoverable reserves ranging from 1.5-5.0 billion barrels oil & 4-15 TCF natural gas, high GOR provides reservoir ‘energy’, natural fracture network, low water saturation, good ‘brittle’ rock properties, Senate Bill 165: signed into Ohio oil and gas law in 2010, intended to streamline permit and operational reporting process. Ohio Senate Bill 315: introduced March 2012, adds horiz well language and procedures.
  - Unknowns: the size of the sweet spots, shallower depth range (5-8000 feet) could require higher permeability for oil completions, surface constraints and environmental resistance (as with all plays in NE).

- **Other Plays**: The Devonian and Ordovician shales in each of the Illinois Basin and Michigan basin have similar characteristics to the Utica Shale play in OH. Trenton-Black River: found immediately below the Utica, extends from Illinois to New York and has historically been a natural gas target. Contribution of crude from Ordovician play in southern Ontario has been less than 1 MBPD.

- **Michigan Basin**: Collingwood Shale (gas) & A-1 Carbonate: rumoured to be richer in liquids. Drilling is underway in deeper sediment of the Michigan (South and Central Michigan) by Devon, Sinclair, Encana and others. Historically, exploration had focused on conventional traps (reefs and carbonate pinchouts) and structural features updip from the central source rock bearing region with oil gravity ranging from 26-49° API in the shallow higher liquid bearing fields. The largest field in the state is the 39 mile long Albion-Pulaski-Scipio trend which has produced over 150 million barrels from the Trenton at roughly 3500 feet.

- **New Albany**: Oil bearing objective in the southern Illinois basin has produced roughly 4 billion barrels to date. The Devonian shale (Antrim equivalent) is similar in many regards to the Bakken and is being tested by several independent operators. Drawbacks are the shallow depth of proven oil saturation and corresponding reduction in reservoir energy.

- **Eastern Canadian**: Collingwood Formation (Lower Utica-Trenton age equivalent) exploration since 2009 is gas dominated with initial potential ranging as high as 12 MMCFPD. Players: Forest, Talisman, Questerre.
Comparison of Type Curves: Utica Shale (oil play)
2 Play Types, 4 Cases averaged (industry sources)

| RIG COUNT: 30 |
| UTICA |
| BASIN REGION |
| APPALACHIAN |

**PLAY:**
- **EUR:** 214 MBO LOW case 300 MBO BASE CASE AVG (AVG)
- **EUR MAX:** 440 MBOE MAX of cases

**WELL COST:**
- $4.5-5.5 MM

**HIGH GAS CASES (LOW LIQUIDS) NOT INCLUDED IN THIS AVERAGE**
- 30 RIGS ACTIVE IN UTICA OIL PLAY IN OHIO.

**ASSUMPTIONS**
- **OIL PLAY:** 300 MBO BASE CASE (AVG) WELL COST: $4.5-5.5 MM
- **GAS:** MCFPD 24 HOUR
- **GOR:** SCF/STBO INITIAL LIQUIDS PCT: 40%
- **IP GAS:** 2740 MCFPD 24 HOUR

**B Factor:** 1.58 Factor ARPS equation (AVG)

**MONTHS**
- UTICA Crude and Wet Gas
Resource Plays – AKA Treadmill Plays

**Drilling Economy of Scale plus Significant Sweet Spot Key to Play Success:** Ultimately the liquids output from each play will depend on rig count and the distribution of EUR (Estimated Ultimate Recovery) from wells. Historically, ‘resource plays’ have a broad range of statistical outcomes. Typically, a relatively small number of high EUR wells make the play profitable while the sum of the medium to low EUR wells contribute to an overall play average return in the 10-20% range.

**Frontend Investments:** Operators must be able to drill enough wells to satisfy the statistical curve. Furthermore, since most of the cash flow is concentrated in the first 6-12 months of production, the number of wells drilled in a given year will be very sensitive to oil and gas pricing.

**Representative Play Profile:** 558 wells were drilled and yielded an average of 168 MBO / well in sales. However, looking at the table; roughly 30% of the wells did not payout (based on A 100 MBO payout). Using the same table it is apparent that the 200-300 MBOE wells represent one third of overall output.
Midwest and Eastern Shale Plays

Marcellus and Utica

Using a simple combination of EUR and potential locations, the Utica fairway can generate over 300 MBPD of stocktank liquids (crude and condensate) with 60 rigs by 2015-2016. Most of the wells drilled in Ohio during 2012 are still waiting on completion or pipeline connection.

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<thead>
<tr>
<th>COMPLETIONS</th>
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<tr>
<td>ANNUAL WELL COUNT</td>
<td>2010</td>
<td>2011</td>
<td>2012</td>
<td>2013</td>
<td>2014</td>
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<tr>
<td>OH UTICA</td>
<td>0</td>
<td>10</td>
<td>252</td>
<td>639</td>
<td>639</td>
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<tr>
<td>PA UTICA OIL</td>
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<td>1</td>
<td>25</td>
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<tr>
<td>MARCELLUS WET GAS</td>
<td>2</td>
<td>315</td>
<td>629</td>
<td>786</td>
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</table>
Midwest and Eastern Shale Plays
Forecast based on 60 rigs continuously active in the Utica Crude-Condensate corridor

Forecast crude increase is heavily weighted toward Ohio side of Utica Shale play although only a small proportion of the overall fairway is required to keep the 60 rig fleet active through 2020. Utica has similar well potential in northwestern PA (5 counties) and NE West Virginia (6 counties) but with less physical area than Ohio (22 counties). Horizontal rig count as of April 2012 were: OH (30), PA (64), WV (25). PA-WV activity includes Marcellus. No rigs in NY due to ongoing review of frac concerns.
Midwest and Eastern Shale Plays  
Statewide Natural Gas Production MMCFPD

Natural gas output from PA quadrupled in 2011 with PA total crude condensate increasing to 10-15 MBPD by year end. The below Scenario shows the impact of natural gas production from Utica shale, starting in 2013, if the Utica were to expand at half the rate of the Marcellus. Data not available for North East States until March of the following year.
The estimated average natural gas consumption through midyear 2012, for the area shown below, amounted to 24 BCFPD with NY & IL having the largest statewide demand. Shortfall in local natural gas supply is offset by imports from Canada, the Gulf Coast and Rocky Mountain producing states.
Pennsylvania Activity

Marcellus and Utica: Horizontal well activity (red dots) is concentrated in Bradford, Susquehanna, Lycoming & Tioga Counties in the north and in Washington and Greene Counties in the southwest.

The wet gas window for the Marcellus is characterized by an increase from 1050 BTU (dry gas) to 1250-1350 BTU (wet gas) roughly parallel to the Utica wet gas transition line shown to the left.

Marcellus rich gas wells recover 25-100 MB of condensate, 250-300 MB of NGL and 3.5-4.5 BCFG for a sum total EUR of 6.4 BCFG.

Utica oil in PA is still in exploration stage
Ohio Activity

Utica activity is concentrated along the wet-gas / crude corridor in Carroll, Columbiana, and Harrison counties. Some Marcellus wells along the OH-PA state line in Jefferson, Monroe and Belmont Counties.

The Utica & Point Pleasant oil window is found at 5,000 to 6,000 feet and transitions to wet gas with increased depth to the east. The deep Utica is dry gas bearing in most of PA.

Initial production rates have been released for roughly a dozen of the ROUGHLY 30 completions reported through July 2012.
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Utica Shale: Refining and Transportation
### Canadian-U.S. Crude Oil Pipeline Network

**Changing Conductivity Across the North American Shale Fairway**

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<thead>
<tr>
<th>MAP REF</th>
<th>PROJECT</th>
<th>TARGET</th>
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<tbody>
<tr>
<td>A</td>
<td>SOUTHERN ACCESS – FLANAGAN 400 MBPD</td>
<td>COMPLETED SPRING 2009</td>
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<tr>
<td>B</td>
<td>ENBRIDGE GATEWAY (CRUDE) 580 MBPD/150 COND</td>
<td></td>
</tr>
<tr>
<td>D1</td>
<td>TMX-2 DONE, TMX 3 PLANNING 300 MBPD BY 2015</td>
<td></td>
</tr>
<tr>
<td>D2</td>
<td>TMX NORTHERN EXPORT 400 MBPD post 2015</td>
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<tr>
<td>F</td>
<td>CDN WATERBORNE EXPORT TO US PSW LIMITED VIA BURNABY</td>
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<td>H</td>
<td>KEYSTONE TO WOOD RIVER DONE JUNE 2010</td>
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<td>I</td>
<td>CUSHING LINK – 155 MBPD DUE FEB 2011</td>
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<tr>
<td>I</td>
<td>KEYSTONE XL – GULF COAST EXTENSION 500-700 MBPD</td>
<td>TARGET 2013</td>
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<td>K</td>
<td>KEYSTONE BAKKEN/EXTENSION CONNECT BAKER MT</td>
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<tr>
<td>R</td>
<td>SEAWAY REVERSAL (150 MBPD) EXPAND TO 400 IN 2014</td>
<td>STARTED UP MAY 2012</td>
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<td>L</td>
<td>KM-PONY EXPRESS CRUDE TARGET 200 MBPD 2014</td>
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<tr>
<td>M</td>
<td>PEGASUS EXPANSION TO 95 MBPD COMPLETED JUNE 2009</td>
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<td>N</td>
<td>TRANSCANADA - LOUISIANA ACCESS CONCEPT</td>
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<td>BUTTE EXPANSION - 150 MBPD IN 2012 TARGET 200 MBPD 2013</td>
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<td>P</td>
<td>LINE-9 REVERSAL TRAILBREAKERS 240 MBPD SHLEVED JULY 2012</td>
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<td>LINE-9 REVERSAL TRAILBREAKERS 240 MBPD SHLEVED JULY 2012</td>
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<td>S</td>
<td>SPEARHEAD EXPANSION TO 190 MBPD COMPLETED MAY 2009</td>
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<td>T</td>
<td>ENBRIDGE ND (PORTAL) EXPANDED TO 161 MBPD JAN 2010 – DONE</td>
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<td>R</td>
<td>PORTAL NORTH – 140 ND TO CDN TARGET 2013</td>
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<td>T</td>
<td>PORTAL NORTH – 140 ND TO CDN TARGET 2013</td>
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North American Shale Fairway Refinery Hubs, Plants Crude Basins & Pipeline Conductivity

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 and Wyoming heavy crude streams. EAI, Inc. tracks and analyzes all plants; Shale Fairway consists of 23 refinery hubs and 88 plants.
Midwest and Eastern Crude Infrastructure

Crude pipeline access into OH-PA-KY is somewhat limited. Refined product pipeline network is extensive and has some surplus capacity. New construction is focused on NGL export from Marcellus & Utica Plays.

East coast and Ohio refiners could benefit from low cost hydrogen (from natural gas) and increased liquids from the growing OH western PA supply. Most of the liquids are NGL range material.

Marathon Cattlettsburg & Canton OH refineries are targets for Utica crude output.

Excess NGL is to be exported to Quebec or the GC on new or expanding pipelines.

Midstream and producers using rail and barge to market NGL. Look to new storage capacity as solution to near term gas overhang.
Ohio-PA NGL Infrastructure

New Fractionation Facilities and NGL Export Pipelines.
Implications of Supply Growth

- **Base Case:** In the base case scenario, PA & OH crude output rises to 250 MBPD by 2015-16. This volume of light sweet crude is sufficient to displace most if not all of the sweet crude currently being refined in Ohio and Kentucky. Most of the current feedstock is conveyed into Ohio by the MidValley pipeline, Enbridge pipeline from Canada, or the Marathon operated system originating in Patoka.

- **Surplus:** Surplus crude to be exported via barge and rail over near term. No crude pipeline projects in works for now.
  - 60 MBPD of Canadian crude reaches Ohio via the Enbridge Ohio Access pipeline completed in 1999 and other routes via Patoka, IL. Some of the imported heavy blend and synthetic grades are committed and or integrated volumes and are less likely to be backed out by Ohio sweet.
  - 853 MBPD of foreign crude delivered to Northeast refiners during first half of 2012. Of this volume, 79 percent is light (sweet or sour) and heavy sweet grades.
Ohio Petroleum Logistical Shift Potential

Increase of Ohio crude output to 300 MBPD as outlined in the base case scenario would have several knock-on effects that extend from western Canada to the U.S. East Coast refining region.

- Increased local crude supply could stimulate refinery expansion,
- Change refined product trade across Midwest, including pipeline imports from GC and exports via east coast ports
- Trigger pipeline conversions for crude and product export from Ohio and Pennsylvania
- Back out WTX, Canadian crude supply and/or displace waterborne crude imports.
- Similar and longer list of NGL-LNG logistical shifts will be realized with long term natural gas supply growth

Potential displacement of Canadian Synthetic
Excess refined product pushing east
Shorter haul than Bakken to NE refining
Could displace crude supply from Patoka
Could displace WTI on MidValley Pipeline
PL Capacity, MBPD
Who are we?

- EAI, Inc. (Energy Analysts International) is a provider of leading edge and high quality products, consulting and services for a growing U.S. domestic and international client base.

- EAI, Inc. was incorporated in 1982 and is headquartered in Westminster Colorado.

- The company’s niche was and continues to be a “bottom-up” and integrated approach to developing opportunities, projects and strategies for companies ranging in size from the Fortune 500 to smaller, regional niche entities.

- EAI, Inc. has evolved a multidisciplinary staff and proven processes to develop and deliver value to its clients drawing on a comprehensive business vision, proven business models and processes, applied Information technologies and comprehensive information resources.

- **EAI, Inc. Global Resource Group** has worked with crude producers, crude buyers, traders, pipeline companies and refiners assessing production developments and outlooks, crude logistics, crude options for refiners, crude pricing and supply economics, crude marketing and crude value assessments.
How do we deliver value?

- EAI, Inc.
- Industry Studies
- Client Specific Consulting & Value Building
- Client Services-Enhancement & Outsourcing
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