

---

***Alberta's  
Industrial  
Heartland  
Association***

October 2017

**Economic Impact  
Assessment of  
Petrochemical  
Project**



---

# *Table of Contents*

---

Executive Summary	1
1. Introduction	4
1.1 Background	4
1.2 Study Objectives	4
1.3 Report Organization	5
1.4 Scope of Review and Limitations	5
2. Alberta Economic Overview	6
3. Background - Reviewed Projects	8
3.1 The Reviewed Projects	8
3.2 The Petrochemical Process	8
3.3 The Markets for the Main Input and Output of the Polypropylene Plant	9
3.4 The Market for the Main Input and Output of the Methanol Plant	13
3.5 The Market for Polyethylene	15
3.6 Refinery	17
3.7 The Market for Natural Gas	20
3.8 Labour Market	22
3.9 Summary	27
4. Input Output Analysis	28
4.1 Methodology	28
4.2 Impact of Development Activities	29
4.3 Impact of Steady-State Operation Activities	29
5. Implications for Alberta	31
5.1 Labour	31
5.2 Non-Labour Inputs	31
5.3 Potential Future Benefits	31
6. Assumptions	32
Appendix A: Sources Used	33
Appendix B: Development Expenditures	34
Appendix C: Operating Expenditures	35
Appendix D: Detailed Impacts	36

---

Appendix E: Limitations

44

Appendix F: Glossary

46

# Executive Summary

Alberta’s Industrial Heartland (“AIHA”) has engaged PricewaterhouseCoopers, LLP (“PwC”, “we”, “our”, or “us”) to provide an assessment of the economic impact on the Alberta economy of the construction and operation of new petrochemical facilities in Alberta.

To this end, we have prepared an analysis which estimates the economic impact (at the direct, indirect and induced levels of both the construction and operating phases; also referred to as “Input-Output Analysis”) of four types of petrochemical facilities (“Reviewed Projects”): propane, ethane, methane and refining. Since the Reviewed Projects have not yet been planned, the expected capital and operating expenditures reflect average size plants.

We estimate the development period of the Reviewed Projects to produce the following economic activity, over the entire development period:

Measure of Economic Activity	Estimated Footprint in Alberta (\$ millions) – Development Period			
	Propane	Methane	Ethane	Refinery
Project type				
Development Period <sup>1</sup>	4 years	n/a	5 years	5 years / phase <sup>2</sup>
Project capacity (output)	525 kTA (Polypropylene)	940,989 lb/hr (Methanol)	1530 kTA (High Density Polyethylene)	240k bbl/d (Diesel)
Output	\$6,263	\$5,741	\$11,714	\$42,335
GDP	\$1,927	\$2,756	\$5,528	\$20,257
Jobs (person-years)	29,233	29,526	55,419	214,399
Taxes on Production & Imports	\$181.7	\$177.18	\$362.15	\$1,305
Personal Taxes <sup>3</sup>	\$255.2	\$248.95	\$508.85	\$1,833
Corporate Taxes <sup>4</sup>	\$133.2	\$129.91	\$265.53	\$956.73

We have also estimated the annual economic activity expected from each of the Reviewed Projects when they reach a steady state level of operation, as follows:

<sup>1</sup> The development period is dependent upon specific project metrics.

<sup>2</sup> Our analysis is based on a 3 phase project, whose development period is expected to span a total of 15 years.

<sup>3</sup> Provincial personal income tax

<sup>4</sup> Relates to provincial corporate income taxes

Measure of Economic Activity	Estimated Annual Footprint in Alberta (\$ millions) – Operating Activities			
	Propane	Methane	Ethane	Refinery
Project type				
Project capacity (output)	525 kTA (Polypropylene)	940,989 lb/hr (Methanol)	1530 kTA (High Density Polyethylene)	240k bbl/d (Diesel)
Output	\$572.9	\$1,435	\$2,489	\$5,342
GDP	\$216.2	\$646.6	\$1,202	\$2,354
Jobs	1,552	3,000	7,713	11,781
Taxes on Production & Imports	\$10.9	\$23.00	\$58.24	\$86.29
Personal Taxes <sup>5</sup>	\$15.3	\$32.32	\$81.84	\$121.24
Corporate Taxes <sup>6</sup>	\$8.0	\$16.87	\$42.71	\$63.27

The primary inputs for the operation of the Reviewed Projects were identified to be natural gas, bitumen and labour. Our analysis indicates that these inputs are currently in over supply situation that will not be resolved in the foreseeable future. As such, the Reviewed Projects would provide an outlet for these inputs, which would lead to economic activities expected from the Reviewed Projects being largely a net economic contributor to Alberta. In addition netback prices to natural gas and bitumen producers in Alberta, which currently are facing a significant discount, may improve as a result of the additional demand coming from local sources.

Our analysis suggests that the US natural gas is expected to continue to displace natural gas produced in Alberta. This coupled with continued low process for natural gas, will force the natural gas industry in Alberta to increasingly rely on domestic (Alberta) demand as well as LNG (going to export through British Columbia). Given the uncertainty surrounding LNG exports, the Reviewed Projects could be part of the longer term solution for excess natural gas in Alberta.

Currently, the majority of heavy oil produced in Alberta is exported to the United States for refining. Bitumen production is expected to grow more rapidly than the capacity of refineries able to process it. For the period of 2016 to 2025, the demand in Alberta is expected to total 11% of bitumen production. As a result, the increase in the production and supply of bitumen will be exported from the province to the United States.

Current unemployment rate in Alberta is 8.5%. While the rate is expected to decline to 4.6% by 2020, most of the employment growth will come from the services sector while employment in the goods sector is expected to stagnate. This suggests that the goods sector is likely experiencing and would continue to experience an oversupply of labour. Some of the excess supply would likely be absorbed in the services sector at lower salary levels and some would likely leave the province. The Reviewed Projects would draw unemployed from the goods sector, underemployed workers from the services sector, as well as interprovincial and international migration, creating net benefits to the province.

<sup>5</sup> Provincial personal income tax

<sup>6</sup> Relates to provincial corporate income taxes. Note that the Reviewed Projects are not subject to royalties. However, the production of bitumen and natural gas used as a feedstock for Reviewed Projects would generate royalties for the Alberta government. For the refinery, we have estimated the yearly value of royalties paid by bitumen producers for the bitumen that is used in the refinery to be approximately \$330 million. For the purpose of this analysis, we have not estimated the yearly royalty from the increased production of natural gas in order to provide inputs to the Reviewed Projects. (see [http://www.energy.alberta.ca/Org/pdfs/FS\\_Royalties.pdf](http://www.energy.alberta.ca/Org/pdfs/FS_Royalties.pdf))

---

We note that since many of the existing energy downstream operations reside in the Industrial Heartland region, the construction of additional downstream operation will generate a cluster effect. In other words, the existence of such operations will likely raise the attractiveness of investing in a new downstream project. Moreover, the new projects will strengthen the cluster and may attract additional investment in the future. The cluster effect, would therefore add additional economic activity that has not been quantified by us in our analysis.

---

# 1. Introduction

## 1.1 Background

Alberta's Industrial Heartland is Canada's largest hydrocarbon processing region. The region's 40+ companies, several being world scale, provide fuels, fertilizers, power, petrochemicals and more to provincial and global consumers. The Alberta's Industrial Heartland Association ("AIHA") is made up of municipalities within Alberta's Industrial Heartland dedicated to sustainable responsible development within the region. It consists of five municipal partners and three associate members:

### *Municipal Partners*

- City of Fort Saskatchewan
- Lamont Country
- Strathcona Country
- Sturgeon Country
- City of Edmonton

### *Associate Members*

- Town of Bruderheim
- Town of Gibbons
- Town of Redwater

In 2016, the five municipal partners and three associate members represented a combined population of 1.03 million residents.

## 1.2 Study Objectives

AIHA has engaged PricewaterhouseCoopers, LLP ("PwC", "we", "our", or "us") to provide an assessment of the economic impact on the Alberta economy of the construction and operation of new petrochemical facilities in Alberta.

To this end, we have prepared an analysis which estimates the economic impact (at the direct, indirect and induced levels of both the construction and operating phases; also referred to as "Input-Output Analysis") of four types of petrochemical facilities ("Reviewed Projects"): propane, ethane, methane and refinery. As our Economic Analysis relates to future potential projects, we have modelled the expected capital and operating expenditures using data collected from industry participants and independent research. Since the Reviewed Projects have not yet been planned, the expected capital and operating expenditures reflect world-scale size plants.

Our Economic Footprint Analysis addresses the following measures of economic activity:

- **Output** – the total gross value of goods and services produced, measured by the price paid to the producer. Output double counts the value of intermediate inputs and so GDP is usually a preferable measure of economic activity.
- **Employment** – the number of jobs expected to be created or supported by expenditures (including those supported in the broader economy);

- **Value added or Gross Domestic Product (“GDP”)** – the value added to the economy, or the unduplicated total value of goods and services. GDP includes only final goods to avoid double counting of products sold during a certain accounting period; and
- **Tax contribution** - the amount of provincial tax revenues expected to be generated from taxes on production and imports, as well as income taxes at the on personal income of employees, self-employed individuals and corporate profits.

The economic impacts in our Economic Input-Output Analysis are estimated at the direct, indirect and induced levels based on estimated capital and operating expenditures in Alberta:

- **Direct impacts** result from the Company’s estimated spending on suppliers and employees.
- **Indirect impacts** arise from the activities of the firms providing inputs to the Company’s suppliers (in other words, the suppliers of its suppliers).
- **Induced impacts** are the result of consumer spending by employees of the businesses stimulated by direct and indirect expenditures.
- The **total economic impact** equals the sum of the direct, indirect, and induced economic impacts.

We note that an Input-Output Analysis does not consider the alternative uses (i.e. opportunity cost) of the inputs (e.g. capital, labour, energy) that are going to be used for the construction and operation of the projects that are being assessed by the Input-Output Analysis. Therefore, an Input-Output Analysis provides in effect an estimate of the gross economic impact. While our mandate did not extend to measuring the net economic impact of the Reviewed Projects, we did conduct a high level analysis on the major inputs that would be used to operate the Reviewed Projects (i.e. labour and natural gas) as well as the conditions and trends of the Alberta economy and the petro-chemical industry in order to provide the reader of this report a basis for the assessment of the opportunity cost of these inputs.

### **1.3 Report Organization**

The report is structured in the following manner:

- A regional economic profile of Alberta (Section 2);
- An overview of the Reviewed Projects as well as the main outputs and inputs (Section 3);
- Input-Output Analysis of the development and operational activities associated with the Reviewed Projects (Section 4);
- Implications for the Alberta Economy (Section 5); and
- Assumptions relied on to complete our analysis (Section 6).

Unless otherwise noted, all dollar amounts in this report are expressed in Canadian currency.

### **1.4 Scope of Review and Limitations**

This economic analysis was prepared using information provided by AIHA, discussions with industry participants, and our research. A complete list of the documents and sources we have reviewed is listed in Appendix A.

The limitations to our analysis are outlined in Appendix E.

## 2. Alberta Economic Overview

Over the past 20 years, Alberta has experienced significant economic growth relative to the rest of Canada. Alberta had a total gross domestic product (“GDP”) of \$290,925 billion in 2016. The oil and gas sector accounted for 18.3% of total GDP, followed by finance and real estate at 15.1%, construction at 11.7% and business and commercial services sector at 11.6% of total GDP<sup>7</sup>.

Alberta has the third largest petroleum reserves in the world and accounts for 80% and 68% of Canada’s total crude oil and natural gas production, respectively<sup>8</sup>. From 2010 to 2014, the Alberta economy has benefited from high oil prices, which led to an average annual GDP growth rate during this period of 5.2%. Since 2014, the decline in oil and gas prices has significantly impacted Alberta’s economy, evidenced by the decrease in GDP of 3.7% in 2015. GDP continued to decrease at a rate of 2.9% in 2016. Capital investment in the energy sector has also decreased significantly by a cumulative rate of over 50% in 2015 and 2016. However, as energy prices begin to increase gradually, GDP is expected to gradually recover but growth rates in the foreseeable future are expected to be less than half the rates exhibited during the 2010 to 2014 era. The following table provides a summary of historical and forecast economic indicators for Alberta<sup>9</sup>:

<b>Economic Indicators</b>	2014	2015	2016	2017f	2018f	2019f	2020f
<b>Real GDP at basic prices (2007 \$millions)</b>	<b>311,083</b>	<b>299,603</b>	<b>290,925</b>	<b>299,164</b>	<b>304,822</b>	<b>311,100</b>	<b>318,612</b>
<i>percentage change</i>	4.9	-3.7	-2.9	2.8	1.9	2.1	2.4
<b>Total employment (1000s)</b>	<b>2,274</b>	<b>2,302</b>	<b>2,266</b>	<b>2,279</b>	<b>2,302</b>	<b>2,331</b>	<b>2,366</b>
<i>percentage change</i>	2.2	1.2	-1.6	0.6	1.0	1.3	1.5
<b>Unemployment rate (percent)</b>	<b>4.7</b>	<b>6.0</b>	<b>8.1</b>	<b>8.4</b>	<b>7.7</b>	<b>6.8</b>	<b>6.1</b>
<b>Personal income per capita (\$)</b>	<b>56,503</b>	<b>57,298</b>	<b>55,698</b>	<b>56,259</b>	<b>57,140</b>	<b>58,241</b>	<b>59,646</b>
<b>Population (1000s)</b>	<b>4,092</b>	<b>4,72</b>	<b>4,243</b>	<b>4,311</b>	<b>4,386</b>	<b>4,465</b>	<b>4,544</b>
<i>percentage change</i>	2.8	2.0	1.7	1.6	1.8	1.8	1.8
<b>Single-family housing starts (1000s)</b>	<b>19.6</b>	<b>14.6</b>	<b>11.4</b>	<b>12.3</b>	<b>13.0</b>	<b>13.1</b>	<b>13.7</b>
<b>Multi-family housing starts (1000s)</b>	<b>21.0</b>	<b>22.7</b>	<b>13.1</b>	<b>12.4</b>	<b>13.8</b>	<b>14.2</b>	<b>15.1</b>
<b>Retail sales (\$ millions)</b>	<b>78,582</b>	<b>74,989</b>	<b>73,643</b>	<b>74,389</b>	<b>75,365</b>	<b>76,840</b>	<b>78,876</b>
<i>percentage change</i>	7.5	-4.6	-1.8	1.0	1.3	2.0	2.6
<b>CPI (2002 = 1)</b>	<b>1.322</b>	<b>1.337</b>	<b>1.352</b>	<b>1.378</b>	<b>1.409</b>	<b>1.442</b>	<b>1.470</b>
<i>percentage change</i>	2.6	1.2	1.1	1.9	2.3	2.3	2.0

f = forecast

Between 2005 and 2015, Alberta’s population grew by 26.3% which was the highest growth rate of any province or state in North America<sup>10</sup>. This translated to an average annual growth rate of 2.4%, which was driven by strong international and inter province migration. In the foreseeable future the population growth is expected to decline to an average of 1.5% driven mainly by international migration. Inter provincial migration in 2016 was negative and is expected to be insignificant in 2017. Historically, the labour market in Alberta was characterised by high demand

<sup>7</sup> Alberta Economic Development and Trade – Highlights of the Alberta Economy 2016

<sup>8</sup> Alberta Economic Development and Trade – Highlights of the Alberta Economy 2016

<sup>9</sup> Conference Board of Canada – Metropolitans Economic Outlook, Autumn 2016

<sup>10</sup> Alberta Economic Development and Trade – Highlights of the Alberta Economy 2016

---

for skilled tradespeople and engineers, resulting in relatively high wages for such professions. The unemployment rate in January 2014 was 4.7% compared to a national average of 7.0%<sup>11</sup>.

Declining oil and gas prices since 2014 have led to significant changes in Alberta labour market. The energy sector and other related industries such as manufacturing, construction and transportation have experienced significant employment reductions. As a result, the provincial unemployment rate increased to 8.5% in December 2016, compared to a national average of 6.9%<sup>12</sup>. This has resulted in excess labour supply in skilled workers in the goods sector (i.e. primary, construction, and manufacturing). The excess supply in the goods sector is not expected to be eliminated in the foreseeable future.

---

<sup>11</sup> StatsCan CANISM Table 282-0087

<sup>12</sup> StatsCan CANISM Table 282-0087

---

# 3. Background - Reviewed Projects

## 3.1 The Reviewed Projects

As noted previously, we have been asked to prepare and assessment of the economic impact on the Alberta economy of the construction and operation of new petrochemical facilities in Alberta. In this section you will find background information about each of the Reviewed Projects, which include:

- Polypropylene plant – used to produce polypropylene from propane recovered from raw natural gas;
- Methanol plant – used to produce methanol from methane recovered from raw natural gas;
- Polyethylene plant – used to produce polyethylene from ethane recovered from raw natural gas;
- Refinery – used to produce various refined petroleum products from bitumen and heavy oils;

## 3.2 The Petrochemical Process

Petrochemicals are products manufactured from crude oil and natural gas. The petrochemical process uses feedstock, typically natural gas or crude oil, to create petroleum-based chemicals and chemical derivatives which are used to produce end-use products. Crude oil processed at refineries yields a variety of petroleum products including Liquid Petroleum Gases (“LPGs”)<sup>13</sup>. Natural gas is a naturally occurring hydrocarbon that is composed primarily of methane and varying amounts of ethane, propane, butane and pentane (Natural Gas Liquids or “NGLs”). NGLs are separated from the natural gas at processing plants to be used as feedstock.

The petrochemical feedstock produced as a result of the processing phase are then converted to petrochemicals. There are various conversion processes which include the following:

- Steam cracking involves cracking hydrocarbon feedstocks (NGLs) with steam at high temperatures. The resulting cracked gas is separated into olefins<sup>14</sup>. Depending on the feedstock used, olefins produced typically include, but are not limited to, ethylene and propylene.
- PDH is a catalytic dehydrogenation technology that produces propylene from propane. High temperatures and a catalyst promote the separation of hydrogen from propane.
- The methanol-to-olefins (“MTO”) processes use a fluidised reactor, regenerator system and proprietary catalyst to convert methanol to olefins.

The olefins go through additional processes to form petrochemical derivatives used to manufacture end-use products. (Canadian Energy Research Institute, 2015).

In the following sub-sections, we describe the current and prospective market conditions for the products to be produced by the Reviewed Projects as well as their main feedstock. In addition, we describe the current and prospective conditions for two of the primary inputs to the Reviewed Projects: natural gas and labour.

---

<sup>13</sup> Liquefied Petroleum Gases are a group of hydrocarbon gases, primarily propane and butane.

<sup>14</sup> Olefins are petrochemical derivatives produced from raw materials such as natural gas and crude oil. The common olefin products include ethylene, propylene, and butadiene. An olefin is a compound made up of hydrogen and carbon that contains one or more pairs of carbon atoms linked by a double bond.

---

### **3.3 The Markets for the Main Input and Output of the Polypropylene Plant**

#### **Product description**

Polypropylene is a generic name for a family of semi-crystalline polymers. Polypropylene, as well as polyethylene, belong to the group of polyolefins that are derived from a group of base chemicals known as olefins. Polyolefins are made by joining together small molecules (monomers) to form long-chain molecules (polymers) with thousands of individual links using a variety of catalysts. The base monomer for polypropylene is propylene, which is a gas at room temperature, but when linked together as polymers, it forms tough, flexible plastic materials with a large variety of applications.<sup>15</sup>

#### **The Market for Propane**

Propane is extracted from raw natural gas as part of processing natural gas, as a by-product from the refining process or from gasses produced as by-products of bitumen upgrading (“off-gas”). Propane has numerous applications and is often used as a heating fuel in furnaces, space heaters, water heaters, fireplaces, barbecues, generators etc. or as a feedstock to make petrochemicals and other derivatives which are components in many end-use products.

Canadian propane production has been increasing since 2010 as a result of the development of the Montney formation (located in northeastern British Columbia and the Alberta Deep Basin) which is one of the world’s largest liquids-rich<sup>16</sup> plays. In 2015, total production was approximately 206.3 thousand barrels of oil equivalent per day (“mboe/d”) of which over 80% was produced from gas plants. The remainder was produced as a by-product of refining or as an off-gas from bitumen upgrading<sup>17</sup>. The production of propane is tied to the production of natural gas and tends to follow similar market trends. In 2016, Alberta exported 2.8 million cubic meters of propane out of, a total volume exported by Canada of 5.9 million cubic meters, or 47%.

Demand for propane fluctuates based on many factors. The demand for propane is impacted by seasonal factors such as the weather and the agricultural conditions. Cold conditions and high agricultural demand can cause propane demand to increase while warmer weather and ideal harvest conditions can cause propane demand to decrease<sup>18</sup>. In 2015, approximately 56% of the propane produced in Canada was used domestically and the remainder was exported. Currently, the US is Canada’s primary propane export market.

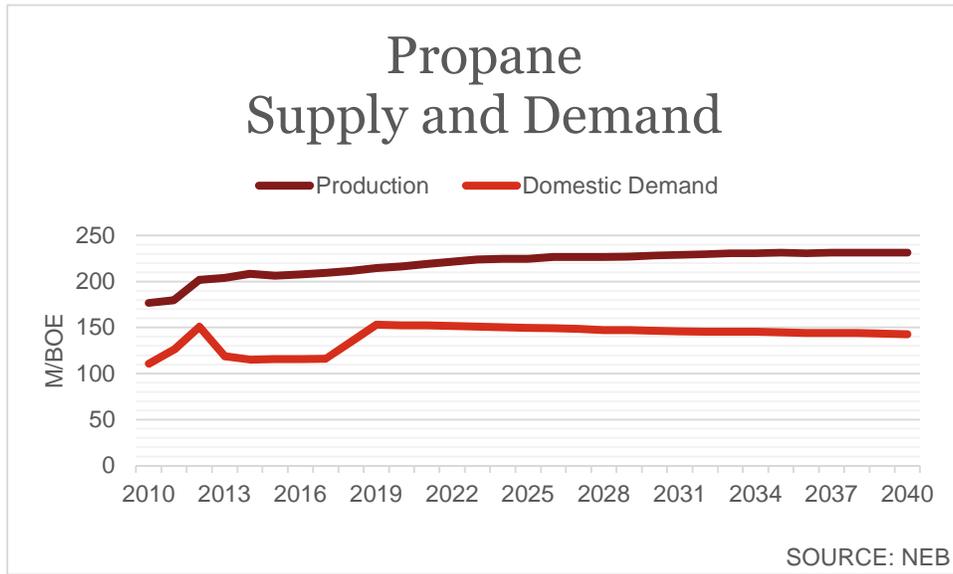
---

<sup>15</sup> Samsung Process Analytics in Polypropylene (PP) Plants

<sup>16</sup> Refers to high concentrations of NGLs.

<sup>17</sup> National Energy Board – An Energy Market Assessment – Canada’s Energy Future 2016

<sup>18</sup> National Energy Board – An Energy Market Assessment – Canada’s Energy Future 2016



As a result of increased production and weak demand, Canadian propane inventories reached a record high of 12.1 million barrels (“MMboe”) in December 2014. The over-supply of propane forced prices down causing some companies to choose not to extract propane from the natural gas stream<sup>19</sup>. By April 2016, Canadian inventories declined to 3.3 MMboe, within the five-year range<sup>20</sup>.

The price of propane is influenced by production, weather and inventory levels. The prices also trend with natural gas prices as propane is used as alternative form of heating<sup>21</sup>.

There are four major North American pricing and storage hubs for propane: Edmonton, Alberta; Sarnia, Ontario; Conway, Kansas; and Mont Belvieu, Texas. Edmonton generally trades at a discount to the other hubs due to high transportation costs<sup>22</sup>.

Propane prices peaked early in 2014. In Edmonton and Sarnia, the price of propane was over \$2.50 US per gallon and subsequently fell to below zero in May through August 2015. Due to the oversupply of propane and lack of transportation methods during this period, producers were losing money on the propane produced. With reduced production, propane prices have gradually increased throughout 2016, reaching \$0.40 US per gallon in Edmonton at the end of October<sup>23</sup>.

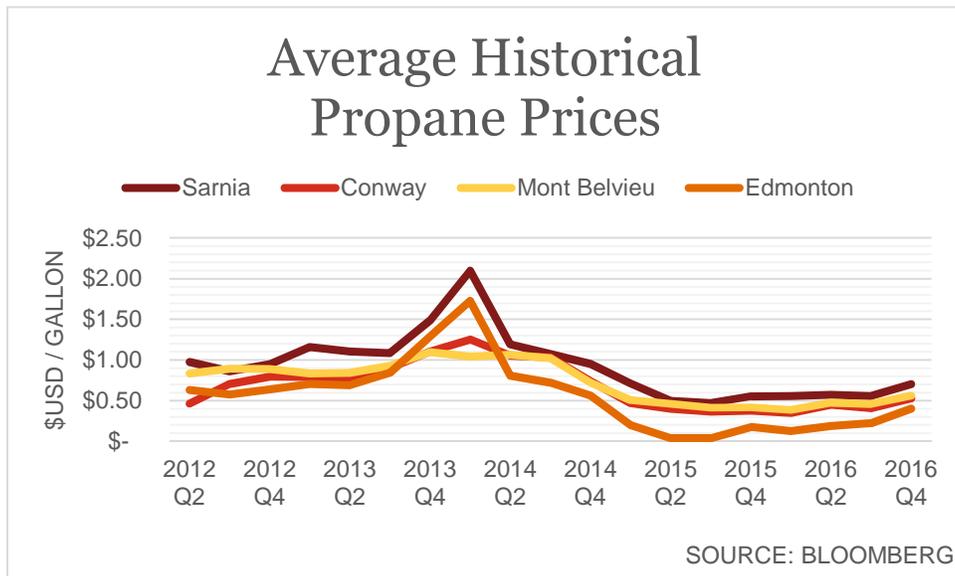
<sup>19</sup> Rejected NGLs are those volumes that are not recovered (i.e. left in the natural gas stream).

<sup>20</sup> National Energy Board - Propane Market Review: 2016 Update

<sup>21</sup> Canadian Propane Association

<sup>22</sup> National Energy Board - Propane Market Review: 2016 Update

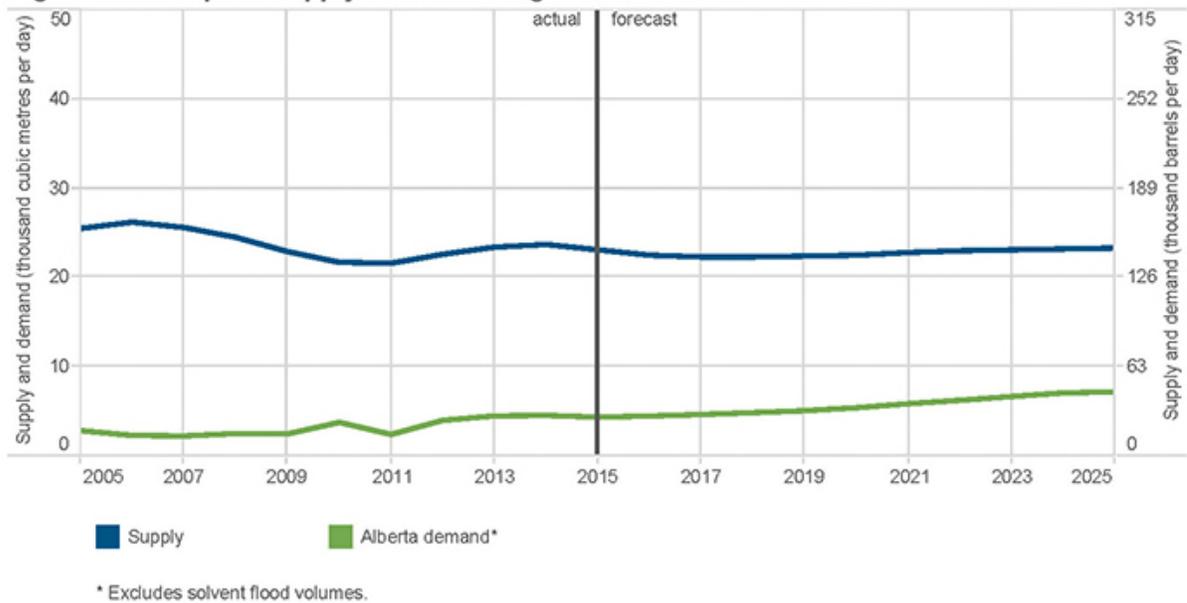
<sup>23</sup> Bloomberg



The expected average annual growth of global demand growth for 2016-2020 is 4.5%, which includes consideration of the planned projects, capacity additions are exceeding demand growth globally<sup>24</sup>. According to a forecast of propane consumption conducted by the NEB, both supply and demand are expected to remain relatively flat from 2016 to 2025:<sup>25</sup>

Propane Supply and Demand. Source: Alberta Energy Regulator, updated March 2017

Figure S6.3 Propane supply from natural gas and demand



<sup>24</sup> Lyondellbasell – Propylene: The “Other” Olefin, March 2016

<sup>25</sup> <https://www.aer.ca/data-and-publications/statistical-reports/propane-supply-demand>

## The Market for Polypropylene

Polypropylene is a versatile product that is used in numerous industries such as toy making, automobile, carpeting, paper, and manufacturing of laboratory equipment. It can be easily customized and can be coloured in various ways without degrading the original quality of the plastic.<sup>26</sup>

The global production of polypropylene was 56.44 million mt in 2016 and is forecasted to reach 75.72 million mt by 2022. The market size in 2016 was USD 105.46 billion and is forecast to reach USD 151.38 billion by 2022 growing at a rate of 6.21% compounded annually. In 2016, Asia-Pacific was the largest consumer with a market share of 44%, followed by Europe. However, Middle East and Africa are expected to be the fastest growing market for the forecasted period in terms of demand. Growth in automotive and construction sectors in emerging countries like India, China, and Indonesia is also expected to drive the growth in the Asia-Pacific region. In recent years, North America experienced a decline in demand and is recovering slowly.<sup>27</sup>

*Global Price of Polypropylene. Source: Platts, September 2017*

### PLATTS GLOBAL POLYPROPYLENE PRICE INDEX



Source: Platts

The market of polypropylene on the basis of end-use is segmented into construction, consumer products, packaging, electrical & electronics, and automotive. The largest industry that uses polypropylene is packaging, thanks to the chemical's stiffness and twist retention that makes it an efficient material for packaging. Polypropylene's unique properties also make it a widely used product in consumer products' packaging industry. In the electrical and electronics segment it is used in the production of switch boards, insulation cables, and capacitors because of its high electric shock resistance. Lastly, the automobile industry uses polypropylene because of its mechanical properties and the availability in lower cost as compared to other plastics.<sup>28</sup>

Factors like demand in packaging industry and increasingly popular light weighting vehicles industry are expected to drive the market of the chemical within the next years. On the other hand, factors like volatility in raw material prices, environmental issues would limit the growth of the market. Polypropylene manufacturers are shifting their focus from synthetic to bio-based polypropylene as a result of increase in demand for the latter. Global

<sup>26</sup> <http://www.grandviewresearch.com/industry-analysis/polypropylene-market>

<sup>27</sup> <http://www.prnewswire.com/news-releases/global-polypropylene-pp-market-report-2017-100-billion-market-size-demand-forecasts-industry-trends-and-updates-2016-2022---research-and-markets-300465031.html>

<sup>28</sup> <http://www.grandviewresearch.com/industry-analysis/polypropylene-market>

---

Polypropylene market is a fragmented market with top 5 players contributing 30% of the market share in 2016. However, with the industry witnessing acquisitions, the market is moving towards a consolidated one.<sup>29</sup>

In 2017, there was a slight oversupply in the global polypropylene market, which is expected to diminish in the next ten years.<sup>30</sup> In the short term, i.e. in 2017 and 2018, polypropylene netbacks are expected to increase, based on the chemical's price projections.<sup>31</sup>

### **3.4 The Market for the Main Input and Output of the Methanol Plant**

#### **Product Description**

Methanol is a basic chemical building block used in various industrial and consumer applications. The majority of methanol is used as a feedstock to manufacture other chemicals including formaldehyde, acetic acid and chlorine dioxide. These traditional uses of methanol account for approximately 60% of total demand (Methanex, 2016). Approximately 40% of the global demand for methanol is for use in the oil and gas industry to produce renewable fuels and as a blending component for gasoline. (Methanex, 2016) Finally, methanol can also be used as a feedstock in the MTO process to produce olefins such as ethylene and propylene. (Methanex, 2016) Although the first MTO facility began production in late 2011, by the end of 2015 there were seven MTO facilities all within China. As a result, the demand for methanol to be used in the MTO process has grown significantly over the past few years. (Alvarado, 2016)

#### **The Market for Methane**

Natural gas is comprised primarily of methane, however it also includes a mixture of ethane, propane and butane. During the natural gas processing process, NGLs are extracted and used in different applications leaving behind methane. Methane can be used as a petrochemical feedstock to produce methanol.

As methane is the main component in natural gas, the supply and demand for methane is similar to that of natural gas. As previously discussed, demand is impacted by the weather as natural gas is used for heating purposes in the residential and commercial sectors. As natural gas can be substituted with select oil products, the price of oil and demand for oil products can impact the demand for natural gas.

As natural gas is comprised mostly of methane, the price of methane is influenced by the price of natural gas.<sup>32</sup>

#### **The Market for Methanol**

There is currently only one company in Canada that produces methanol from natural gas feedstock. Methanex Corporation currently operates a methanol plant in Medicine Hat, Alberta which has a production capacity of 48 mmcf/day (0.6 tonnes per year). As of August 2016, Methanex was planning to double the output of its Medicine Hat facility, conditional on favourable economic conditions. As of October 2016, Methanex exports approximately 40 per cent of the methanol produced at the Medicine Hat manufacturing facility.

Based on the uses of methanol, the demand is largely dependent on consumer spending, manufacturing activity and oil and gas activity. Demand for methanol from Canada is also driven by global trade, the exchange rate and oil and natural gas prices. In 2015, Chinese methanol consumption accounted for approximately 54% of global demand while North America and Western Europe accounted for approximately 11% and 10%, respectively.

---

<sup>29</sup> <http://www.prnewswire.com/news-releases/global-polypropylene-pp-market-report-2017-100-billion-market-size-demand-forecasts-industry-trends-and-updates-2016-2022---research-and-markets-300465031.html>

<sup>30</sup> <http://blogs.platts.com/2017/09/07/infographic-whats-store-global-polyethylene-polypropylene-2027/>

<sup>31</sup> Macquarie Research: Equities – Global petrochemicals, January 2017

<sup>32</sup> A discussion on natural gas prospects is included later in Section 3

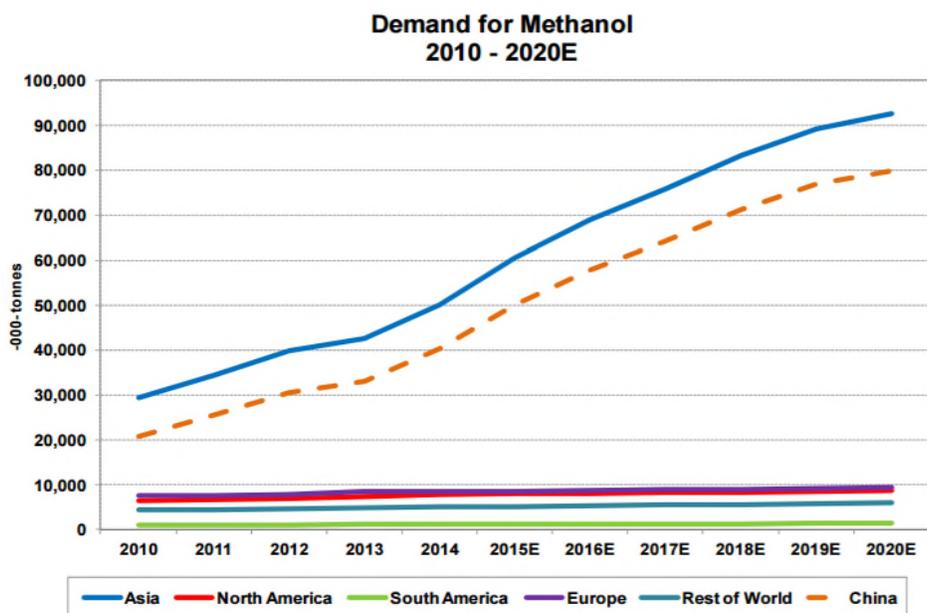
Methanex posts regional contract methanol prices for North America, Europe and Asia. (Methanex, 2016) The global pricing of methanol is based on the price in China (the largest consumer of methanol) and adjusted for freight and duty differentials, handling costs and the Middle East producers balancing exports to regions for the highest netback value<sup>33</sup>. In particular, the price of methanol to North America is equal to the price in China, in addition to freight differential and duties, as well as the Middle East producers export markup. As methanol can be used to create other chemical derivatives and alternatives to crude oil products, the price is impacted by crude oil prices, global fuel markets and light olefins markets. (Alvarado, 2016) (ChemInfo Services Inc., 2014)

The global demand for methanol is expected to increase at an average annual growth rate of 7%, largely the result of a growth in MTO projects. In a 2015 report, the Methanol Market Services Asia (MMSA) forecasted that the price of methanol in North America is expected to keep increasing in a gradual rate from 2016 to the end of the projection period at 2020. Methanol prices in other regions, including China and Western Europe are expected to follow the same trend.<sup>34</sup>

There are counteracting effects on supply and demand. There is a potential short term oversupply as a result of recent increases in production from the US. However, global demand is also increasing, led by China, as new uses are being uncovered for the product (i.e. MTO).<sup>35</sup> One study finds that demand will be relatively flat worldwide, with the exception of China driving the Asian market. See figure below<sup>36</sup>.

According to IGP Energy: “Also, while global methanol demand growth for 2013 to 2023 is projected at 5.9% annually, demand in China contributes almost 80% of the global demand growth with the rest of the world growing at an average rate of only 1.6% annually.”<sup>37</sup>

*Demand for Methanol. Source: Methanol Market Services Asia (MMSA), July 2015*



<sup>33</sup> [http://www.ptq.pemex.com/productosyservicios/eventosdescargas/Documents/Foro%20PEMEX%20Petroqu%EDmica/2012/PEMEX\\_DJohnson.pdf](http://www.ptq.pemex.com/productosyservicios/eventosdescargas/Documents/Foro%20PEMEX%20Petroqu%EDmica/2012/PEMEX_DJohnson.pdf)  
<sup>34</sup> <http://www.methanolmsa.com/wp-content/uploads/2015/07/Chapter-IX-Price-Forecast.pdf>  
<sup>35</sup> <http://www.gpcaforum.net/wp-content/uploads/2016/04/ihs4.pdf>  
<sup>36</sup> <http://www.methanolmsa.com/wp-content/uploads/2015/07/Chapter-V-Regional-Market-Analysis.pdf>  
<sup>37</sup> <http://igpenergy.com/methanol-overview/>

## 3.5 The Market for Polyethylene

### Products Description

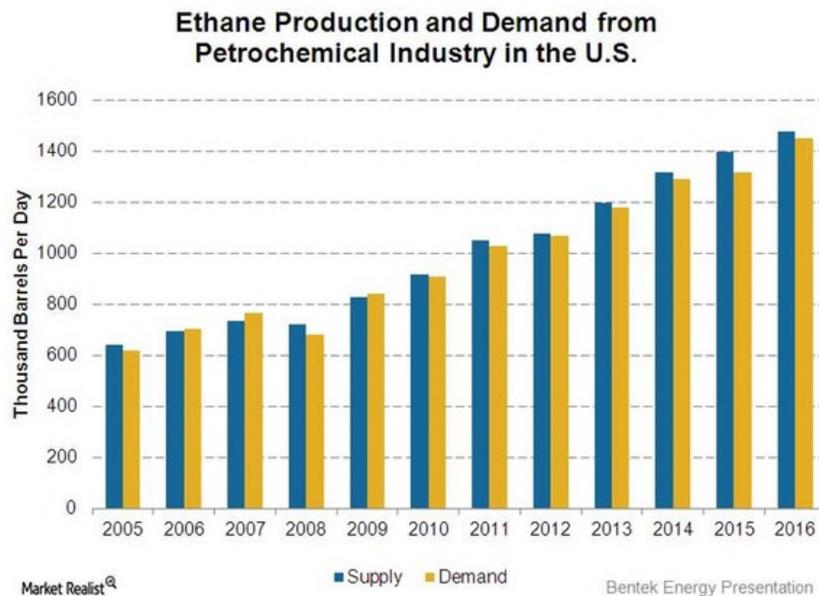
Polyethylene is the most common form of plastic. It is also one of the common polymers used daily and is synthesized chemically from ethylene. Thanks to its unique properties, polyethylene is employed in a variety of forms and can be used for different products such as plastic containers, plastic films, and plastic bags.<sup>38</sup>

### The Market for Ethane

Ethane is extracted from raw natural gas as part of the natural gas processing or from gasses produced as by-products of bitumen upgrading (“off-gas”). Ethane is used as a feedstock in the petrochemical industry to make ethylene, which is used to create a variety of derivatives that can be used to manufacture various end-use products such as plastics, rubbers and solvents.

Currently, the demand for ethane in Alberta is supplied by the production of natural gas, oil sands off-gas and imports from the US. In 2015, approximately 95% of total ethane produced in Alberta was extracted from natural gas while the remaining 5% was from off-gas. In the last five years, US ethane production alone has increased by more than 30 percent. As such, ethane is now in surplus in the North American market.

*Ethane Supply and Demand. Source: Bentek Energy Presentation, accessed 2017*



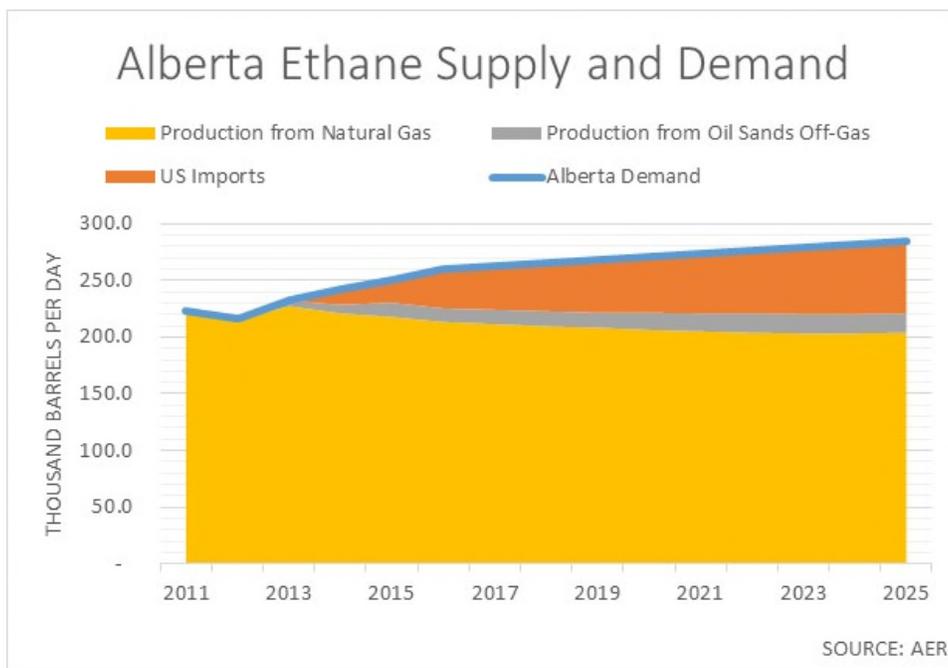
As a result, prices for ethane have fallen and in recent years prices were below the price of natural gas due to the oversupply in the US. If ethane prices are low, producers may choose not to extract ethane from the natural gas stream. This results in a lower production of ethane despite the production of natural gas. The AER expects that Alberta ethane production will decline by approximately 6% by 2025 (Alberta Energy Regulator, 2016).

Ethane supply is expected to increase to 2 million barrels per day by 2020 – from around 1 million barrels per day in 2015. As such, although petrochemical demand in North America is experiencing steady expansion, it will not be

<sup>38</sup> <http://www.transparencymarketresearch.com/polyethylene-market.html>

able to absorb the excess volumes of ethane. Currently, the market for ethane is largely a local market with production and use confined to North America. Low prices for ethane, however, have given rise to a possibility to export to Europe and other overseas markets. Recently, the US has begun to create facilities in Pennsylvania and along the US Gulf that will allow exporting ethane to overseas markets. It is expected that the US could export between 600,000 and 1 million barrels per day by 2020.<sup>39</sup>

*Alberta Ethane Supply and Demand. Source: AER, accessed 2016*



### The Market for Polyethylene

The global polyethylene market is the largest volume polymer business in the world today. As the industry matures and becomes increasingly integrated, key market drivers have become correspondingly globalized. The demand for polyethylene is expected to rise substantially in the coming years owing to the growing use of plastic containers in several vertical industries and domestic households. The use of these polyethylene products is likely to further increase due to increasing world population and developing world economy. Although polyethylene is a highly valued chemical thanks to its broad applicability, its negative impact on the environment is substantially high. This is expected to negatively affect the growth of the global polyethylene market over the coming years. On the other hand, while polyethylene cannot be easily degraded, it can be melted and again used for making different products.<sup>40</sup>

<sup>39</sup> <http://blogs.ft.com/nick-butler/2015/01/18/ethane-the-next-challenge-for-the-energy-market/>

<sup>40</sup> <http://www.transparencymarketresearch.com/polyethylene-market.html>

## PLATTS GLOBAL LOW-DENSITY POLYETHYLENE PRICE INDEX



According to one forecast, the Asia-Pacific region will continue to be the largest and fastest growing polyethylene market through 2018, fuelled by strong growth in China, which alone accounted for nearly one-quarter of global demand in 2013. India and Vietnam will also be among the world's most rapidly expanding markets. However, advances in most emerging Asian countries will rise at a slower pace than during the 2008-2013 period. On the other hand, North America will see a significant improvement in polyethylene demand, while the markets in Western Europe and Japan will rebound from recent declines.<sup>41</sup>

In 2017, global polyethylene market is expected to remain in balance. In the next ten years, a global shortage of the chemical is expected.<sup>42</sup> In the short term, i.e. in 2017 and 2018, netbacks are projected to slightly decline, based on polyethylene price forecasts.<sup>43</sup>

### 3.6 Refinery

#### Product Description

Refineries convert crude oil and other feedstock into various refined petroleum products such as gasoline, diesel, jet fuel, natural gas liquids and condensate/naphtha. We were asked to consider a project which would use bitumen and/or other heavy oils as the feedstock to produce petroleum products, in particular, diesel fuel. An example of such a project is the proposed Sturgeon Refinery that will be situated within the AIHA region. We have used this example for the purpose of our analysis.

#### The Market for Bitumen

Bitumen is a very viscous form of crude oil found in the oil sands. In order to process bitumen, it must first be extracted from the oil sands. There are two methods for extracting bitumen. Open-pit mining is used to extract bitumen if the oil deposits are near the surface. For deep oil deposits, bitumen is extracted using in-situ process. Steam is injected into the ground which heats the bitumen and reduces its viscosity so that it can be pumped to the

<sup>41</sup> <https://www.freedoniagroup.com/industry-study/world-polyethylene-3210.htm>

<sup>42</sup> <http://blogs.platts.com/2017/09/07/infographic-whats-store-global-polyethylene-polypropylene-2027/>

<sup>43</sup> Macquarie Research: Equities – Global petrochemicals, January 2017

surface. Next, bitumen must be upgraded into a lighter crude oil product and refined to produce various petroleum products. In order to transport bitumen, it must be diluted<sup>44</sup> with lighter hydrocarbons.

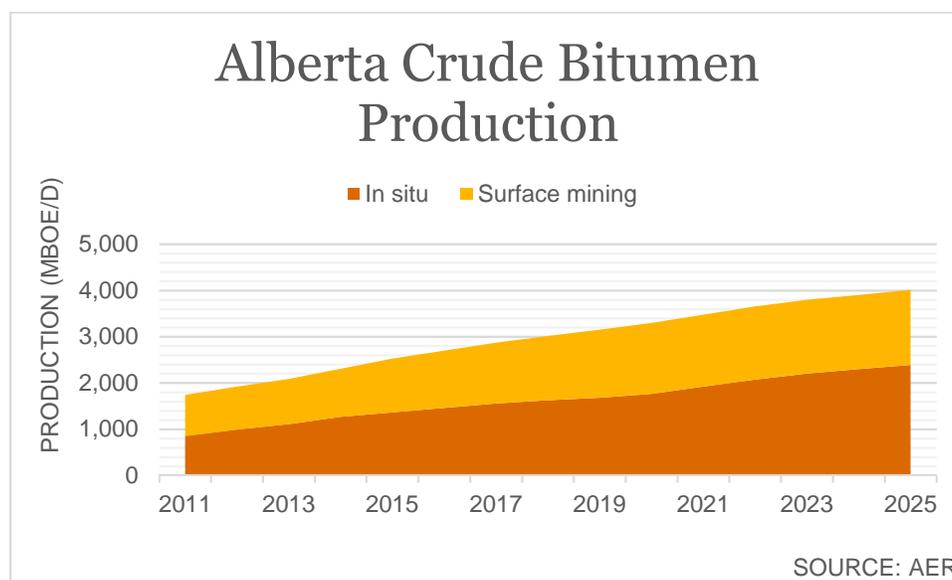
The majority of bitumen produced in Alberta is upgraded to a lighter synthetic crude oil using a heavy oil upgrader before being transported to refineries. An alternative process is to transport blended bitumen to a refinery that has the ability to process heavy oil feedstock. (IHS Cera, 2013) (Oil Sands Magazine, 2016).

The market for bitumen is a global market with Asia displaying the highest demand using around 33 percent of global output, followed by the Americas with just under 33 percent and Europe using around 18 percent of global output. This reflects the rise in infrastructure development in emerging markets over the past few years as bitumen is used mainly in construction, waterproofing and insulation.

The global market for bitumen is expected to reach roughly USD 80 billion by 2024 – from a value of USD 71.44 billion in 2013 (Grand View Research Inc., 2016). At roughly 30 percent, North America currently holds the biggest market share in bitumen consumption. According to recent estimates, however, Asia Pacific is estimated to be the fastest growing market with a compound annual growth rate (CAGR) of 3 percent between 2016 and 2024. In Europe, demand is expected to grow by CAGR 1.8 percent over the same time period. Overall, the medium and long term outlook for bitumen demand is rather positive. First, infrastructure projects in developing countries (notably Africa) and emerging markets will drive demand. Secondly, infrastructure repairs in the developed world will contribute to this development.

As a consequence, Alberta is expected to benefit from this development. Alberta’s oil sands are the largest, most developed oil sands in the world (CAPP, n.d.). In 2015, bitumen production in Alberta increased 10% year over year to approximately 2.5 million bbl/d. The Alberta Energy Regulator (“AER”) expects that bitumen production will continue to increase and reach 3.8 million bbl/d by 2025 (AER, 2016).

*Alberta Crude Bitumen Production. Source: AER, accessed 2016*



There are currently four operating refineries in Alberta, of which only two have the capacity to handle bitumen as feedstock<sup>45</sup>. Two of them – Strathcona (owned by Imperial Oil) and Suncor (owned by Suncor energy) – are located

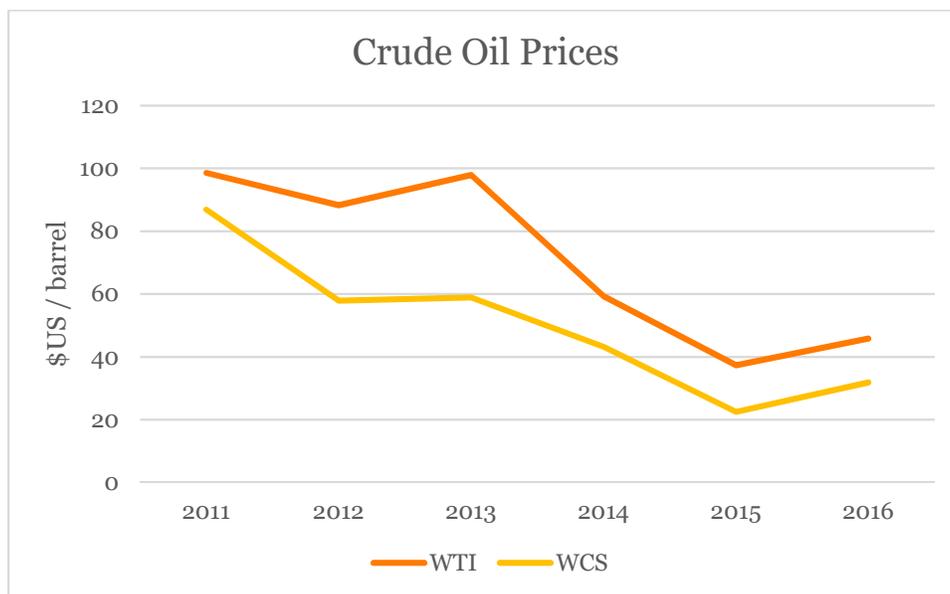
<sup>44</sup> The most common bitumen blend involves diluting bitumen with a natural gas condensate which is often called dilbit. A typical blend is approximately 72% bitumen and 28% condensate (IHS Cera, 2013).

in the “Refinery Row” concentration in Sherwood Park, east of the city of Edmonton. In addition to those two refineries, Shell operates a refinery in Scotford, Strathcona County, while Husky Energy has a facility in Lloydminster. Thus, from an infrastructure standpoint, three of the existing refineries are clustered around the Alberta’s Industrial Heartland region. Together, the two bitumen refineries have capacity of 242,000 bbl/d (AER, 2015). Approximately half of Alberta’s bitumen is upgraded and transported to refineries, while the remaining half is diluted and sent directly to the refineries (Oil Sands Magazine, 2016). Currently, the majority of heavy oil produced in Alberta is exported to the United States for refining. Bitumen production is growing more rapidly than the capacity of refineries which are able to process heavy oil (CERI, 2014).

The North West Redwater Partnership Sturgeon Refinery (“Sturgeon Refinery”), which is currently in the construction phase, will be able to accommodate approximately 80,000 bbl/d of blended bitumen and heavy oil by 2017<sup>46</sup>. Other than the increased demand from the Sturgeon Refinery, the demand for bitumen in Alberta is not expected to change significantly. On average, for the period of 2016 to 2025, the demand in Alberta is expected to total 11% of bitumen production. As a result, the increase in the production and supply of bitumen will be exported from the province. Currently, the majority of bitumen is exported to the United States (AER, 2015).

Western Canadian Select (“WCS”) is a heavy crude oil stream that is composed of bitumen, conventional heavy oil, synthetic crude oil and diluent. WCS Crude Oil Futures Contracts trade as a differential to WTI and therefore trend with the price of WTI. The differential reflects the heavy oil discount as heavy oil requires more energy to refine than light oil. The graph below shows the historical crude oil prices up to November 2016.

*Crude oil prices. Source: Alberta Economic Dashboard, November 2016*



### The Market for Refined Products

Crude oil and other feedstock (such as bitumen) can be refined into various petroleum products including gasoline, diesel, jet fuel, natural gas liquids and naphtha. In June 2017, refinery production and domestic sales increased 11.1% and 3.9%, respectively, compared to July 2016. Closing inventories of refined petroleum products held at

<sup>45</sup> The four refineries are operated by Suncor Energy Inc., Imperial Oil, Shell Canada and Husky. The Imperial Oil refinery and the Husky asphalt refinery accept only conventional oil as a feedstock, while the Suncor and Shell refineries have the capability to upgrade bitumen and heavy oil.

<sup>46</sup> Phase 1 of the project is currently under construction. Phase 2 and Phase 3 are planned to increase capacity by an additional 80,000 bbl/d of blended bitumen per phase.

---

refineries increased also increased by 7.3% compared to the same time last year (StatsCan, 2017). Alberta accounts for approximately 20% of total Canadian production of refined products<sup>47</sup>.

As additional refineries are built to handle the increased oil production, the production and supply of refined products will also increase. It is expected that the US & Canada will have a small surplus of refined products for the next five years<sup>48</sup>.

North America's demand for refined products is relatively stable. Due to an increase in supply of refined products and constant demand in North America, an increase in exports to Asian countries is expected (Canadian Energy Research Institute, 2015).

Prices for refined products fluctuate based on type of product, supply, demand, transportation and other factors.

### **3.7 The Market for Natural Gas**

As noted previously the primary feedstock behind the three major inputs to three of the Reviewed Projects is natural gas. Natural gas is a naturally occurring hydrocarbon that is composed primarily of methane and varying amounts of ethane, propane, butane and pentane. Natural Gas Liquids (NGLs) are separated from the natural gas at processing facilities and used in many different ways. In Canada, over 80% of NGLs are produced at natural gas processing plants while the remainder is produced as a by-product of oil refining or bitumen upgrading.

Natural gas has various applications in the residential, commercial, industrial and power generation sectors. Natural gas is primarily used for space heating, water heating and in cooking applications in the residential and commercial sectors. The industrial sector uses natural gas for heating purposes, as a fuel and as a feedstock in the production of petrochemicals and fertilizers. The power generation sector uses natural gas to produce electricity.

In 2015, Canada produced 163.5 billion cubic meters (5,826 bcf) of natural gas, which was an increase of 0.9% over 2014 and accounted for 4.6% of total world production. Historically, over 60% of natural gas production in Canada has been from Alberta<sup>49</sup>. At the end of 2016, Canada had 2.2 trillion cubic metres (76.7 trillion cubic feet) of proven natural gas reserves which is 1.2% of the total proven natural gas reserves in the world<sup>50</sup>. There are a number of factors that impact the production of natural gas including drilling activity, drilling economics and the productivity of existing and new wells.

Drilling activity is influenced by natural gas prices and changing technologies. From a pricing standpoint, fewer wells are drilled and production declines when the price of natural gas is low. Advances in horizontal drilling, 3-D seismic technology and hydraulic fracturing have made it possible to access additional resources, improve well productivity and improve economics. This is evidenced by the fact that fewer wells have been drilled in the past few years despite relatively stable production.

As a result of the decrease in natural gas prices, capital expenditures and drilling activity has decreased significantly since 2008.

---

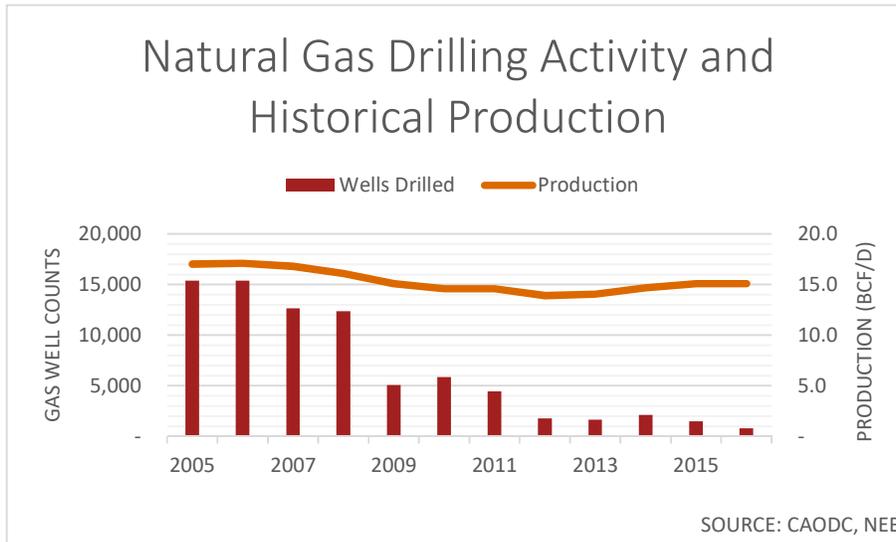
<sup>47</sup> Statistics Canada Table 134-004 (<http://www5.statcan.gc.ca/cansim/a47#F6>)

<sup>48</sup> Expected surplus/deficit from OPEC's 2016 World Oil Outlook report, Figure 6.2.

<sup>49</sup> National Energy Board of Canada – An Energy Market Assessment 2016

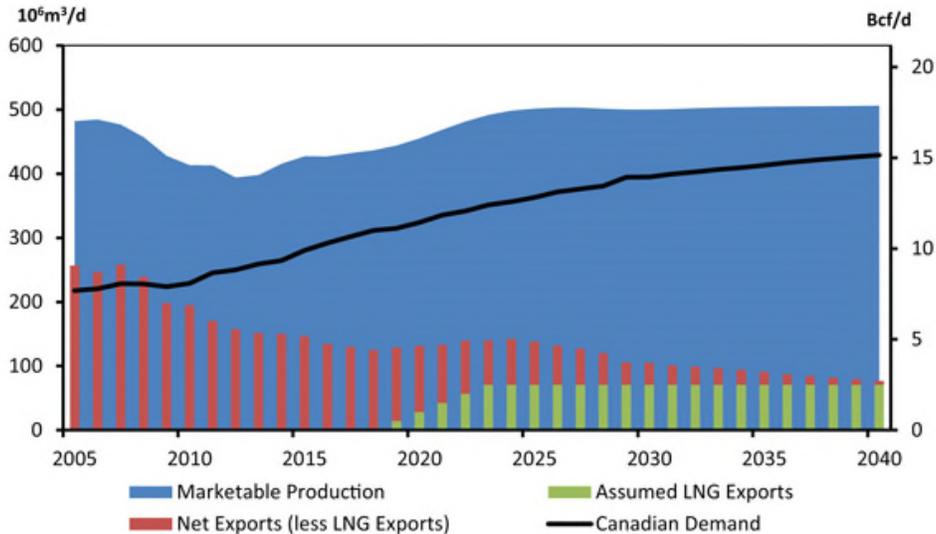
<sup>50</sup> BP Statistical Review of World Energy 2017

Natural gas drilling and production. Source: CAODC, NEB, accessed 2016



Any excess production in Western Canada is exported to the US, while Eastern Canada imports from the US. Canada remains a net exporter, however, net exports have been decreasing and are expected to continue decreasing, as low cost US production has increased significantly. As a result, it is expected that natural gas producers in Alberta will increasingly rely on domestic demand. For example, the National Energy Board (“NEB”) forecasts domestic demand to account for up to 85% of total production by 2040. In 2015, domestic demand accounted for approximately 65% of total production.

LNG Supply and Demand balance. Source: NEB, accessed 2017



The increased natural gas production in North America (particularly the US), and unusually warm weather in recent years, that is likely related to the global warming phenomena, has negatively impacted the price of natural gas. There are two primary benchmarks related to the price of natural gas in North America. In Canada, the

---

primary natural gas pricing benchmark is AECO-C, a distribution hub on the natural gas pipeline system in Alberta. It represents the price of natural gas in Alberta and is traded on the Natural Gas Exchange.

In the United States, the primary natural gas pricing benchmark is Henry Hub, located in Louisiana. The NYMEX natural gas futures contract is also used as an international benchmark price for natural gas and is based on the Henry Hub in the US.

Historically AECO-C traded at a discount to Henry Hub. This reflects the fact that Alberta is far from key demand markets in eastern Ontario and California. With fast-growing production from the low-cost regions in the US, Alberta production has been displaced, and the price discount has more than doubled in the last couple of years from an historic average level of approximately 15%. This new discount level is expected to persist in the foreseeable future.

The general consensus about long term Henry Hub price is US\$4 per MMBTU. Assuming a discount of 30% and a long term exchange rate of 78 US cents to \$1 Canadian dollar, suggest an AECO-C long term price of \$4 per GJ. According to the Canadian Energy Research Institute, at this price many natural wells in Alberta are uneconomic in the long term. On that basis, the Canadian Energy Research Institute predicts a decline of 25% in natural gas production from 2016 to 2020. It is expecting that after 2020 production will increase to an annual average level that is similar to the 2016 level, driven mainly by demand for liquefied natural gas (“LNG”) exported through British Columbia. In this regard, it is important to note that the prospects for exports of LNG have declined in recent year, due to the substantial reduction in the price of oil (the price of LNG is tied to oil price). Given the general consensus of a long term oil price of US\$65<sup>51</sup> per barrel and the fact that natural gas producers in Western Canada require a long term oil price of US\$70 to US\$82 per barrel in order to breakeven on LNG exports, it is unclear to what extent would LNG exports through British Columbia materialize. For example, Canada’s Energy Future 2016, prepared by the National Energy Board, considers forecast scenarios ranging from high LNG production (including exports of the product starting in 2019) to no significant LNG production.<sup>53</sup> Furthermore, the results of the latest US elections and resulting possible increase in the production of coal may make Canadian natural gas exports subject to increased competition from cheaper energy sources.

Another source of uncertainty for future production level is the imbedded assumption in current production forecasts that domestic demand will increase as a result of tougher environmental regulations, which will phase out coal in Canada as an input for electricity production. The uncertainty in this regard stems from the following:

1. Uncertainty about environmental regulations in the US following the latest elections and the potential spill over to Canada;
2. Tough environmental regulations may limit production in the oil sands, which is a large natural gas user (16.5% of total demand for Alberta natural gas in 2015); and
3. The future of renewable energy and its displacement of natural gas in the production of electricity.

In summary natural gas production in Alberta is expected to increasingly rely on domestic demand (including LNG) and its ability to maintain current levels is mainly tied to the success of exporting LNG and the impact of environmental regulations.

### **3.8 Labour Market**

As noted previously, Alberta’s unemployment has increased to 8.5% in December 2016 compared to a national level of 6.9%. According to the Conference Board of Canada, wages, salaries and hiring in the province are all estimated

---

<sup>51</sup> <http://www.wsj.com/articles/oil-at-50-a-barrel-offers-no-guarantees-about-crude-rallys-potential-1464246642>

<sup>52</sup> <http://video.cnbc.com/gallery/?video=3000577984>

<sup>53</sup> <https://www.neb-one.gc.ca/nrg/ntgrtd/ft/2016/2016nrgftr-eng.pdf>

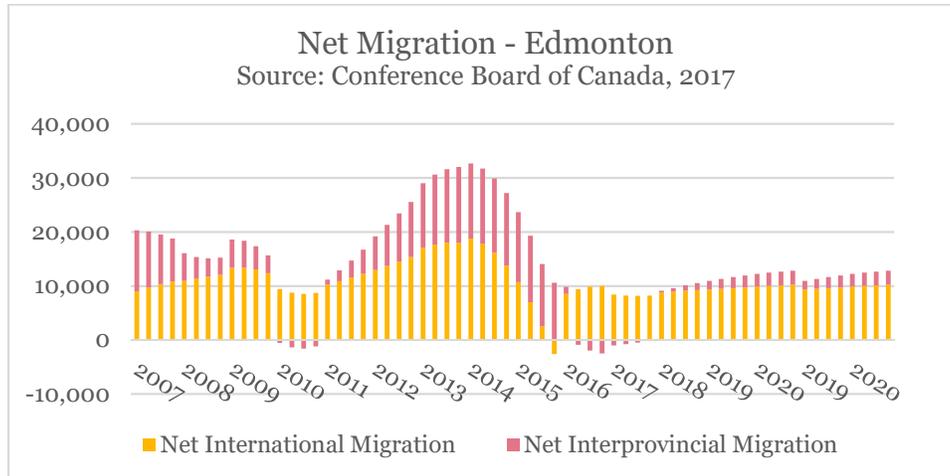
to show a decline in 2016<sup>54</sup>. Furthermore, it will take several more years for the economy to absorb the excess labour – unemployment is thus expected to remain relatively high.

The Conference Board of Canada projects the number of employed to recover from 2.261 million in 2016 to 2.41 million in 2020 and unemployment will decline to 4.6% by 2020. However, most of the employment growth will come from the services sector while employment in the goods sector is expected to stagnate, mainly due to reductions in conventional oil production that have led to a stagnation in the primary and utilities sector. For example, in 2013 the Edmonton metropolitan area had 184,000 employees in the goods sector. By 2016 the number is expected to decline to 169,000. The Conference Board of Canada is forecasting that only by 2020 the number of employees in the goods sector will return to its 2013 level of 184,000. During the same period (2013-2020) population in the Edmonton metropolitan area is expected to increase from 1.286 million to 1.485 million and the size of the services sector is expected to increase from 543,000 to 626,000. For total employment in the Edmonton area, the Conference Board of Canada projects the number to recover from 766,000 in 2016 to 810,000 in 2020. The public sector is expected to be a key contributor to the gradually improving labour market in that area.

The above suggests that the goods sector is likely experiencing and would continue to experience an oversupply of labour. Some of the excess supply would likely be absorbed in the services sector at lower salary levels and some will leave the province (this trend is already underway). On that basis, it is reasonable to expect that employment in the goods sector will not recover quickly, unless the labour demand in that sector increases due to an overall expansion in manufacturing, construction and primary & utilities. With the expectation that many skilled workers in the goods sector have or will move to the services sector or emigrate out of Alberta, such expansion would draw underemployed workers in the services sector, as well as interprovincial and international migration.



<sup>54</sup> The Conference Board of Canada: Metropolitan Outlook 1: Economic Insights into 13 Canadian Metropolitan Economies, Autumn 2016



We have identified the following six occupations<sup>55</sup> as essential for the operations phase of the Reviewed Projects:

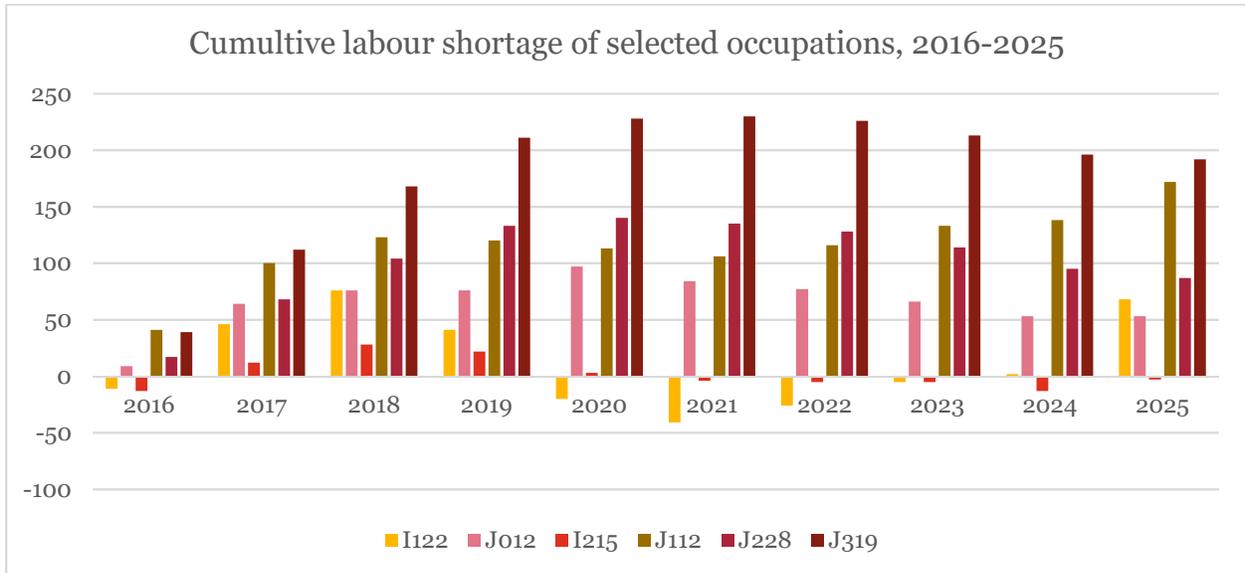
- Supervisors, oil and gas drilling and service (NOC: I122)
- Supervisors, petroleum, gas and chemical processing and utilities (NOC: J012)
- Oil and gas drilling, servicing and related labourers (NOC: I215)
- Petroleum, gas and chemical process operators (NOC: J112)
- Other assemblers and inspectors (NOC: J228)
- Other labourers in processing, manufacturing and utilities (NOC: J319)

Using the Alberta’s Occupational Demand and Supply Outlook 2015-2025<sup>56</sup>, we have matched the following occupations with their respective labour shortage and surplus estimates for years 2016 to 2025. The following graph illustrates the estimated cumulative shortage or surplus of labour<sup>57</sup> for each of the relevant occupations:

<sup>55</sup> The NOC codes in the brackets are NOC-S 2006

<sup>56</sup> <https://work.alberta.ca/labour/occupational-demand-and-supply-forecast.html>. The outlook is based on the Alberta Occupational Demand Outlook Model (AODOM) that uses economic and occupational components to arrive at labour demand projections, as well as the Alberta Occupational Supply Outlook Model (AOSOM) that makes occupational supply forecasts using data on demographics, labour participation, education enrolment and graduation rates, and net migration into the province.

<sup>57</sup> Labour supply shortage if positive, supply surplus if negative.



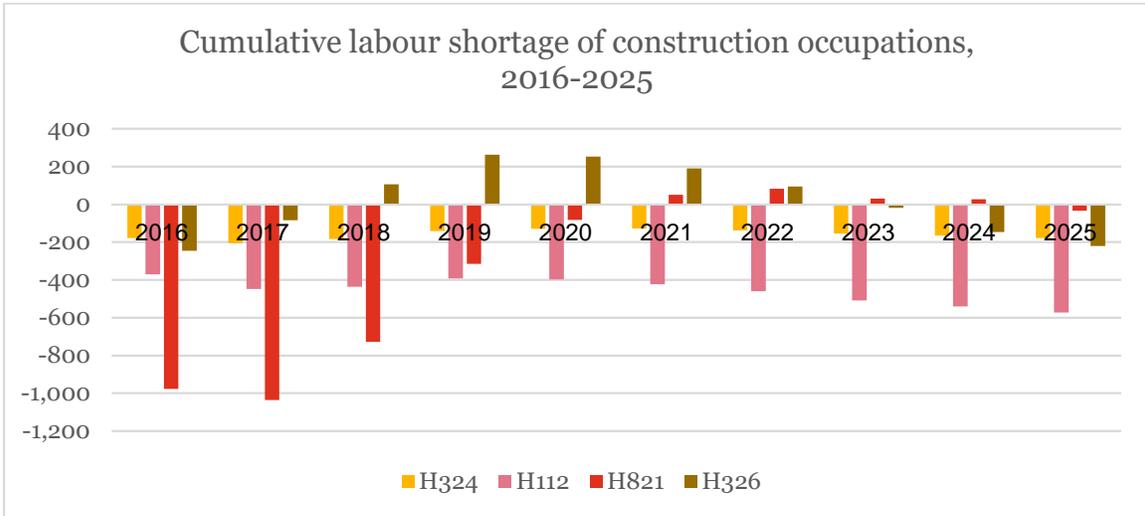
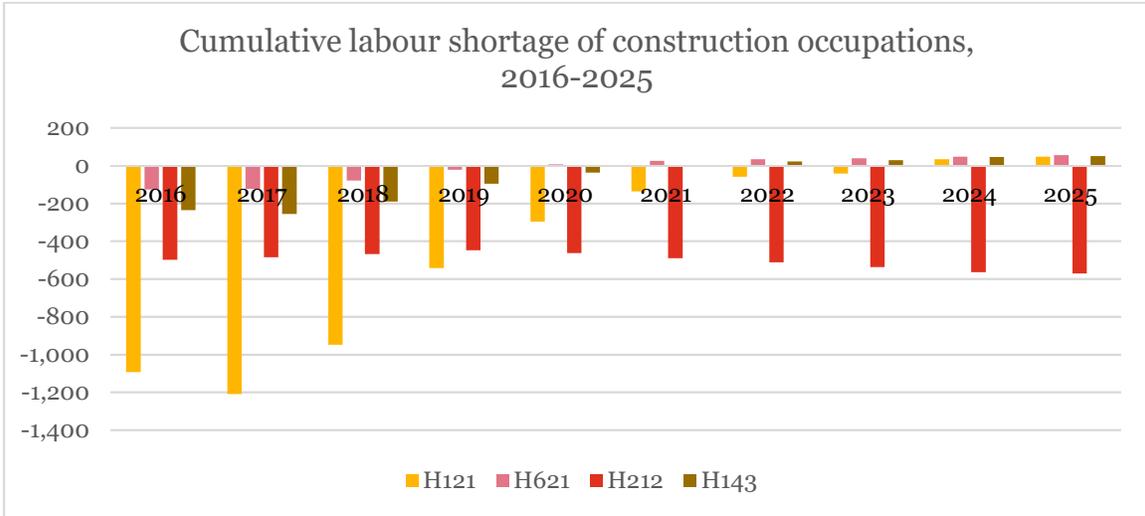
According to the above data, the demand for occupations essential for the operation of the Reviewed Projects is estimated to exceed the labour supply of workers skilled in those areas. This is expected to be especially the case for petroleum, gas and chemical process operators, assemblers and inspectors, and labourers related to operations of facilities examined in this report –the shortage of workers in each of these categories is expected to exceed 50 from 2017 throughout the projection period. For supervisors, the labour market is expected to have more slack, with a shortage of supervisors related to the oil and gas drilling and service from 2017 to 2019 and in 2025, as well a small surplus expected from 2020 to 2022.

Therefore, the operations of the Reviewed Projects are expected to demand more labour in specific occupations than is expected to be available in Alberta. This implies that the necessary labour force would either have to come from interprovincial or the international migration. Alternatively, other unemployed or under employed former employees from the goods sector may be retrained, so they can be employed in the operations of the Reviewed Projects

The following eight occupations were identified as essential for the construction phase of Reviewed Projects:

- Carpenters (NOC: H121)
- Crane Operators (NOC: H621)
- Industrial electricians (NOC: H212)
- Insulators (NOC: H143)
- Ironworkers & structural metal fabricators (NOC: H324)
- Steamfitters & pipefitters (NOC: H112)
- Construction trades helpers & labourers (NOC: H821)
- Welders (NOC: H326)

The following two graphs illustrate the estimated cumulative shortage or surplus of labour for each of those occupations until 2025:



With the exception of welders, for whom the labour market is expected to be relatively tight between 2018 and 2022, virtually all other occupations are expected to be in a surplus for the next ten years. Certain occupations, including carpenters and trade helpers & labourers are estimated to have over 1000 more job seekers than jobs demanded.

The specific number of workers required for the construction of facilities discussed in this report is higher than in the case of the operations phase. For example, a construction of a refinery in Alberta would require 6000 direct workers to complete over the entire development period. Therefore, while the labour market for construction occupations is projected to be in a significant labour surplus in the next decade, the large number of workers required for construction of the facilities exceeds the projected number of job-seekers in the above identified key positions. This implies that the construction phase of Reviewed Projects is likely to bring back skilled persons that left the province, skilled international immigration and would require retraining of unemployed and underemployed former good sector employees.

---

### 3.9 Summary

In section 3, we have described the current and prospective market conditions for the products to be produced by the Reviewed Projects (polypropylene plant, methanol plant, polyethylene plant and bitumen refinery), as well as the main inputs (i.e. bitumen, natural gas and labour) to be utilized in the operations of the Reviewed Projects. The following summarizes the key points from the preceding sections:

- Demand for products – the expectation is that there will be an increase in demand for each of the products to be produced by the Reviewed Projects. While it is generally not expected that markets for these products will face a supply shortage, there is room for new supply, provided that it is produced at a competitive cost.
- Market for inputs – our analysis suggests that the major inputs required for the Reviewed Projects are generally available and for the most part are in excess supply. Thus the opportunity cost (i.e. benefits from an alternative use of these inputs) for the use of these inputs is relatively low.

The above suggests that the economic activity to be generated by the Reviewed Projects will likely be, for the most part, a net economic contribution to Alberta.

---

# 4. Input Output Analysis

## 4.1 Methodology

The fundamental philosophy behind economic impact analysis is that spending on goods and services has attendant impacts throughout the economy. For instance, a petrochemical plant will generate demand for the inputs to this process (including labour) that in turn generates additional demand that extends beyond the initial spending. Our analysis permits the estimation of this cascading effect by using the multipliers calculated by Statistics Canada based on its input-output model of the Canadian and Alberta economies.

The input-output model used for the purpose of this report estimates the relationship between a particular “demand shock” for a given good or service and the resulting impacts throughout the economy (including demand for other goods and services and tax revenues). For the purpose of this report economic impacts were estimated for the following measures of economic activity:

- **Output** – the total gross value of goods and services produced, measured by the price paid to the producer. Output double counts the value of intermediate inputs and so GDP is usually a preferable measure of economic activity.
- **Value added or GDP** – the value added to the economy, or the unduplicated total value of goods and services. GDP includes only final goods to avoid double counting of products sold during a certain accounting period.
- **Employment** – the number of jobs created or supported. It is expressed as the number of full-time equivalent (“FTE”) jobs indicated in person years.
- **Taxes on Production and Imports** – the amount of tax revenues expected to be generated from taxes on production and imports at the provincial level.
- **Personal Income Tax** – the amount of provincial tax revenues generated from taxes on the income of employees and self-employed individuals.
- **Corporate Income Tax** – the amount of provincial tax revenues generated from taxes on the profits of corporations.<sup>58</sup>

Economic impacts are typically estimated at the direct, indirect and induced levels:

- **Direct impacts** result from the Company’s spending on suppliers and employees.
- **Indirect impacts** arise from the activities of the firms providing inputs to the Company’s suppliers (in other words, the suppliers of its suppliers).
- **Induced impacts** are the result of consumer spending by employees of the businesses stimulated by direct and indirect expenditures.
- The **total economic impact** equals the sum of the direct, indirect, and induced economic impacts.

---

<sup>58</sup> Since the input-output modelling system only estimates total tax implications for provincial taxes on production and imports, we approximate provincial income and corporate taxes by assuming that the ratio of each of those tax impacts to the production and import tax is the same as the actual ratio of the same taxes collected by the Government of Alberta. See Statistics Canada Table 384-0047 (accessed: December 8, 2016). Note that sales taxes, excise taxes and other consumer level taxes are not included in the impact estimates.

## 4.2 Impact of Development Activities

Using the input-output model, we estimated the total static one-time economic footprint (i.e., including direct, indirect, and induced impacts) of construction, design and engineering. Our analysis gives consideration of the source of the inputs (that is, whether the inputs will come from within Alberta or outside of the province). The results are summarized in the table below. A detailed breakdown of the direct, indirect and induced impacts, as well as top ten industries affected by employment have been provided in Appendix D. We estimate the development period of the Reviewed Projects to produce the following economic activity over their development period:

Measure of Economic Activity	Estimated Footprint in Alberta (\$ millions) – Development Period			
	Propane	Methane	Ethane	Refinery
Project type				
Development Period <sup>59</sup>	4 years	n/a	5 years	5 years / phase <sup>60</sup>
Project capacity (output)	525 kTA (Polypropylene)	940,989 lb/hr (Methanol)	1530 kTA (High Density Polyethylene)	240k bbl/d (Diesel)
Output	\$6,263	\$5,741	\$11,714	\$42,335
GDP	\$1,927	\$2,756	\$5,528	\$20,257
Jobs (person-years)	29,233	29,526	55,419	214,399
Taxes on Production & Imports	\$181.7	\$177.18	\$362.15	\$1,305
Personal Taxes <sup>61</sup>	\$255.2	\$248.95	\$508.85	\$1,833
Corporate Taxes <sup>62</sup>	\$133.2	\$129.91	\$265.53	\$956.73

## 4.3 Impact of Steady-State Operation Activities

Using the input-output model, we estimated the total static annual economic footprint (i.e. including direct, indirect and induced impacts) of steady-state operational spending and employment based on information provided by AIHA, industry participants and through our research. Our analysis gives consideration of the source of the inputs (that is, whether the inputs will come from within Alberta or outside of the province).

The results are summarized in the table below. A detailed breakdown of the direct, indirect and induced impacts, as well as top ten industries affected by employment have been provided in Appendix D.

<sup>59</sup> The development period is dependent upon specific project metrics.

<sup>60</sup> Our analysis is based on a 3 phase project, whose development period is expected to span a total of 15 years.

<sup>61</sup> Provincial personal income tax

<sup>62</sup> Relates to provincial corporate income taxes

Measure of Economic Activity	Estimated Annual Footprint in Alberta (\$ millions) – Operating Activities			
	Propane	Methane	Ethane	Refinery
Project type				
Project capacity (output)	525 kTA (Polypropylene)	940,989 lb/hr (Methanol)	1530 kTA (High Density Polyethylene)	240k bbl/d (Diesel)
Output	\$572.9	\$1,435	\$2,489	\$5,342
GDP	\$216.2	\$646.57	\$1,202	\$2,354
Jobs	1,552	3,000	7,713	11,781
Taxes on Production & Imports	\$10.9	\$23.00	\$58.24	\$86.29
Personal Taxes <sup>63</sup>	\$15.3	\$32.32	\$81.84	\$121.24
Corporate Taxes <sup>64</sup>	\$8.0	\$16.87	\$42.71	\$63.27

<sup>63</sup> Provincial personal income tax

<sup>64</sup> Relates to provincial corporate income taxes. Note that the Reviewed Projects are not subject to royalties. However, the production of bitumen and natural gas used as a feedstock for Reviewed Projects would generate royalties for the Alberta government. For the refinery, we have estimated the yearly value of royalties paid by bitumen producers for the bitumen that is used in the refinery to be approximately \$330 million. For the purpose of this analysis, we have not estimated the yearly royalty from the increased production of natural gas in order to provide inputs to the Reviewed Projects. (see [http://www.energy.alberta.ca/Org/pdfs/FS\\_Royalties.pdf](http://www.energy.alberta.ca/Org/pdfs/FS_Royalties.pdf))

---

# 5. Implications for Alberta

## 5.1 Labour

We expect that the Reviewed Projects will contribute to a vibrant labour market that will benefit from increased migration and immigration of skilled workers. Depending on the timing of these projects, the market for some skills may overheat and lead to some labour cost inflation.

## 5.2 Non-Labour Inputs

The large majority of the other input costs are expected to be spent within Alberta, and are comprised of maintenance & materials, power, natural gas, consumables and other costs. We note the following with respect to these inputs:

- **Maintenance & materials:** Any maintenance contracting would result in net gains in economic activity for Alberta to the extent that Alberta contractors are utilized, however, material costs could relate to products from outside of Alberta.
- **Power:** Vast majority of electricity needed for the development and operation phases of Reviewed Projects is expected to be produced in Alberta. Most facilities discussed in this report will likely produce power by cogeneration and so the existing Alberta power production would not be affected. We note, however, that electricity prices in Alberta may be affected in a situation when power would need to be drawn off the power grid.
- **Bitumen and Natural Gas:** The supply of natural gas and bitumen is expected to come exclusively from the Province. The Reviewed Projects will provide net benefits to these sectors including potentially a reduction in current pricing discount.
- **Consumables:** Consumable products would only be a net gain in economic activity for Alberta to the extent that such products are manufactured and/or sold in Alberta.

## 5.3 Potential Future Benefits

We note that since many of the existing energy downstream operations reside in the Industrial Heartland region, the construction of additional downstream operation will generate a cluster effect. In other words, the existence of such operations will likely raise the attractiveness of investing in a new downstream project as it would have a positive effect on production efficiency. Moreover, the new projects will strengthen the cluster and may attract additional investment in the future. The cluster effect, would therefore add additional economic activity that has not been quantified by us in our analysis. This could translate into overall higher economic strength of the province.

## 6. Assumptions

The conclusions expressed in this report rely on the following major assumptions:

- The cost and headcount data provided by AIHA and industry participants provides reliable data on the development and operation of the Reviewed Projects.
- The Input Output modelling software based on the Statistics Canada 2012 industry relationships in Alberta is a reasonable representation of the underlying relationships in the economy during the relevant periods modelled in the report.
- Potential profits associated with the operations of Reviewed Projects, defined as the difference between revenues and costs, were not incorporated into the Input Output modelling software, because the particular use of such profits, including particular reinvestment of profits, was not known.
- For the purpose of estimating costs associated with operations of the Refinery, a linear extrapolation of costs was performed using output capacity. This assumed that the share of particular operating costs remained at a fixed ratio relative to total operating costs.
- Throughout this report, the foreign exchange rate of 0.75 \$US/\$CAD was used.
- Provincial tax implications of the Reviewed Projects, including taxes on production and imports, personal taxes and corporate taxes were only estimated at their total impact, without a breakdown at direct, indirect and induced effects.
- The following assumptions on the prices and uses of chemicals were imposed for the purpose of estimating the cost structure of Reviewed Projects:
  - Ethane: \$US 222.6 / ton. Units per ton of ethylene: 1.3
  - Cooling water: \$US 0.05 / m<sup>3</sup>. Units per ton of ethylene: 230
  - Electricity: \$US 0.07 / kWh. Units per ton of ethylene: 50
  - PG Propylene: \$US 1107 / ton. Units per ton of ethylene: 0.06
  - Hydrogen: \$US 2.9 / MMBTU. Units per ton of ethylene: 27
  - Propane: \$US 18.62 per barrel. Units per kilo ton of propylene produced: 40
  - Undiluted bitumen price (WCS): \$CAD 50

We note that significant deviations from the above listed major assumptions may result in a significant change to our analysis.

---

# Appendix A: Sources Used

Alberta Economic Dashboard (2017, January 15). Retrieved from <http://economicdashboard.alberta.ca/>

Alberta's Industrial Heartland Association. (2016, August 10). *About*. Retrieved from <http://industrialheartland.com/>

Alberta's Occupational Demand and Supply Outlook, 2015-2025 (2016, December 1). Retrieved from <https://work.alberta.ca/labour/occupational-demand-and-supply-forecast.html>

Chemical Market Resources, Inc. (2016, May) *Sarnia-Lambton Propylene Investment Opportunity Study. Final Report*. Retrieved from <http://33sgq1wqdn71n18qv11fgblh.wpengine.netdna-cdn.com/wp-content/uploads/2016/05/Sarnia-Lambton-Propylene-Investment-Opportunity-Final-Report-E.pdf>

National Energy Board. (2016, August 23). *Natural Gas Liquids*. Retrieved from Government of Canada - National Energy Board: <https://www.neb-one.gc.ca/nrg/sttstc/ntrlgslqds/index-eng.html>

National Energy Board. (2016, May). *Propane Market Review: 2016 Update*. Government of Canada - National Energy Board.

Precise Consult International. *Profile on the Production of High Density Polyethylene (HDPE)*. Retrieved from [http://preciseethiopia.com/download/publication/business\\_opportunities/Profile%20on%20the%20Production%20of%20High%20Density%20Polyethylene%20\(HDPE\).pdf](http://preciseethiopia.com/download/publication/business_opportunities/Profile%20on%20the%20Production%20of%20High%20Density%20Polyethylene%20(HDPE).pdf)

# Appendix B: Development Expenditures

Development Expenditures (\$ millions)	Ethane	Propane <sup>65</sup>	Methane	Refinery
Engineering	\$1,221.93	\$400	\$308.03	\$2,802.48
Procurement and Construction	\$4,351.14	\$2,300	\$2,170.32	\$15,793.36
<b>Total Direct Construction Costs</b>	<b>\$5,573.0</b>	<b>\$2,700</b>	<b>\$2,478.4</b>	<b>\$18,595.8</b>
Owner's and other costs	\$426.9	\$500	\$629.7	\$4,100.3
<b>Total Capital Costs</b>	<b>\$6,000</b>	<b>\$3,200</b>	<b>\$3,108.0</b>	<b>\$22,691.1</b>

<sup>65</sup> Numbers have been rounded due to data sensitivity.

# Appendix C: Operating Expenditures

Operating Expenditures (\$ millions)	Ethane	Propane <sup>66</sup>	Methane	Refinery
Maintenance	\$157.56	\$10	\$41.85	\$234.64
Labour	\$20.62	\$35	\$42.41	\$293.3
G&A	\$57.18	\$25		\$117.32
Environmental	\$192.32			
<b>Total Fixed Costs</b>	<b>\$427.7</b>	<b>\$70</b>	<b>\$84.27</b>	<b>\$1,210</b>
Feedstock	\$576.8	\$200	\$848.10	\$2,737.5
Chemicals	\$130.00	\$35	\$8.96	\$58.66
Electricity	\$193.76	\$50		\$58.66
Transportation		\$25		
<b>Total Variable Costs</b>	<b>\$902.52</b>	<b>\$310</b>	<b>\$857.1</b>	<b>\$2,854.8</b>
<b>Total Operating Costs</b>	<b>\$1,330.4</b>	<b>\$380</b>	<b>\$941.3</b>	<b>\$3,500.0</b>

<sup>66</sup> Numbers have been rounded due to data sensitivity.

# Appendix D: Detailed Impacts

## Propane – Development Activities

Measure of Economic Activity	Estimated Footprint in Alberta (\$ millions)			
	Direct Effect	Indirect Effect	Induced Effect	Total Effect
Output	\$3,085	\$1,974	\$1,204	\$6,263
GDP	\$1,445	\$914.9	\$660.9	\$3,020
Jobs (FTE)	14,989	8,186	6,057	29,233
Taxes on Production & Imports				\$181.7
Personal Taxes <sup>67</sup>				\$133.2
Corporate Taxes <sup>68</sup>				\$255.2

### Top Ten Industries Affected (by employment)

Sector	Employment
Non-residential building construction	6,193
Engineering construction	4,856
Administrative and support services	3,428
Retail trade	1,999
Legal, accounting and architectural, engineering and related services	1,801
Repair and maintenance	1,734
Accommodation and food services	1,142
Wholesale trade	1,065
Support activities for mining and oil and gas extraction	659
Fabricated metal product manufacturing	593

<sup>67</sup> Provincial personal income tax

<sup>68</sup> Includes provincial corporate taxes and royalties

## Propane – Operation Activities

Measure of Economic Activity	Estimated Footprint in Alberta (\$ millions)			
	Direct Effect	Indirect Effect	Induced Effect	Total Effect
Output	\$268.6	\$240.6	\$63.7	\$572.9
GDP	\$86.4	\$94.8	\$35.0	\$216.2
Jobs (FTE)	626	605	321	1,552
Taxes on Production & Imports				\$10.9
Personal Taxes <sup>69</sup>				\$15.3
Corporate Taxes <sup>70</sup>				\$8.0

### Top Ten Industries Affected (by employment)

Sector	Employment
Administrative and support services	269
Truck transportation	189
Retail trade	124
Repair and maintenance	119
Basic chemical manufacturing	113
Electric power generation, transmission and distribution	82
Accommodation and food services	67
Wholesale trade	60
Plastic product manufacturing	50
Other finance, insurance and real estate services and management of companies and enterprises	40

<sup>69</sup> Provincial personal income tax

<sup>70</sup> Includes provincial corporate taxes and royalties

## *Methane – Development Activities*

Measure of Economic Activity	Estimated Footprint in Alberta (\$ millions)			
	Direct Effect	Indirect Effect	Induced Effect	Total Effect
Output	\$2,921	\$1,705	\$1,115	\$5,740
GDP	\$1,335	\$808.52	\$612.13	\$2,756
Jobs (FTE)	16,243	7,673	5,610	29,526
Taxes on Production & Imports				\$177.18
Personal Taxes <sup>71</sup>				\$129.91
Corporate Taxes <sup>72</sup>				\$248.95

### Top Ten Industries Affected (by employment)

Sector	Employment
Non-residential building construction	10,490
Administrative and support services	5,576
Retail trade	1,877
Legal, accounting and architectural, engineering and related services	1,763
Accommodation and food services	1,077
Engineering construction	1,072
Wholesale trade	1,037
Fabricated metal product manufacturing	623
Other finance, insurance and real estate services and management of companies and enterprises	465
Computer systems design and other professional, scientific and technical services	461

<sup>71</sup> Provincial personal income tax

<sup>72</sup> Includes provincial corporate taxes and royalties

## *Methane – Operation Activities*

Measure of Economic Activity	Estimated Footprint in Alberta (\$ millions)			
	Direct Effect	Indirect Effect	Induced Effect	Total Effect
Output	\$934.68	\$360.09	\$139.89	\$1,435
GDP	\$400.08	\$169.70	\$76.80	\$646.57
Jobs (FTE)	946.5	1,349	704	3,000
Taxes on Production & Imports				\$23.00
Personal Taxes <sup>73</sup>				\$32.32
Corporate Taxes <sup>74</sup>				\$16.87

### Top Ten Industries Affected (by employment)

Sector	Employment
Repair and maintenance	635
Oil and gas extraction	319
Administrative and support services	285
Retail trade	262
Other finance, insurance and real estate services and management of companies and enterprises	156
Accommodation and food services	149
Support activities for mining and oil and gas extraction	131
Legal, accounting and architectural, engineering and related services	128
Wholesale trade	126
Computer systems design and other professional, scientific and technical services	105

<sup>73</sup> Provincial personal income tax

<sup>74</sup> Includes provincial corporate taxes and royalties

## Ethane – Development Activities

Measure of Economic Activity	Estimated Footprint in Alberta (\$ millions)			
	Direct Effect	Indirect Effect	Induced Effect	Total Effect
Output	\$5,874.47	\$3,620.99	\$2,217.87	\$11,713.34
GDP	\$2,608.82	\$1,701.44	\$1,217.87	\$5,527.46
Jobs (FTE)	28,446	15,812	11,162	55,419
Taxes on Production & Imports				\$362.15
Personal Taxes <sup>75</sup>				\$508.85
Corporate Taxes <sup>76</sup>				\$265.53

### Top Ten Industries Affected (by employment)

Sector	Employment
Non-residential building construction	21,031
Administrative and support services	4,812
Engineering construction	4,251
Legal, accounting and architectural, engineering and related services	3,813
Retail trade	3,679
Wholesale trade	2,161
Accommodation and food services	2,059
Fabricated metal product manufacturing	1,338
Other finance, insurance and real estate services and management of companies and enterprises	934
Computer systems design and other professional, scientific and technical services	495

<sup>75</sup> Provincial personal income tax

<sup>76</sup> Includes provincial corporate taxes and royalties

## Ethane – Operation Activities

Measure of Economic Activity	Estimated Footprint in Alberta (\$ millions)			
	Direct Effect	Indirect Effect	Induced Effect	Total Effect
Output	\$1,238.35	\$589.31	\$265.29	\$2,093.10
GDP	\$600.18	\$265.46	\$145.64	\$1,011.28
Jobs (FTE)	3,088	2,064	1,335	6,486
Taxes on Production & Imports				\$48.97
Personal Taxes <sup>77</sup>				\$68.82
Corporate Taxes <sup>78</sup>				\$35.91

### Top Ten Industries Affected (by employment)

Sector	Employment
Repair and maintenance	1468
Administrative and support services	786
Waste management and remediation services	671
Retail trade	529
Electric power generation, transmission and distribution	352
Accommodation and food services	285
Oil and gas extraction	235
Wholesale trade	201
Other finance, insurance and real estate services and management of companies and enterprises	195
Computer systems design and other professional, scientific and technical services	147

<sup>77</sup> Provincial personal income tax

<sup>78</sup> Includes provincial corporate taxes and royalties

## Refinery – Development Activities

Measure of Economic Activity	Estimated Footprint in Alberta (\$ millions)			
	Direct Effect	Indirect Effect	Induced Effect	Total Effect
Output	\$21,478	\$12,676.02	\$8,181.60	\$42,335.31
GDP	\$9,765.46	\$5,999.95	\$4,491.68	\$20,257.08
Jobs (FTE)	116,571	56,663	41,165	214,399
Taxes on Production & Imports				\$1,304
Personal Taxes <sup>79</sup>				\$1,833
Corporate Taxes <sup>80</sup>				\$956.73

### Top Ten Industries Affected (by employment)

Sector	Employment
Non-residential building construction	76,336
Administrative and support services	36,979
Retail trade	13,738
Legal, accounting and architectural, engineering and related services	13,117
Engineering construction	9,751
Accommodation and food services	7,850
Wholesale trade	7,663
Fabricated metal product manufacturing	4,623
Other finance, insurance and real estate services and management of companies and enterprises	3,418
Computer systems design and other professional, scientific and technical services	3,353

<sup>79</sup> Provincial personal income tax

<sup>80</sup> Includes provincial corporate taxes and royalties

## Refinery – Operation Activities

Measure of Economic Activity	Estimated Footprint in Alberta (\$ millions)			
	Direct Effect	Indirect Effect	Induced Effect	Total Effect
Output	\$3,354	\$1,458	\$531.12	\$5,342
GDP	\$1,397	\$665.46	\$291.58	\$2,354
Jobs (FTE)	4,020	5,089	2,672	11,781
Taxes on Production & Imports				\$86.29
Personal Taxes <sup>81</sup>				\$121.24
Corporate Taxes <sup>82</sup>				\$63.27

### Top Ten Industries Affected (by employment)

Sector	Employment
Repair and maintenance	2,160
Administrative and support services	1,684
Oil and gas extraction	1,059
Retail trade	1,004
Accommodation and food services	571
Other finance, insurance and real estate services and management of companies and enterprises	552
Wholesale trade	483
Legal, accounting and architectural, engineering and related services	451
Support activities for mining and oil and gas extraction	435
Computer systems design and other professional, scientific and technical services	381

<sup>81</sup> Provincial personal income tax

<sup>82</sup> Includes provincial corporate taxes and royalties

---

# Appendix E: Limitations

**Data limitations:** PwC has relied on the information provided by AIHA and the industry participants regarding the magnitude, composition, and timing of expenditures as well as the expected size, composition, and characteristics of the Reviewed Project's workforce. PwC has relied upon the completeness, accuracy, and fair presentation of all information and data obtained from AIHA and the various sources set out in Appendix A which were not audited or otherwise verified. The findings in this report are conditional upon such completeness, accuracy, and fair presentation, which have not been verified independently by PwC. Accordingly, we provide no opinion, attestation or other form of assurance with respect to the results of this study.

Where the information or data provided is not sufficient to conduct the analysis that has been requested, we have made assumptions, as set out in Section 6.

We accept no responsibility or liability for any losses occasioned by any party as a result of our reliance on the financial and non-financial information that was provided to us by AIHA, the industry participants or Statistics Canada or found in the public domain.

**Liability:** PwC is providing its report solely for AIHA's use and benefit for the purpose set out in an engagement letter signed on July 6, 2017. PwC acknowledges that, as part of its use and benefit, AIHA may make the report available to the public but, if it chooses to do so, AIHA shall disclose our report in its entirety. PwC may include a statement in the report that indicates to the reader that:

1. The report has been prepared by PwC for AIHA only;
2. It is not intended for the benefit, use or reliance of any other party; and
3. PwC disclaims any contractual or other responsibility or duty of care to others based upon the Work.

Should AIHA wish to provide a statement to the public about our report it will either:

1. Seek permission from PwC in order to ensure that the statement fairly describes our report; or
2. State explicitly that the statement reflects AIHA's own interpretation of the PwC Report.

**Receipt of new data or facts:** PwC reserves the right at its discretion to withdraw or make revisions to this report should we receive additional data or be made aware of facts existing at the date of the report that were not known to us when we prepared this report. The findings are as of October 2017 and PwC is under no obligation to advise any person of any change or matter brought to its attention after such date, which would affect our findings.

**Input-Output Analysis:** Input-Output Analysis (a model used to estimate GDP and employment footprint) does not address whether the inputs have been used in the most productive manner or whether the use of these inputs in this industry promotes economic growth by more than their use in another industry or economic activity. Nor does Input-Output Analysis evaluate whether these inputs might be employed elsewhere in the economy if they were not employed in this industry at the time of the analysis. Input-Output Analysis calculates the direct, indirect and induced economic impacts that can reasonably be expected to affect the economy based on historical relationships within the economy. This analysis does not take into account fundamental shifts in the relationships within the economy that may have taken place since the estimation of multipliers by Statistics Canada, nor shifts that may take place in the future.

---

**Use limitations:** Any use that a third party makes of this report or reliance thereon, or any decision made based on it, is the responsibility of such third party. PwC accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken, based on this report.

**This report related analysis must be considered as a whole:** Selecting only portions of the analysis or the factors considered by us, without considering all factors and analysis together, could create a misleading view of our findings. The preparation of our analysis is a complex process and is not necessarily susceptible to partial analysis or summary description. Any attempt to do so could lead to undue emphasis on any particular factor or analysis.

---

# ***Appendix F: Glossary***

- bbl/d - Barrels per day
- kTA - Kilo tons per annum
- LPGs - Liquid Petroleum Gases
- MMboe - Million barrels
- MTO process - Methanol-to-olefins process
- NGLs - Natural Gas Liquids
- PDH - Propane dehydrogenation
- PE – Polyethylene
- PP – Polypropylene