

## Responding to the Call to Action: The Case for a Sarnia-Lambton Bitumen Upgrader Refinery

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### ABSTRACT

The oil sand industry was initially launched by a few large multi-national oil companies with surface-mining operations who produced and upgraded the bitumen in Alberta. Today, a broad mix of oil sand companies produces bitumen from both surface-mining operations and 'in situ' thermal processes, such as steam-assisted gravity drainage (SAGD). Some of these companies have refineries in the United States and, for corporate economic reasons, have opted to pipeline the raw bitumen to these refineries for upgrading to value-added products. However, there are an increasing number of independent companies that produce bitumen without an internal capacity to produce high-value finished products. These companies would clearly benefit from additional upgrading capacity in Canada.

Ontario's Sarnia-Lambton region offers a unique and early opportunity to increase Canada's bitumen upgrading capacity, using existing pipeline networks to safely deliver the bitumen. The refinery would produce high-value products on the threshold of one of the world's largest energy market, the US Midwest. The St. Lawrence Seaway would provide ready access to global markets.

A team of pro bono ex- senior executives and recent retirees was assembled from Bayer, Imperial Oil, Novachem, Polysar, Shell, and Suncor to provide greater definition for this opportunity. The team identified the fact that benefits from this major project would accrue to all Canadians. Bitumen producers obtain the benefits of downstream integration. The Sarnia-Lambton community would spearhead the effort to develop the project. Alberta would gain a new market for 100,000 BPD of bitumen with more stable revenue. Ontario would receive a major increase in employment, though benefits would eventually be spread across Canada. From a national perspective, Canada would capture the value-added with a significant increase in export revenue.

An acceptable Return on Investment (ROI) can be achieved if the new upgrader is built to produce gasoline, diesel and other value-added petroleum products. At current prices the value-added is \$2.5 billion per year, an additional \$45 per barrel of diluted bitumen. Capital Expenditure (CAPEX) is expected to be in the order of \$10 billion.

The team has recognized that for this opportunity to be realized, a corporate champion will be needed, ideally from the ranks of experienced refiners with the skills to market the product. A financial feasibility study was determined to be the next step.

## Introduction

Chapter 3, which summarized the “Bitumen – Adding Value: Canada’s National Opportunity” Conference held in Sarnia in May 2013, presented the case that Canada can capture enormous wealth by upgrading its raw natural resources to value-added products. Four communiqués from that conference are highly relevant to the subject of this chapter:

1. Delegates urged Canada to shift to a more diversified value-added economy, diverting from its historic staple-based economy.
2. Canada should launch national-scale energy projects as the foundation of its energy strategy and its pathway to sustainable wealth creation and jobs.
3. The Ontario and Alberta governments should commit to dramatically enhancing their value-added collaboration to improve energy supply chain opportunities, to enhance transportation networks and to develop new energy-efficient and environmentally advanced technology.
4. A Sarnia-Lambton bitumen upgrading project to produce refinery ready crudes was identified as a high priority national-scale project, with a call for action, with strong support by a committed region.

## The Hypothesis

The momentum behind the project continued. The Sarnia-Lambton Research Park’s Bowman Centre next assembled a team of executives with petroleum industry experience to study the viability of the project. They gathered at the Sarnia-Lambton Research Park to respond to the Call to Action that had emerged from the Sarnia Conference. This team hypothesized that a Sarnia-Lambton bitumen upgrader refinery is viable for six major reasons.

First, the value added will benefit all Canadians: a strong economic stimulus locally, higher employment and taxes for Ontario, new markets for Alberta, and a significant increase in export revenue for the country as a whole. Secondly, they identified the ability to deliver bitumen through existing pipelines, and pointed to the advantages accruing to all stakeholders. They recognized that production will be globally competitive, and cited Sarnia’s proximity to American and global markets through its advantageous location on the St. Lawrence Seaway. They stated that a social license is available as a result of strong local support and, finally, they deemed the project to be financeable by means of either a single proponent or multiple partners.

The actual financial performance of the Marathon Detroit refinery was cited as an example<sup>1</sup>, as shown in Figure 1. Market pricing from 2012 and 2013 indicates that this project is making Earnings before Interest, Taxes, Depreciation & Amortization (EBITDA)<sup>2</sup> returns of 15 to 20% on CAPEX. Since this refinery is only 100 kilometers from Sarnia, this represents a strong indication that a Sarnia-Lambton project could also be profitable, either as a new stand-alone upgrader or as an add-on to an existing refinery.

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<sup>1</sup> Marathon September 2013 Investor Presentation

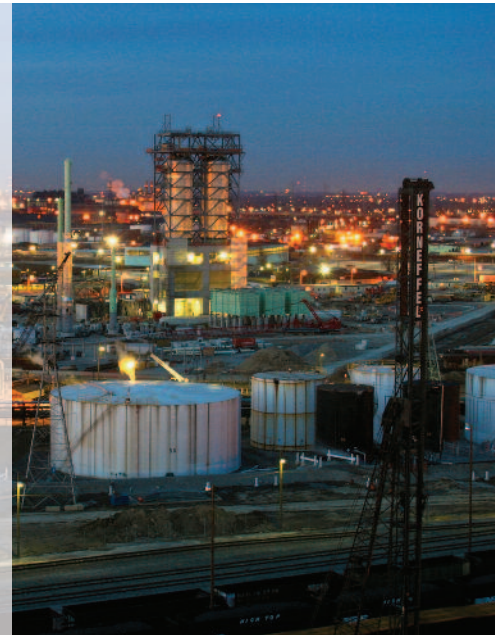
<sup>2</sup> Earnings Before Interest, Taxes, Depreciation and Amortization

**Figure 1**  
**Detroit Heavy Oil Upgrade**  
**Project**

### **Detroit Heavy Oil Upgrade Project**

- Increased heavy oil capacity from 20,000 BPCD to 100,000 BPCD
  - 28,000 BPCD delayed Coker
  - 36,000 BPCD Distillate Hydrotreater (DHT)
- Crude capacity increased ~14,000 BPCD
- Discounted Canadian crude
- Investment: \$2.2 billion\* project
- Estimated incremental annual EBITDA based on:
  - 2006-2010 Prices: ~\$200 million
  - 2011 Prices: ~\$350 million
- Operated at design capacity YTD 2013

\*Excludes capitalized interest



## **The Project Concept**

The oil sand industry was initially launched by a few large multi-national oil companies with surface-mining operations who produced and upgraded the bitumen in Canada. There is now a broad mix of oil sand companies who produce bitumen from both surface-mining operations and in situ thermal processes, such as SAGD. Some of these companies have refineries in the United States and, for corporate economic reasons, have opted to pipeline the raw bitumen to these refineries for upgrading to value-added products. They have no incentive to build facilities to upgrade bitumen in Canada and would have limited interest in participating in the Sarnia-Lambton upgrader project proposed in this chapter. However, there are an increasing number of independent companies that produce bitumen without an internal capacity to produce high-value finished products. These companies would clearly benefit from participating in the Sarnia-Lambton project outlined in this chapter.

In the current environment, Alberta crude oil producers have both a marketing problem and a transportation problem. In the United States, the supply and marketing of crude oil is undergoing unprecedented rebirth, transformation and growth with the rapid development of light sweet crude oil from shale sources by horizontal drilling and fracturing. Much of this supply is situated in locations not served by pipelines. This has created a surplus of domestic light crude oil often sold at discounted prices, with which the Alberta bitumen producers must compete for access to refinery capacity. Furthermore, in Canada, the rapid development of bitumen supply in Alberta has outpaced the development of pipeline capacity to take it to market. Many bitumen producers, particularly those using the thermal and SAGD processes, are spread around the northeastern section of the province not served by pipelines. These producers are developing options to ship by rail, but the long-term viability of this route is questionable. All these factors have led to lower and variable bitumen prices, recently discounted by as much as \$40 per Bbl. By producing gasoline, ULS diesel, and fuel products, all of this discount can be recovered, and additional value obtained. The purpose of this project is to help secure the long-term market for bitumen and to realize the full value for the resource.

Since Sarnia-Lambton is served by pipelines from Alberta, with production costs competitive to the US Gulf coast and unrivalled access to the US Midwest market, this project represents a unique opportunity for Canada. A team of pro bono ex-senior executives and recent retirees has been assembled from Bayer, Imperial Oil, Novachem, Polysar, Shell, and Suncor to pursue this opportunity.

## The Project Principles

The following principles were used to guide the project through its various phases.

1. Build and assemble local support through involvement throughout the process
2. Maintain current Alberta bitumen/heavy oil processing at Sarnia's Imperial Oil, Shell or Suncor refineries
3. Establish a significant project size – 100,000 BPCD bitumen (~150,000 BPCD dilbit)
4. Involve existing Sarnia refiners where possible
5. Leverage existing infrastructure
6. Review with Alberta bitumen producers and stakeholders

## Why Sarnia-Lambton?

Sarnia-Lambton has grown from its earlier days in the 1860's as the processing location for the first oil discoveries in the Petrolia and Oil Springs areas of Lambton County. The community has supported over 40 refining, petrochemical, bio-industrial and associated plants since then, as illustrated in Figure 2. There are major refining and petrochemical facilities in the region including three refineries owned by Imperial Oil (~120,000 BPCD), Shell Oil (~80,000 BPCD) and Suncor (80,000 BPCD), and world-scale ethylene plants with polymer plant derivatives operated by Esso Chemical, Nova Chemical and LanXess.

All of these facilities have access to shipping on the St. Clair River, part of the St. Lawrence Seaway, giving access to international and mid-continental markets by pipeline, marine, rail, and truck.

**Figure 2**  
**Sarnia Refinery Complex**



## The Project Deliverables

The main driver behind a Sarnia-Lambton bitumen upgrader is the objective of maximizing value-added to bitumen in Canada. In order to be considered a successful project there are several requirements that must be achieved. First, the project must provide a return to investors/partners while defining itself as an internationally competitive gasoline, diesel and fuels exporter. The project must also leverage existing petroleum refining capacity and infrastructure by either adding capacity to one of the three existing refineries or by adding a new facility that would be integrated with existing infrastructure. Finally, the project must meet societal expectations for environmental and social performance.

## The Projected Benefits

### For Canada

A world class upgrader refinery keeps value-added processing in Canada. This project is sized at 150,000 BPCD diluted bitumen (dilbit) feed and represents an increase in annual fuel product<sup>3</sup> exports of over \$6 billion, over 30% if operating in 2013, and a 1½ % increase in total Canadian exports.<sup>4</sup> The project revenues would be in excess of \$6 billion at current crude oil values. The primary plant assets are estimated to be about \$10 billion.

### For Alberta

The market for 100,000 BPCD of bitumen represents a significant advantage to stakeholders in Alberta. The emergence of abundant new crude oil supplies produced by horizontal drilling and fracturing shale oil formations from new locations has destabilized the conventional crude oil market in North America. It has given much more power to the refiner customers and represents market diversification. Participation directly in the fuels market is very different from selling bitumen at whatever price the refiner is willing to pay. The upgrader refinery opportunity would enable access to the refining value-added with the effect of downstream integration. A Sarnia-Lambton upgrader refinery would provide for new and different access to the market, and it would enable participation in the mid-continent US PADD<sup>5</sup> 2 gasoline and fuels market. It should be noted that this market consumes about 3.5 million BPCD of oil directly and a further 0.5 million BPCD of product imports. Such participation as a player in the marketing of the products would give strategic access to critical information for the planning and marketing of bitumen and bitumen-sourced crude oils. It would also help to capture the value-added to the benefit of the stakeholders, through enabling the effect of a fully integrated oil company.

An upgrader refinery would also moderate variations in revenue. During the period from 2011 through 2013, the netbacks to Alberta on sales of synthetic crude oil suffered a discount from the conventional crude oil market by up to \$40 per BBL. This has followed the swings in West Texas Intermediate (WTI) prices, and has been impacted by the new supplies of oil from the shale oil fields, primarily the Bakken-Three Forks, and Eagle Ford fields. Meanwhile gasoline, diesel, distillate and fuel products have tracked the European Brent/ICE prices, with much more moderate price swings. Price changes in this market are much smaller with a lower risk of error in generating a revenue forecast or a royalty income forecast.

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<sup>3</sup> Assumes project capacity of 100,000 BPCD of bitumen processed.

<sup>4</sup> Patricia Mohr, Scotia Bank, Oil and Gas Dominates Canadian Economy 2013.

<sup>5</sup> Petroleum Administration for Defense Districts.

The Sarnia-Lambton refinery upgrader opportunity would provide market access sooner than other alternatives. The major unknowns in this timeline are the minor increase in capacity in Enbridge Line 6B or Line 5, and obtaining the social license to build the upgrader refinery.

### **For Ontario**

The major benefits to Ontario relate to jobs, products and wealth generation. During the construction of the upgrader refinery, construction trades employment to build the \$10 billion capital cost facility is projected to engage about 5,000 workers for two years. It would require supplies from across Ontario and generate services and activity throughout the entire Province, including the production of primary materials like steel, and the manufacture of equipment and pipe.

The plant and business operations will employ approximately 500 engineering, operating, maintenance, and business management staff on an ongoing basis. Direct support employment after construction is likely to equate to 1,000 to 1,500 additional high quality jobs.

The primary products from this project would be ultra-low sulphur diesel fuel, distillate, gasoline, and aviation fuel. In addition, it would make feedstocks for high value petrochemicals. The value of the exports from this project in 2013 dollars represents 1½ % of total Canadian exports, making a significant positive contribution to value-added creation in Canada.

### **For the Operator/Investor**

The processing and marketing fees would represent a benefit to the operator and the investors. The value-added capture is estimated to exceed \$2.5 billion per year at current prices of crude oil and products, netted back to the plant in Sarnia-Lambton. This can be applied to the ROI of the investors after paying operating and maintenance costs. The size of the value-added capture indicates that there will be a return sufficient to attract investors or, alternatively, to support a business model providing a tolling fee for the owner(s) of the bitumen.

### **For Sarnia-Lambton**

This project would provide a major stimulus to Sarnia-Lambton. The region is well suited to host such a project, and expansion opportunities would flow from the support needs of the project related to maintenance, plant turnarounds, upgrades, and debottlenecking.

The upgrader would provide raw materials for other high value-added products as well as finished fuels and access to global markets via pipeline, rail and marine transportation.

## **Bitumen Production**

The outlook for new bitumen production has changed considerably in the past few years. The current Alberta government policy is to use BRIK (Bitumen Royalty In Kind) barrels to support worthy projects (<http://www.energy.alberta.ca/includes/3435.asp>).

The TCPL<sup>6</sup> Energy East pipeline project proposes to convert part of the underutilized Trans Canada Pipelines Ltd. (TCPL) mainline natural gas system, which is all within Canada's borders, and to add a new pipeline in eastern Canada to ship 1.1 million BPCD of oil from Alberta and Saskatchewan to refineries in Ontario, Quebec, the Atlantic seaboard and international markets. The Alberta Petroleum Marketing Commission (APMC)<sup>7</sup> has committed to a 20-year "take or pay" transportation service agreement to move Alberta crude oil to eastern Canada and beyond, designed to obtain a fair netback for Alberta crude oil based on a world price.

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<sup>6</sup> Trans Canada Pipeline.

<sup>7</sup> Alberta Petroleum Marketing Commission.

The NorthWest Redwater Refinery Project<sup>8</sup> is owned 50/50 by NorthWest Upgrading Inc. and Canadian Natural Resources Ltd. The first phase of the refinery project will have processing capacity of 78,600 BPCD of bitumen blend feedstock and will be operational in 2017. APMC has signed a processing agreement which is based upon a 30 year tolling arrangement. APMC will provide 75% of the required bitumen blend feedstock. Condensate will be recovered and the bitumen will be processed into diesel, vacuum gas oil and Liquefied Petroleum Gases (LPGs). APMC will retain ownership of the condensate and refined products, which will be sold into the local and export markets.

Table 1 is a project list ranked by new production in the 2018 to 2025 period.

Table 2 is a prospect list ranked by production, fit, and possible interest.

**Table 1**  
**Prospect List Ranked by**  
**New Production Planned**  
**2018-2025**

Source: (<http://www.albertacanada.com/business/statistics/oil-sands-quarterly.aspx>, and corporate websites)

|                    | New BPCD<br>2018-2025 | Comments                                                                                                                                             |
|--------------------|-----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cenovus            | 520,000               | <ul style="list-style-type: none"> <li>• Have JV in 2 refineries with Phillips 66</li> <li>• Might be good fit in fuels market</li> </ul>            |
| Brion              | 225,000               | <ul style="list-style-type: none"> <li>• No current production</li> <li>• PetroChina funded</li> </ul>                                               |
| Athabaska          | 193,000               | <ul style="list-style-type: none"> <li>• No current production</li> <li>• Financed via Brion</li> </ul>                                              |
| CNRL               | 170,000               | Invested in NWU                                                                                                                                      |
| Teck Resources     | 162,000               | <ul style="list-style-type: none"> <li>• Unknown but could be interested in an outlet</li> <li>• Miner, used to big projects, fast acting</li> </ul> |
|                    |                       |                                                                                                                                                      |
| Statoil            | 120,000               |                                                                                                                                                      |
| Sunshine Oil Sands | 110,000               |                                                                                                                                                      |
| Total E&P          | 107,000               |                                                                                                                                                      |
| BP                 | 70,000                | <ul style="list-style-type: none"> <li>• Have done deals with Husky both upstream and downstream</li> </ul>                                          |
| Husky              | 55,000                | <ul style="list-style-type: none"> <li>• Would be a good fit as both supplier and refinery partner</li> </ul>                                        |
| MEG Energy         | 41,000                | 2020 will have ~200,000 BPCD                                                                                                                         |

**Table 2**  
**Prospect List Ranked by**  
**Production, Fit, and Possible**  
**Interest**

|                | New BPCD<br>2018-2025 | Comments                                                                                                                                                                                                                                 |
|----------------|-----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cenovus        | 520,000               | <ul style="list-style-type: none"> <li>• Have JV in 2 refineries with Phillips 66, Wood River and Borger</li> <li>• Opportunity for Philips to increase market share in PADD II?</li> <li>• Might be good fit in fuels market</li> </ul> |
| Brion          | 225,000               | <ul style="list-style-type: none"> <li>• No current production</li> <li>• PetroChina Oil funded</li> </ul>                                                                                                                               |
| Athabaska      | 193,000               | <ul style="list-style-type: none"> <li>• No current production</li> <li>• Financed via Brion</li> </ul>                                                                                                                                  |
| Teck Resources | 162,000               | <ul style="list-style-type: none"> <li>• Unknown but could be interested in an outlet</li> <li>• Miner, used to big projects</li> </ul>                                                                                                  |
| Statoil        | 120,000               |                                                                                                                                                                                                                                          |
| Husky          | 55,000                | <ul style="list-style-type: none"> <li>• Would be a good fit as both supplier and refinery partner</li> <li>• Possible fit in fuels market</li> </ul>                                                                                    |
| MEG Energy     | 41,000                | 2020 will have ~200,000 BPCD                                                                                                                                                                                                             |

<sup>8</sup> Northwest Partnership website  
<http://www.nwrpartnership.com>.

## Deliverable Bitumen

Enbridge presented the following information at the Canaccord Genuity Infrastructure Conference which was held in Toronto in September 2012. Unlike other prospective bitumen destinations where no pipelines exist, Enbridge has two lines, shown in Figure 3, which at the time of commitment may require only minor capacity expansion. The company expects that such expansion will be relatively inexpensive.

Sarnia-Lambton is now served by line 5 and line 6B with a total capacity of over 800,000 BPCD.

Line 9 reversal and expansion is planned to take away 300,000 BPCD. Line 6B expansion is in the Enbridge 2016 CAPEX plan. The current tariff is approximately \$5.50 per barrel from Hardisty, Alberta to Sarnia-Lambton.

**Figure 3**  
**Enbridge Pipeline Systems**



## Sarnia-Lambton Area Advantages

Sarnia-Lambton is situated at a strategic location on the Ontario/Michigan border. Half of the Canadian and American populations live within 500 miles – a day's drive! It is one hour to Detroit, three hours to Toronto, and five hours to Chicago. Sarnia-Lambton is connected on the Ontario 400 series highways and to the USA Interstate highway system – Interstate 94 starts at the Bluewater Bridge. The Chris Hadfield International Airport is located 9 KM from the Sarnia city centre. In addition, Sarnia-Lambton offers affordable housing, short commutes to and from work, as well as outstanding recreational amenities.

This region includes the city of Sarnia and ten municipalities in Lambton County (see Figure 4), and offers many attractive features for such a project. First, Sarnia-Lambton, which is located at approximately the same latitude as Oregon, has a population of 129,000 with a labour force of 62,000 workers. A surplus number of these workers are skilled in the construction trades. There is an adjacent labour force of 300,000 workers within a 100 KM radius of Sarnia- Lambton, including highly educated engineers, process operators and

**Figure 4**  
**Sarnia-Lambton Region**



technical tradesmen with refinery and chemical plant maintenance turnaround expertise. There are also excellent labour-management relationships in the region which would provide for continuity of services for the project. The construction safety record is excellent, on an order of magnitude higher than the provincial average.

There is serviced land zoned for heavy industry and the available sites for industrial development are highly disturbed (i.e. not pristine forest) and present little risk of ecological or archeological impacts. The St. Clair River

can be an abundant source of clean cold water as long as the water is used responsibly.

Businesses in the region are now making refinery type process modules in Sarnia, for plants in Alberta and Nova Scotia. These include Heat Recovery Steam Generators (HRSG's), pressure vessels and distillation towers. Local industry supports the Sarnia-Lambton bio-industrial complex of over 35 diverse manufacturing and emerging technology sectors. The region is also home to the industry-oriented Lambton College.

There are three operating refineries and five major petrochemical plants in Sarnia-Lambton and a range of infrastructure, and brown field and green field sites with heavy industrial zoning are available. Sarnia-Lambton sits above a deep saline aquifer that may be suitable for stored CO<sub>2</sub> should carbon capture and sequestration become part of the project scope.

## **An Energy Transportation and Storage Hub**

The existing pipeline web in Sarnia-Lambton connects storage, product distribution pipelines and refineries in order to move oil, intermediates, natural gas liquids (NGLs), and refined products to a range of storage and distribution infrastructure. These include salt caverns and above ground storage facilities, product distribution pipelines, deep water docks, a CN Rail Tunnel and the Bluewater Bridge which connects Sarnia to Port Huron, Michigan and to marine, rail and truck loading facilities. The area is also located above underground salt layers at depths of 600 to 800 meters.

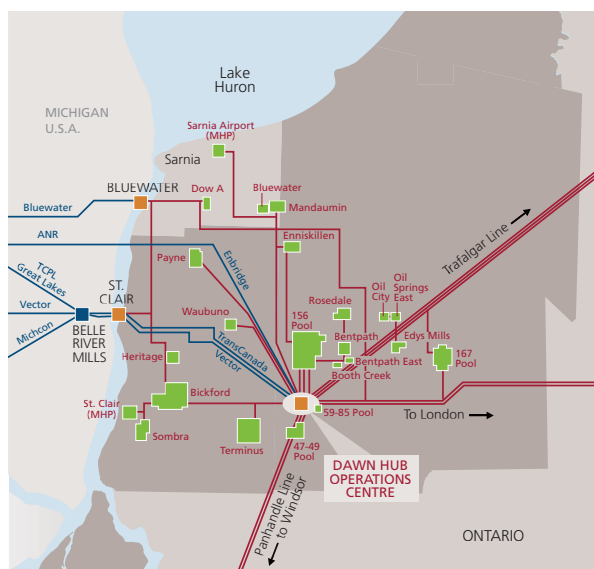
This is storage and distribution infrastructure comparable to that existing along the US Gulf Coast. The Houston ship channel/Galveston Bay area has crude supply from pipelines and offshore production facilities and distribution of products by pipeline and by marine. Thirty miles north of Houston is the Mont Bellieu NGL cavern storage system. A further 200 miles

<sup>9</sup> Heat Recovery Steam Generators, a component in cogeneration and in combined cycle power plants.

to the east in Erath, Louisiana is the Henry Hub, a major natural gas price reference point. Sarnia-Lambton has the same facility advantages, but all within a 50 x 50 km area.

## The Dawn Natural Gas Storage Hub

**Figure 5**  
**Dawn Natural Gas Storage Site**



The Dawn Hub (Figure 5) encompasses the junction of major natural gas transmission lines over a large natural gas storage system. Some notable features of the Hub include high deliverability pinnacle reefs which have been developed for storage and are connected to major transmission lines and river crossings to enable off peak storage and high deliverability rates during peak demand periods. The Hub is the preferred location

in which to store the gas from the transmission lines in order to serve markets in the Midwest.

The Hub offers a competitive advantage to a local refinery for energy, and for feedstock for making low cost hydrogen. There is an available supply of electrical power to candidate industrial sites and there is access water for cooling and for processing (e.g. to manufacture hydrogen). Responsible water use and conservation, however, will be critical to societal acceptance of the project.

A key material required to upgrade bitumen is hydrogen, usually made from natural gas by steam methane reforming. Natural gas for hydrogen production and fuel is available from the Marcellus shale from nearby Pennsylvania, at a cost which is competitive to US Gulf Coast refiners, and at one quarter to one half the cost found at European and Asian locations.

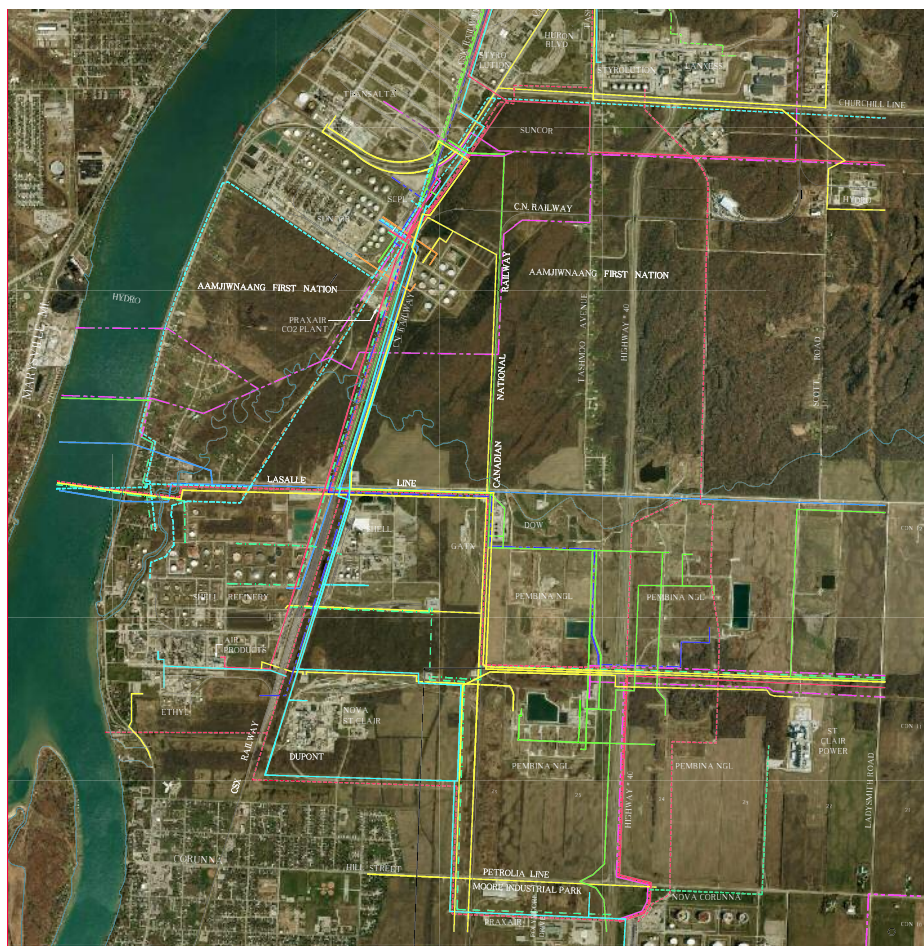
This area is an oil and gas field with operations dating back to the 1860's. The red and blue lines represent high pressure transmission and storage connection lines. The green boxes represent storage pools.

## Pipelines and Storage

These pipeline systems (see Figure 6) were built to support the Imperial Oil, Suncor, and Shell refineries, and the Dow Chemical, Polysar (now Novachem) and LanXess complexes. The system enables operators to receive, store, and exchange crude oil, NGLs, brine, and intermediates, and to ship out gasoline, diesel, fuel products, petrochemicals, and polymers. Over 100 pipelines are in place and routinely move crude oil, NGL/LPGs, naphtha, raffinates, distillates, gasoline, hydrogen, olefins, aromatics, brine, and water. There is also substantial underground salt cavern storage capacity in the area, as well as pipelines connected under the St. Clair River to a commercial storage operation at Marysville, Michigan. The pipeline system

**Figure 6**  
**Pipeline and Storage Facilities**

The coloured lines show pipeline corridors containing multiple lines in each.



delivers gasoline, diesel, and other refined fuel products to major Midwest markets. There is marine loading capability for both barges for distribution through the Great Lakes and the St. Lawrence Seaway system, and ocean vessels to global markets. The storage systems are also connected to load rail and trucks for product distribution to Midwest markets.

## Globally Competitive with Accessible Markets

In 2009, the United States became a net exporter of gasoline and refined products (exports minus imports, Figure 7). When the imports on the US east coast (primarily from Canadian refineries) are removed, actual exports from the USGC in 2012 averaged 2,430,000 BPCD, with 2013 indications projected slightly higher.

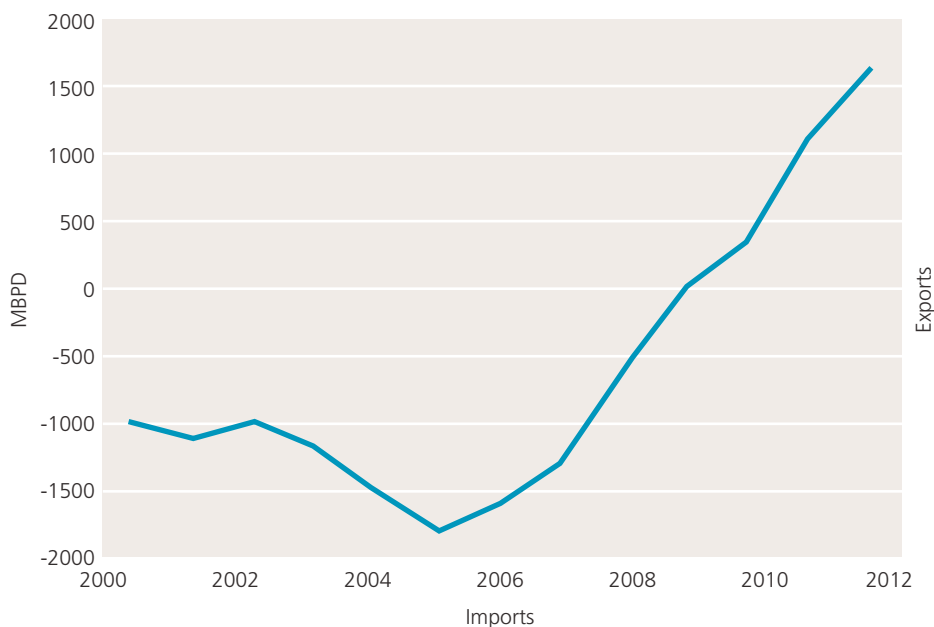
The US Gulf Coast refiners' exports into the Atlantic Basin markets surged, enabled by "advantaged" competitive crude and super competitive natural gas costs. Sarnia-Lambton product sales would represent about 5% of the current US Gulf Coast exports.

Atlantic Basin refinery closures since 2008 totaled 4,000,000 BPCD of crude running capacity, including the shutdown of refineries in Aruba and St. Croix, reduced operating rates due to political intervention in Venezuela, and the shutdown of 1,000,000 BPCD of European capacities, including many low complexity refineries.

BRENT/ICE European markets became the pricing basis in early 2011 (Figure 8). Prior to that the US gasoline prices tracked the US WTI crude oil price postings.

**Figure 7**  
**US Imports/Exports**

VALERO – HOWARD WEIL Energy  
Conference, March 20, 2013.

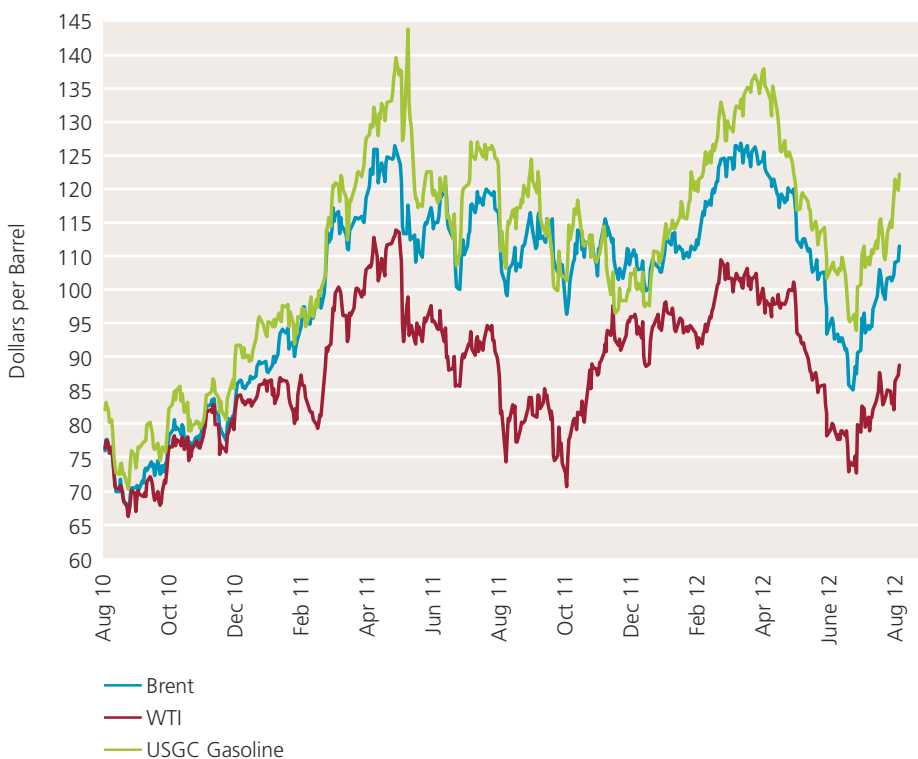


With the emergence of significant US Gulf Coast exports demonstrating the capability to compete in these markets, price netback levels were established that had to be met by US domestic buyers. It is important to note that US gasoline and distillate prices are set by netbacks from export gasoline and diesel sales priced based on Atlantic Basin crude oil costs – Brent/ICE.

While the crude oil price differential between Brent/ICE and US WTI closed in summer of 2013 due to softness in the European economy, the gap opened again in the fourth quarter of 2013.

**Figure 8**  
**USGC Gasoline Pricing Basis**

(Source – Marathon Petroleum Corporation, Barclays CEO Energy/Power Conference Sept 4-6, 2012).



The US PADD 2 Midwest market is a major importer of gasoline, diesel, and fuel products (Figure 9).

The PADD 2 market has approximately 3.5 million BPCD refining capacity, with a 4.0 million BPCD market demand, per US EIA<sup>10</sup> data. Imports into the market, primarily from the US Gulf Coast refineries, correspond to 13% of the PADD 2 gasoline, diesel and fuel products' demand. This is per the Marathon Petroleum Corporation Business Update, December 2012, and confirmed by the Valero presentation at the Howard Weil Energy Conference, March 20, 2013.

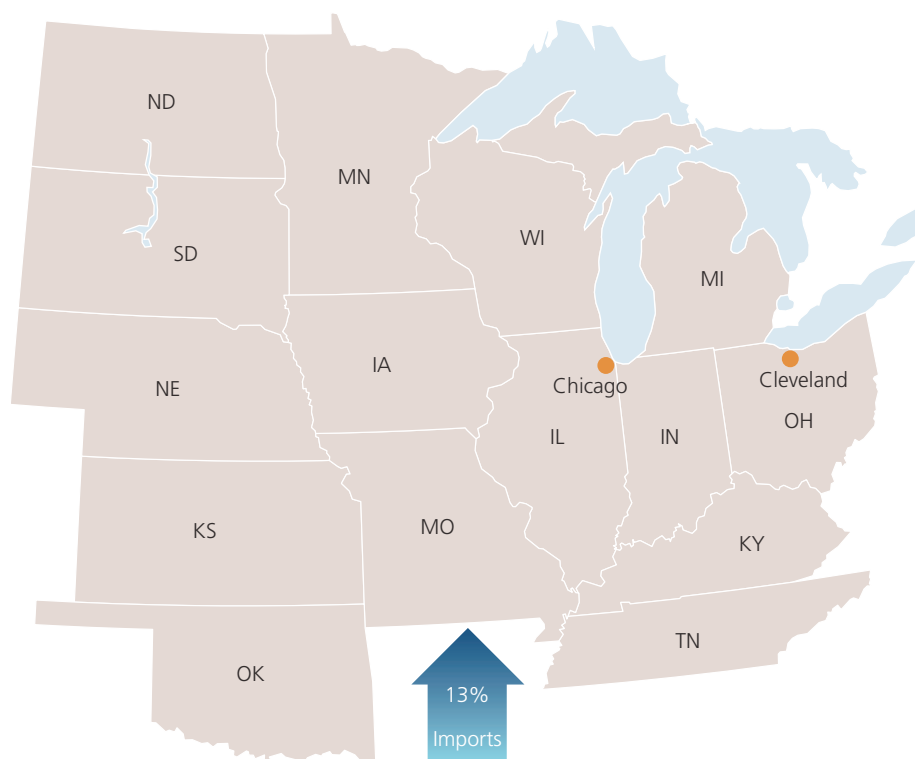
A Sarnia-Lambton refinery upgrader processing 150,000 BPCD of diluted bitumen would represent about 3.5% of this market. A new Sarnia-Lambton refinery upgrader using locally available natural gas from the Marcellus shale for hydrogen production and fuels would be cost competitive with the US Gulf Coast refineries. Product distribution costs by product pipeline from the US Gulf Coast to this market are about \$2.00 per Bbl. Distribution costs from Sarnia-Lambton by marine barge and pipeline would be equal to or lower than the distribution costs from the US Gulf Coast refineries.

A Sarnia-Lambton refinery upgrader would have additional markets including those adjacent to US PADD 2, and markets in Ontario and along the US East Coast. For eight months of the year there would also be marine access to world markets.

It is important to consider that the US Gulf Coast refiner has access to substantial additional export markets, and it would be indifferent on a pricing basis in terms of selling into the PADD 2 market or to the world market.

Clearly the participation of a refiner marketer as a stakeholder in the project is desirable.

**Figure 9**  
**US PADD 2 Midwest Market**



<sup>10</sup>Energy Information Administration

## The Social License

The Sarnia-Lambton area and community have a history of supporting development based on crude oil; a history dating back to the 1860s discovery at nearby Petrolia and Oil Springs (Figure 10). This led to the development of the refinery now owned by Imperial Oil and was

**Figure 10**  
**Oil Museum at Oil Springs, Site**  
**of the First Commercial Oil Well**  
**in North America (1858)**



prior to the availability of crude oil from Alberta. Sarnia was selected as the eastern terminus of the first crude oil line from Alberta to Ontario. Early transparent two-way responsive dialogue with local stakeholders and consultation with First Nations communities will be essential to the success of the project.

The presentation made to the Oil Sands Symposium on December 4th, 2013 was reviewed by key stakeholders as it was being developed, and input was included from local construction trades; the Sarnia Lambton Industrial Association, refinery and major plant managements, the Sarnia Construction Association, and municipal, county, provincial and federal elected representatives. All provided valuable input from their perspectives and all were supportive.

Local issues will need to be addressed and local firms have excellent experience in working with the range of stakeholders in the project. We now have in the community locally based firms that are experienced in this type of consultation. There are nine First Nations groups within 100 km of the project and they will need to be meaningfully involved in the project. Issues involving First Nations peoples, as well as their businesses, will need to be addressed..

The goal of building confidence in the project and obtaining the social license to proceed will be aided by the incorporation of the latest proven technologies. Process selection will consider the best match of stakeholder supplier synthetic crude oil quality, market demand and social license considerations. Water use will be minimized, and the design will incorporate zero liquid waste discharge from the site or to the watershed and St. Clair River. The project will use the latest process design, energy efficiency and emissions control technology to ensure minimizing discharges to the atmosphere as well as minimizing the GHG footprint.

Obtaining a social license will involve work and consultation; however, the objective is achievable given the extraordinary support for the project from the local community.

## Financing

The project is financeable, likely with partners. Using publicly available information, the three local refineries were analyzed to identify possibilities for modifications to process diluted bitumen. No clear fit was identified. To provide options to attract a refining partner, the analysis was based on a grassroots bitumen upgrading refinery of conventional design.

The project design leverages existing unused infrastructure. There are two “brown field” sites available. These are the Dow plant site, now owned by TransAlta, and the Polysar plant site, now owned by LanXess. These properties are available, border the St. Clair River with docks

still in place, and have utilities readily available. NovaChem is converting its Corunna petrochemical refinery to ethane and propane feed stocks from the Marcellus shale fields. This leaves crude oil atmospheric and vacuum distillation towers unused, along with crude oil pipelines and onsite storage. It also leaves multiple pipelines connecting to the Shell and Suncor refineries, the LanXess site, and to product pipelines to markets, all unused. Access to underground salt cavern storage is also available. It is assumed that a new facility will make optimal use of this infrastructure.

The design elements for the upgrader refinery include a feed stream of 150,000 BPCD of diluted bitumen (dilbit) with 30% diluent, and 70% bitumen. Additionally, a number of process units would be required. These include an Atmospheric and Vacuum Distillation unit, Coker and Hydrocracking units. A Hydrogen Plant would be required, together with a Sulphuric Acid Alkylation unit, Intermediate and Product Hydrotreaters, and units for BTX extraction and Isomerization. A Catalytic Reformer unit would be required, as well as a Gas Plant and Sulphur Recovery unit.

Product streams that would be produced by the project include:

- a. 9,000 BPCD Liquified Petroleum gases
- b. 5,000 BPCD Jet Fuel
- c. 7,000 BPCD Aromatic solvents (B,T,X)
- d. 70,000 BPCD Gasoline
- e. 44,000 BPCD Low Sulphur Diesel
- f. 1300 BPCD Heavy Fuel Oil
- g. 600 TPD Sulphur
- h. 2,900 TPD Petroleum Coke
- i. Gasoline/Diesel (G/D) ratio: 1.5

The Capital Cost Estimate, Class 5 Magnitude, equates to \$8.6 billion in Canadian funds. For discussion purposes, a CAPEX of \$10 billion Canadian funds has been assumed. The estimate is based upon current Greenfield site, process unit capacity factored estimates, and a Sarnia/ US. Gulf Coast cost ratio of 1.33. A contingency of 30% has been factored, as well as a Canadian/ US rate of exchange of \$1.05.

No detailed feasibility studies have been undertaken to date. It was recognized that the combination of partners in the project would undertake their own feasibility studies to determine the optimum design, considering their supply and marketing positions and their perspective on design considerations needed to obtain the social contract for the facility. This basic design is well understood by refiners, and represents an understandable starting point.

## Value-Added Capture

Using an assumed input of 150,000 BPCD of dilbit and the refinery configuration and product slate outlined above, a value added calculation can be easily projected. The first step is to assume a West Texas Intermediate (WTI) crude oil price of \$100 per Bbl. If the diluted bitumen is sold to a US Gulf Coast refinery, there is a pipeline transportation cost of \$7.35 per Bbl. There is also a quality differential which has varied from time to time, and which has been

assumed as \$20 per Bbl, based upon the IHS CERA study Alberta Upgrading, March 2013, Table 2, and multiple other studies. This gives a netback to Hardisty, AB of \$73.65 per Bbl. The Enbridge Pipeline transportation tariff from Hardisty to Sarnia is \$5.50 per Bbl, which lands the dilbit mix in Sarnia at an input cost of \$78.15 per Bbl. The weighted average netback of the product slate yielded by the refinery design, based on an analysis done by the Bowman Centre for 2011 is \$123.98 per Bbl. This gives a value added capture of \$45.83 per Bbl or \$2.5 billion per year, or over \$62 billion over 25 years.

The export potential of this project is significant to Canada<sup>11</sup>. Refined products exports from this refinery upgrader would be valued at over \$6 Billion Canadian funds, or 1 1/2% of the total 2012 Canadian products exported valued at over \$400 Billion. This would also correspond to 30% of total 2012 Canadian refined product export of over \$20 Billion.

## The Path Forward

There will be eleven Alberta bitumen producers coming on stream between 2018 and 2025, with a total production of over 1.5 million BPCD. An initial analysis suggests that participation in a Sarnia-Lambton Upgrader might fit the interests of seven of these companies, totaling over 1.2 million BPCD of bitumen production.

A corporate champion, however, is required for the Sarnia-Lambton Upgrader. Ideally the champion would be an experienced refiner that knows how to build and operate refineries and is experienced in marketing the products, ideally with a PADD 2 market position.

The energy world is dominated by super international oil companies, and national oil companies like Total, Statoil, Aramco, Pemex, Petrobras, IPIC, and YPF to name a few. Canada, Alberta and Ontario need to be involved and supportive of the project to help to level the playing field.

There are many levers that government partners can pull to enable financing. One very promising lever is BRIK (Alberta Bitumen Royalty In Kind) barrels to support worthy projects. The NW Upgrader project has a commitment of BRIK barrels for 30 years, while the Alberta Petroleum Marketing Commission has committed barrels to the TransCanada Energy East project for 20 years.

A financial feasibility study is the next step for this project. The Bowman Centre is following the “Call to Action” to proactively take this business case to potential corporate partners to try to convert this into a feasibility study that fits with the partners’ business interests.

The creation of a bitumen upgrader refinery in Sarnia-Lambton is one of the “big picture, big project” undertakings that can begin to recharge Canada’s pursuit of recapturing our national image as a sustainable energy powerhouse.

Sarnia-Lambton was there at the beginning of North America’s oil industry. The men of the Aamjiwnaang First Nation saw it first, seeping from the sticky gum beds near Oil Spring’s Black Creek. This was followed by the continent’s first oil wells, and the construction of Sarnia’s Chemical Valley, where the oil refineries and production of synthetic rubber helped to lead the Allies to victory in WW II. The people of Sarnia-Lambton are ready, willing, and able once again to do their part in this new national quest.

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<sup>11</sup> Patricia Mohr, Vice President, Scotia Bank, Canada’s Merchant Trade in Oil & Gas 2012

## Biography

**Donald E. Wood**, B.Sc. (RMC), B.A.Sc. (U of Toronto), is Associate and Advisory Board member of the Sarnia-based Bowman Centre, and is president of his own consulting firm. He has had 45 years experience in the energy and petrochemical industries, including natural gas utility (Union Gas), petrochemical refinery restructuring (Polysar Limited, retired Vice President Logistics and Business Development), greenhouse gas capture, conversion and management (Marsulex, retired senior operating Vice President), merger and acquisitions (15 M&A projects completed). His efforts in the Sarnia-Lambton region have helped medium-sized organizations assess strategic alternatives. On a broader front, he has acted on behalf of owners and been involved within many mergers, joint venture establishments, divestitures and acquisitions, and acquisition integrations.

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## List of Abbreviations

|                |                                                                     |              |                                                                  |
|----------------|---------------------------------------------------------------------|--------------|------------------------------------------------------------------|
| APMC .....     | Alberta Petroleum Marketing Commission                              | ISBL.....    | Inside Battery Limit                                             |
| BBL .....      | Barrel (oil barrel)                                                 | LPG .....    | Liquefied Petroleum Gas                                          |
| BPD .....      | Barrel (oil) per day                                                | LTPD.....    | Long Ton per Day                                                 |
| BPCD .....     | Barrels (oil) per Calendar Day                                      | MBPD .....   | Thousand Barrels per Day (“M” refers to 1000 in Imperial system) |
| BRENT/ICE..... | Brent/Intercontinental Exchange (European)                          | MTD .....    | Metric Tonne per Day                                             |
| BRIK .....     | Bitumen Royalty In Kind                                             | NGL .....    | Natural Gas Liquids                                              |
| BTX.....       | Benzene, Toluene and Xylene                                         | NWU .....    | Northwest Upgrader                                               |
| CAPEX .....    | Capital Expense                                                     | OSBL.....    | Outside Battery Limit                                            |
| CN .....       | Canadian National (rail)                                            | OPEX .....   | Operating Expense                                                |
| COSIA .....    | Canadian Oil Sands Innovation Alliance                              | PADD .....   | Petroleum Administration Defense District                        |
| Dilbit .....   | Diluted bitumen (diluted with naphtha or similar light hydrocarbon) | ROI .....    | Return on Investment                                             |
| DHT .....      | Distillate Hydrotreater                                             | PSA.....     | Pressure Swing Absorber                                          |
| EBITDA .....   | Earnings Before Interest, Taxes, Depreciation and Amortization      | Synbit ..... | Bitumen diluted with synthetic crude oil                         |
| EIA.....       | Energy Information Administration (US)                              | TCPL .....   | Trans Canada Pipelines Ltd.                                      |
| FCC .....      | Fluidized Catalytic Cracking                                        | YTD .....    | Year to date                                                     |
| G/D.....       | Gasoline to Distillate (ratio)                                      | TPD.....     | Ton (Tonne) per day                                              |
| HRSG .....     | Heat Recovery Steam Generator                                       | UDEX .....   | Union Dow Extractor                                              |
|                |                                                                     | USGC .....   | United States Gulf Coast                                         |
|                |                                                                     | WCS .....    | Western Canadian Synthetic                                       |
|                |                                                                     | WTI.....     | West Texas Intermediate                                          |