Economic Impacts of Adding Value To Alberta's Hydrocarbon Resources

Prepared For:

Alberta's Industrial Heartland Association

By:

Schlenker Consulting Ltd.

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Executive Summary

Schlenker Consulting Ltd. (SCL) was commissioned by the Alberta's Industrial Heartland Association (AIHA) to estimate the potential economic impacts of expanding value added processing of provincial energy resources such as natural gas liquids (NGLs), raw natural gas and bitumen. Projected expansions in the petrochemical, fertilizer and refining industries are outlined and the net economic impacts of upgrading various products in terms of contributions to Gross Domestic Product (or GDP/output/value added), labour income, employment and provincial government revenues are estimated.

Background

Development of energy resources in Alberta has been one of the main drivers of growth in the provincial economy in recent decades. Currently, the oil and gas extraction industry, the overall manufacturing sector and the chemical industry all make significant contributions to the provincial economy. In recent years, these include the following:

- Roughly 24% of Alberta's GDP has been generated by the oil and gas extraction industry, while the overall manufacturing sector's share of provincial output has been 7%.
- Both the manufacturing sector as a whole and the chemical industry in particular have made relatively large contributions to provincial government revenues given their shares of GDP.
- The manufacturing sector has been responsible for roughly 15% of the net corporate provincial income taxes paid in Alberta.
- Alberta's chemical industry (primarily petrochemical and fertilizer production) has accounted for roughly 12% of provincial manufacturing GDP (or about $2 billion annually), but has been responsible for about 25% of the net corporate provincial income taxes paid by the manufacturing sector as a whole.
- Weak natural gas and bitumen prices have had some negative impacts on economic activity and government revenues in the province. However, simultaneously, these lower prices have improved the profitability of industries that use these resources as feedstocks.
- This has created an opportunity to expand these industries in the province, as well as to stabilize provincial government revenues.

Methodology

The analysis here employs an input output framework to measure the direct, indirect and induced impacts arising from various value added projects in Alberta.

- The impacts typically shown in an impact analysis can be referred to as gross economic impacts as opposed to net economic impacts.
- Gross economic impacts include the effects of the purchases of all inputs required to produce the end product of a project.
- Because the emphasis here is on identifying the value that would be added to various Alberta hydrocarbon resources and it is assumed that the resources in question would be produced with or without the value added projects under consideration, the economic impacts associated with the production of the resources being used as feedstocks in the projects are subtracted from the gross economic impacts for the operating phases of these projects. The differences will be referred to as net economic impacts in this report.
- To the extent that incremental supplies of resources would ultimately be required to satisfy feedstock requirements for the value added projects under consideration, the net impact approach used here may be conservative. Similarly, if cumulative feedstock demand from the projects were to lead to higher NGL, gas and/or bitumen prices thereby increasing cash flows to producers and royalties to the Alberta government, additional induced impacts beyond the scope of this report could materialize.

Potential Economic Impacts of Additional Hydrocarbon Value Added Processing in Alberta by the Chemical Industry

AIHA previously commissioned studies on feedstock availability and the potential profitability of producing various petrochemical and fertilizer products in the province. Given that information, AIHA requested that net economic impacts associated with incremental production of the following products be estimated.

- 900 kilotonne(kt)/year (or 300 million US gallons/ year) of methanol
- 600 kt/year of urea

- 900 kt/year (or 2 million lbs/year) of ethylene derivatives using ethane as the initial feedstock
- 900 kt/year (or 2 million lbs/year) of propylene derivatives using propane as the initial feedstock

Production of the various petrochemical and fertilizer volumes noted above would result in the net economic impacts summarized in Table ES.1. The results shown are for operational impacts only and are expressed on an annual basis.

TABLE ES.1 – POTENTIAL NET ANNUAL ECONOMIC IMPACTS IN ALBERTA OF CHEMICAL INDUSTRY EXPANSIONS USING HYDROCARBON FEEDSTOCKS OVER THE NEXT DECADE

(values are in millions of 2012 Cdn$, employment in person years)

Product - Annual Volume	GDP	Labour Income	Prov.Gov. Revenue	Employment
Methanol – 900 kt/year	270	53	21	541
Urea – 600 kt/year	78	34	10	343
NGLs/Olefins from Oilsands Offgas	537	197	54	2062
Propylene – 900 kt/yr	398	174	46	1890
Polyethylene – 900 kt/yr	712	236	72	2542
Polypropylene – 900 kt/yr	396	102	33	1113
TOTAL	2391	796	236	8491

- Chemical industry expansions based on the hydrocarbon value added projects set out in Table ES.1 would generate approximately $2.4 billion (2012$) annually in additional GDP for the Alberta economy, a figure that is slightly larger than current chemical industry GDP in the province in recent years. It also is equivalent to about 1% of current overall GDP in Alberta.
- Provincial government revenues would rise by roughly $240 million per year. About half of that increase would be direct corporate income taxes paid by project sponsors, an amount equivalent to about 3% of the annual average corporate provincial income taxes paid in Alberta in the last decade.
- About 8500 ongoing jobs would be created along with $800 million in labour income annually. Average annual labour income per worker is

projected to be more than 60% higher than the current average in the overall Alberta economy.

- Construction phase impacts for most of the projects above would, on an annual basis, be of the same order of magnitude as the operational impacts shown above. In general, annual labour income and employment impacts would be slightly larger than those shown in Table ES.1 while GDP and government revenue impacts would be slightly smaller. With construction of the various projects likely to be spread out over many years, it is less likely that labour market constraints would become a major issue.
- No consideration has been given in this report to further processing of materials such as polyethylene or polypropylene in Alberta. In addition, should derivatives such as ethylene oxide or propylene oxide be produced in the province, these could be used as feedstocks for other petrochemical derivatives.

Potential Economic Impacts of Other Hydrocarbon Value Added Projects in Alberta

The upgrading of bitumen or natural gas into refined petroleum products such as diesel fuel, gas oil or naphtha represents another opportunity to add value to Alberta's energy resources. Given the information sources available regarding potential projects of this nature, more crude estimates of net economic impacts were developed for the following operations.

- A refinery that would convert 150,000 barrels per day (bpd) of bitumen into refined products such as diesel fuel and vacuum gas oil.
- A 96,000 barrel (bpd) gas-to-liquids (GTL) plant that would convert methane into refined products such as diesel fuel and naphtha.

Net economic impacts estimates for these projects are shown in Table ES.2. Like the impacts presented for potential chemical industry development, only annual operating impacts are included in the table.

- Each of the projects would generate around $2 billion in GDP and $200 million in provincial government revenues annually.
- The refinery and GTL projects would create an additional 6300 jobs and 3800 jobs per year respectively, and about $1 billion annually in labour income between them.

TABLE ES.2 – POTENTIAL NET ANNUAL ECONOMIC IMPACTS IN ALBERTA OF BITUMEN REFINING AND GAS-TO-LIQUIDS PROJECTS OVER THE NEXT DECADE

(values are in billions of 2012 Cdn$, employment in person years)

Annual Volume / Products (Feedstock)	GDP	Labour Income	Prov.Gov. Revenue	Employment
150,000 bpd diesel/gas oil (bitumen)	2.00	0.61	0.21	6300
96,000 bpd diesel/naphtha (methane)	1.80	0.36	0.18	3800

Table 3 summarizes the overall net annual economic impacts of the value added projects under consideration in this study. It is clear that these projects could generate very significant economic impacts in Alberta over the next decade.

TABLE ES.3 – POTENTIAL NET ANNUAL ECONOMIC IMPACTS IN ALBERTA OF THE ANALYZED VALUE ADDED PROJECTS OVER THE NEXT DECADE

GDP	$6.2 billion
Labour Income	$1.8 billion
Provincial Government Revenue	$630 million
Federal Government Revenue (generated in Alberta only)	$1.0 billion
Employment	19,000 jobs

Table of Contents

List of Figures and Tables

1. Introduction

Development of energy resources in Alberta has been one of the main drivers of growth in the provincial economy in recent decades. For example, production of conventional oil, bitumen, raw natural gas and natural gas liquids has represented roughly one quarter of provincial output in the last 5 years.[1] In addition, royalties and land bonuses associated with the development and production of these resources have constituted about 30% of provincial government revenue over the last decade.[2] However, these revenues are notoriously volatile and the Alberta government has projected that in upcoming years, this percentage is expected to drop to around 20%.[3] Natural gas and bitumen prices in particular have been relatively low recently and this has had some negative impacts on economic activity and government revenues in the province.

At the same time however, these lower prices improve the profitability of industries that add value to these resources. This creates an opportunity to expand on these types of industries in the province. There has been increased interest and calls for additional processing of Alberta's energy resources within the province. Currently, the chemical industry in Alberta, which primarily uses local hydrocarbon feedstocks, is one of the largest industries in the provincial manufacturing sector and it is expected to grow significantly in the near future, along with other industries that could add value to provincial resources.

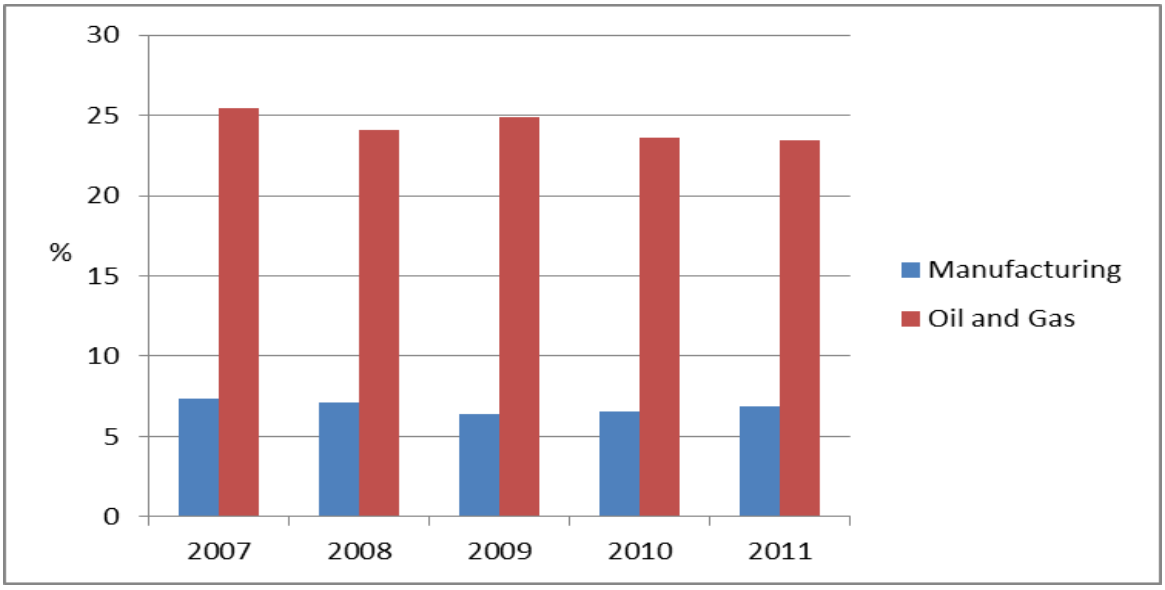
Given these developments and opportunities, Schlenker Consulting Ltd. (SCL) was commissioned by the Alberta Industrial Heartland Association (AIHA) to estimate the potential economic impacts of expanding value added processing of provincial energy resources such as natural gas liquids, raw natural gas and bitumen.[4]

[1] See Statistics Canada Cansim Table 3790030.
[2] Data from online Government of Alberta Budget documents at http://finance.alberta.ca/publications/budget.
[3] See http://finance.alberta.ca/publications/budget/budget2013/fiscal-plan-operational-plan.pdf.
[4] This study was prepared by Ron Schlenker, president of Schlenker Consulting Ltd. and senior instructor in the Department of Economics at the University of Calgary. Dr. Robert Mansell, principal of Wright Mansell Research Ltd. and professor in the Department of Economics at the University of Calgary, served in an advisory role in the preparation of the report.

2. Background and Objective

Figure 1 illustrates the share of real (2007$) provincial Gross Domestic Product (GDP or simply output) of the oil and gas extraction industry and the manufacturing sector in Alberta since 2007.[5] The shares of both the oil and gas and manufacturing sectors have been relatively constant over the period at about 24% and 7% respectively. Concern is often expressed regarding the relatively small share of manufacturing activity in the province given the natural resource production that occurs in Alberta, especially since there are so many ways of adding value to hydrocarbon products.

FIGURE 1 – MANUFACTURING AND OIL AND GAS INDUSTRY SHARES OF ALBERTA REAL GDP: 2007-2011



Source: Statistics Canada

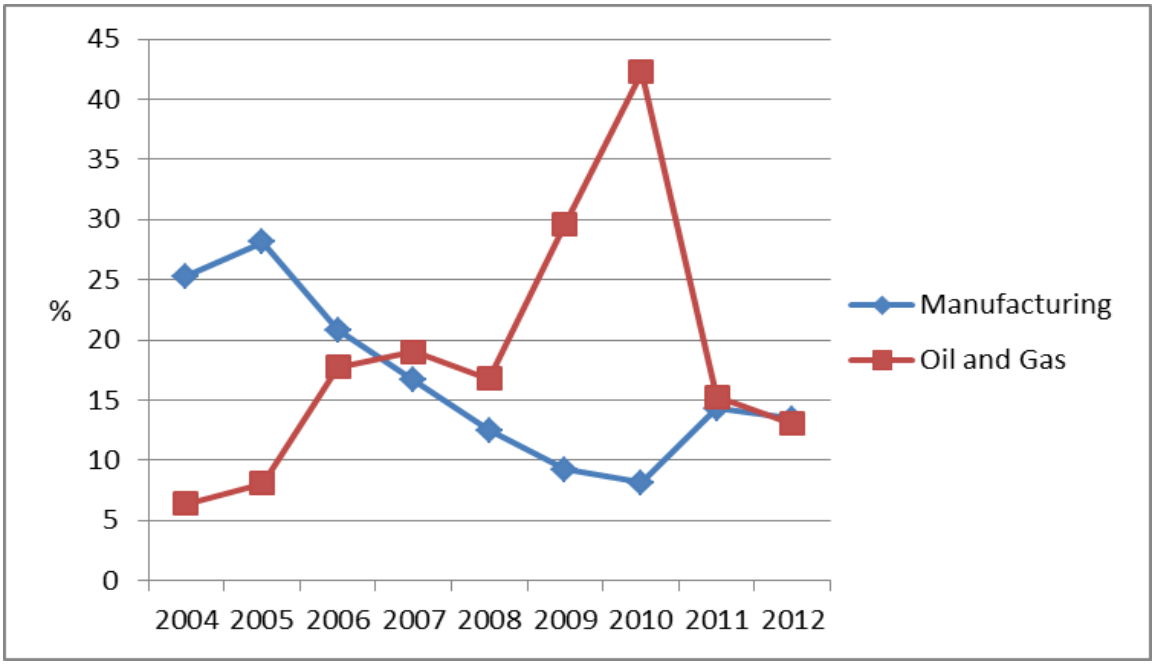
However, whether it be petrochemical, fertilizer or refined petroleum product development, the venture must be commercially viable given cost and product marketability factors. If this happens to be the case, the development of value added industries can also provide additional benefits to the economy in terms of a sort of stabilizer. When feedstock costs are

[5] See Statistics Canada Cansim Table 3790030. Bitumen upgraders that produce synthetic crude oil are included in oil and gas extraction industry by Statistics Canada.

relatively low and the resource industries are not as profitable, the value added industry should be more profitable, and vice versa.

Figure 2, in which the proportions of net provincial corporate taxes paid by the manufacturing sector and the oil and gas sector in Alberta are illustrated, seems to support this idea. The figure also shows that the manufacturing sector's share of provincial corporate taxes has averaged about 15% over the last decade, more than double the sector's share of provincial GDP (or value added).

FIGURE 2 – PROPORTIONS OF NET CORPORATE PROVINCIAL INCOME TAXES PAID BY THE MANUFACTURING SECTOR AND THE OIL AND GAS INDUSTRY IN ALBERTA: 2004-2012

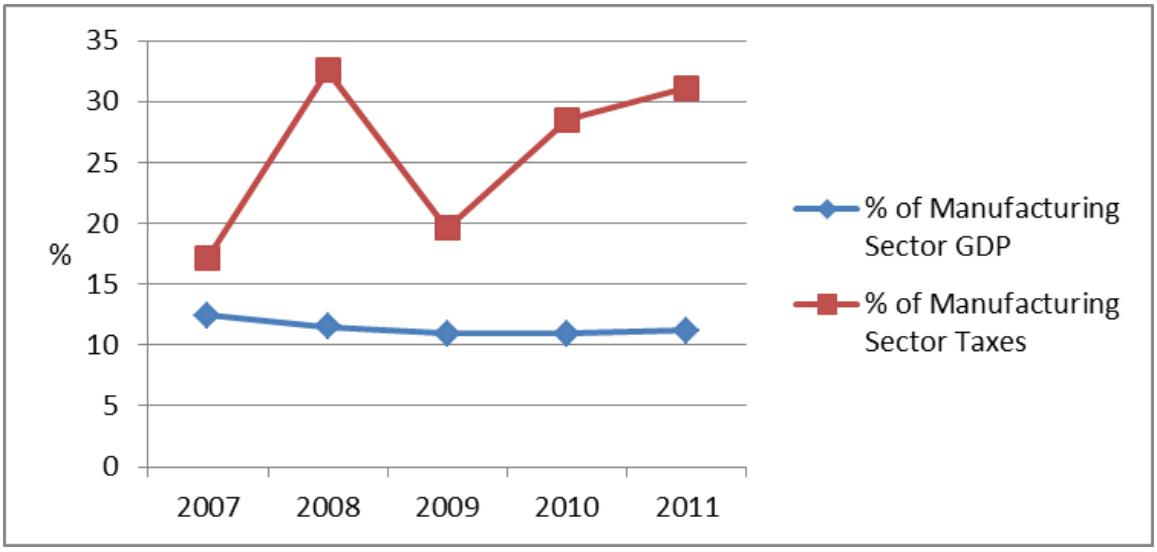


Sources: Tax and Revenue Administration, Government of Alberta and Statistics Canada

Another noteworthy feature within the manufacturing sector is the contribution of the province's existing chemical industry to provincial government revenues. Figure 3 shows the chemical industry's share of overall manufacturing GDP in Alberta as well its share of net corporate taxes paid by the overall manufacturing sector since 2007. While the chemical industry has generated about 12% of the total manufacturing value

added in the last 5 years (averaging about $2 billion (2007$) annually), net corporate income tax revenue from the industry has represented roughly 25% (or slightly over $100 million annually) of the total paid by the manufacturing sector.

FIGURE 3 – CHEMICAL INDUSTRY SHARES OF TOTAL MANUFACTURING GDP AND TOTAL NET CORPORATE PROVINCIAL INCOME TAXES PAID BY THE MANUFACTURING SECTOR IN ALBERTA: 2007-2011



Sources: Tax and Revenue Administration, Government of Alberta and Statistics Canada

Given these considerations, it is apparent that expansion of the chemical industry (and other value added industries) within Alberta may be particularly helpful in terms of enhancing and also possibly stabilizing overall economic activity and provincial government revenue streams in the future.

The objective is this study is to estimate the net economic impact of adding value to Alberta's energy resources. Projected expansions in the petrochemical, fertilizer and refining industries are outlined and the net economic impacts of upgrading various products in terms of contributions to Gross Domestic Product (GDP or value added), labour income, employment and provincial government revenues are estimated.

3. Methodology for the Evaluation of Economic Impacts

The analysis in this report is referred to as an impact analysis. Various economic measures (such as GDP, labour income, employment and government revenues) are estimated taking into account the 'multiplier' effects that occur as a result of new expenditure in an economy. For example, spending on project construction would create a direct impact on the economy that would involve an increase in purchases of labour, machinery and materials. However, these expenditures would also cause those industries or sectors providing the inputs to the project to increase their purchases from other industries or sectors. This indirect impact (or inter-industry impact) will be more significant the greater the backward and forward linkages in the economy. In addition, the spending of labour income generated by the project (both directly and indirectly) would produce further activity in the economy in order to satisfy additional demand in the economy (or induced impact). Induced impacts can also be created with reinvestment of the corporate profits and spending of the government revenues generated by a project. These types of induced impacts are not considered in this analysis.

Direct, indirect and induced impacts are typically estimated using an Input-Output model.[6] The analysis used in this report involves the use of multipliers and intensity ratios in the 2008 Statistics Canada Interprovincial Input Output Model (the I/O model). [7] Impacts on GDP, labour income and employment in the Alberta economy were estimated in this fashion. Some additional modeling was also undertaken in order to estimate the overall impacts on government revenues.[8]

[6] An interregional input-output model can be used to simulate the effect of regional changes in output in a particular industry or changes in final demand for a particular commodity. The effects of such changes (or shocks) on the various industries and regions in the national economy can then be evaluated.

[7] An intensity ratio is the ratio of the impact on some affected variable compared to the change in the variable that generates that impact. For example, if the construction of $1 billion petrochemical plant generates $800 million in GDP, the GDP intensity ratio would be 0.8. A multiplier is the ratio of total impacts (either direct + indirect or direct + indirect + induced) to direct impacts in a particular variable. For example, if the operation of a plant created 100 direct jobs and 500 jobs in total, the employment multiplier would be 5.

[8] The Statistics Canada Interprovincial Input-Output model provides estimates of only indirect tax impacts (i.e. consumption taxes like GST, PST or HST, gas and other excise taxes, etc.). Often more substantial government revenues are generated via direct taxes on personal and corporate income or, in the case of oil and gas projects, royalties. Property taxes are another form of government revenues that may also be significantly affected by a project. In this analysis, property taxes are included in the provincial government revenue estimates.

There are several important assumptions concerning this methodology that should be noted. First, an input-output model is a static model with inter-industry relationships estimated for a specific, past time period (in this case, 2008). Should there have been significant changes in these relationships in the economy since the estimation period, the model results may not provide the most accurate representation of what would actually happen in a current or future environment.

Second, production technologies are assumed fixed regardless of the scale of production. Impacts are estimated given the average input usage by an industry, regardless of whether one unit or a million units of a particular output is produced. It is quite possible that the marginal usage of inputs in an industry as a result of a new project could differ from the average usage in the existing industry, but it is not possible to capture this effect in a traditional I/O model.[9]

Third, an implicit assumption is made that any additional demand resulting from new activity in the economy can be met using available capacity. As a result, it is assumed that no significant inflationary pressure would be created by a project. Should a project lead to higher prices for inputs (or possibly lower prices for outputs if supply were significantly increased), the accuracy of any estimated impacts would be undermined.

Fourth, an impact analysis deals purely with economic impacts and is not to be used to evaluate the efficiency or overall return associated with that project or policy. An organization could pay people thousands of dollars to dig holes and fill them up and this type of activity would generate economic impacts. It would, however, produce no benefit to the organization or society and thus would be totally inefficient. Private and social cost benefit analyses can respectively be used to evaluate economic efficiency from a company's or society's perspective. No attempt has been made in this report to evaluate the efficiency of any of the projects under consideration here.

Finally, the impacts typically shown in an impact analysis can be referred to as gross economic impacts as opposed to net economic impacts. Gross economic impacts include the effects of the purchases of all inputs required to produce the end product of a project. **Because the emphasis here is on identifying the value that would be added to various Alberta**

[9] Estimates of certain government revenues in this study such as taxes on labour income and indirectly generated corporate taxes are also based on province/territory wide averages.

hydrocarbon resources and it is assumed that the resources in question would be produced with or without the value added projects under consideration, the economic impacts associated with the production of the resources being used as feedstocks in the projects are subtracted from the gross economic impacts for the operating phases of these projects. The differences will be referred to as net economic impacts in this report.

Given the distinction between gross and net economic impacts defined here, one would expect differences between the gross and net economic impacts associated with the operating phase of any of the projects under consideration. However, the construction phase of any project would not involve feedstock use and thus the gross and net economic impacts in that stage would be identical.

Some impact estimates have been made publicly available by companies that are sponsoring some of the projects described in the appendix of this report. These estimates are almost invariably for gross impacts, so it is likely that the net operating economic impacts shown in this report would be very different than these other estimates.

To the extent that some of the value added projects could ultimately use feedstocks that would not otherwise be produced in the absence of these projects, the net economic impact estimates shown in this report may be conservative. In addition, the cumulative demand for feedstocks from numerous projects could eventually be large enough to significantly affect supply/demand balances for commodities and thus prices. Higher prices for natural gas, NGLs and bitumen would result in higher royalties for the Alberta government and higher cash flows for oil and gas producers. In turn, both the government and oil and companies could potentially spend more, resulting in further induced impacts. The analysis of these effects would involve much more extensive modeling and was beyond the scope of this study. However, should such a scenario materialize, there would be additional positive net impacts for the Alberta economy.

4. Potential Economic Impacts of Additional Hydrocarbon Value Added Processing in Alberta by the Chemical Industry

AIHA commissioned a report investigating hydrocarbon processing opportunities and prospects in Alberta's Industrial Heartland.[10] In that report, various potential value added projects in the Alberta economy were identified. Some of the more promising opportunities including the following: using methane as a feedstock to produce methanol, ammonia or urea; using ethane as a feedstock to produce ethylene and then derivatives such as polyethylene or ethylene glycol; and, using propane as a feedstock to produce propylene and then derivatives such as polypropylene, propylene oxide, or propylene glycol.

Wherever possible, detailed project information on expected capital costs, operating costs, production volumes and revenues was provided by the companies sponsoring projects and this information was incorporated in developing the potential net impact estimates for specific projects. Projects that are already at a more advanced stage of development include Williams Energy Canada (Williams) projects involving additional processing of oilsands offgas (which would create incremental supplies of ethane, ethylene, propane, propylene, etc. in the province) and propane dehydrogenation (or PDH, which would produce propylene). As well, a planned expansion by NOVA Chemicals of its polyethylene production capacity is set to start construction this year.

In other cases, where the project development is not currently quite as advanced or there were major confidentiality concerns, AIHA provided information so that costs and revenues could be estimated in order to facilitate a net impact analysis. Information sources, individual project descriptions and net impact estimates for individual projects appear in the Appendix of this study.

Given the projected feedstock availability in the province and appropriate economic conditions, AIHA believes that there is the potential for the expansions in the petrochemical and fertilizer industries (or the chemical

[10] See *Alberta's Hydrocarbon Processing Opportunities, Prospects and Marketing Approaches* by IHS Consulting – Chemical Group New York (February 2012).

industry) in the next decade that would ultimately allow incremental production of the following:[11]

- 900 kilotonne(kt)/year (or 300 million US gallons/ year) of methanol
- 600 kt/year of urea
- 900 kt/year (or 2 million lbs/year) of ethylene derivatives using ethane as the initial feedstock
- 900 kt/year (or 2 million lbs/year) of propylene derivatives using propane as the initial feedstock

Production of the various petrochemical and fertilizer volumes noted above would result in the net economic impacts summarized in Table 1.[12] **All the impacts shown in the tables in this section represent the combination of direct, indirect and induced impacts** as defined in Section 3. **The results shown are for operational impacts only and are expressed on an annual basis.**

TABLE 1 – POTENTIAL NET ANNUAL ECONOMIC IMPACTS IN ALBERTA OF CHEMICAL INDUSTRY EXPANSIONS USING HYDROCARBON FEEDSTOCKS OVER THE NEXT DECADE

(values are in millions of 2012 Cdn$, employment in person years)

Product - Annual Volume	GDP	Labour Income	Prov.Gov. Revenue	Employment
Methanol – 900 kt/year	270	53	21	541
Urea – 600 kt/year	78	34	10	343
NGLs/Olefins from Oilsands Offgas	537	197	54	2062
Propylene – 900 kt/yr	398	174	46	1890
Polyethylene – 900 kt/yr	712	236	72	2542
Polypropylene – 900 kt/yr	396	102	33	1113
TOTAL	2391	796	236	8491

[11] See IHS report described in previous note and Canadian Energy Research Institute (CERI*), Natural Gas Liquids in North America, Overview and Outlook to 2035*, July 2012.

[12] The impacts for methanol and urea production, as well as the production of the various products from Williams' offgas processing, are taken directly from Appendix Tables A.4 and A.5 and A.1 respectively. Given the assumed capacity for the planned Williams PDH plant (450 kt/year) versus the assumed propylene volumes in this section (900 kt/year), the impacts shown in Table A.2 have been multiplied by 2 in order to get the estimates in Table 1. For similar reasons, the impacts shown in Table A.3 for the NOVA Chemicals polyethylene expansion have been multiplied by 2 to produce the results shown in Table 1. Finally, the impacts shown in Table A.6 for a 300/kt polypropylene plant have been multiplied by 3 to reflect the impacts of the assumed 900kt/year of overall polypropylene production.

Chemical industry expansions based on the hydrocarbon value added projects set out in Table 1 could generate approximately $2.4 billion annually in additional GDP for the Alberta economy, a figure that is slightly larger than current chemical industry GDP in the province in recent years. It also is equivalent to about 1% of current overall GDP in Alberta.[13]

Provincial government revenues would rise by roughly $240 million per year.[14] About half of that increase would be direct corporate income taxes paid by project sponsors, an amount equivalent to about 3% of annual average corporate provincial income taxes paid in Alberta in the last decade.[15]

In addition, labour income would increase by close to $800 million annually while roughly 8500 jobs would be created by the chemical industry expansions. In comparison to the GDP and government revenue impacts, the projects would produce relatively smaller increases in labour income and employment given the levels of the variables in the provincial economy. This is typical of capital intensive projects like the ones under consideration here. What is also typical of such projects is that the average earnings per worker (even when indirect and induced impacts are included) far exceed the average in the economy as a whole. For example, average annual labour income per worker in the operation phase of the various projects is projected to be $94,000, well above the overall average in Alberta of $58,000 last year.[16]

As noted in the Appendix, given the typical expected construction time period for various projects, annual construction phase impacts would be roughly of the same order of magnitude as the operational impacts shown in the above table. In general, annual labour income and employment impacts would be slightly larger than those shown in Table 1 while GDP and government revenue impacts would be slightly smaller. With construction

[13] Provincial GDP from Statistics Canada.
[14] In addition to the revenues for the Alberta government shown in Table 1, the value added projects listed there would generate federal government revenues of roughly $380 million annually in Alberta alone. Additional federal government revenues and revenues to other provincial governments would also be created elsewhere in Canada through indirect and induced linkages.
[15] Corporate tax statistics from Tax and Revenue Administration, Government of Alberta.
[16] Average weekly earnings from Statistics Canada.

of the various projects likely to be spread out over many years, it is less likely that labour market constraints would become a major issue.

No consideration has been given in this report to further processing of materials such as polyethylene or polypropylene in Alberta. In addition, should derivatives such as ethylene oxide or propylene oxide be produced in the province, these could be used as feedstocks for other petrochemical derivatives.

5. Potential Economic Impacts of Other Value Added Projects

The upgrading of bitumen or natural gas into refined petroleum products such as diesel fuel, gas oil or napthta represents another opportunity to add value to Alberta's energy resources. For example, Northwest Redwater Partnership (NWR) has sanctioned the construction of the first phase of a bitumen refinery in Alberta's Industrial Heartland that will use 50,000 barrels per day (bpd) of bitumen and convert it into various value added refined products, primarily ultra-low sulphur diesel but also low sulphur vacuum gas oil and other products. There are plans to eventually expand this plant to process 150,000 bpd of bitumen. In addition, there has been some interest in developing a gas-to-liquids facility (which would convert methane into diesel fuel and naphtha) in Alberta.

Detailed capital and operating cost estimates were not available for either of these possibilities. Nevertheless, more crude estimates of net economic impacts were developed for the following potential value added projects.

- A refinery that would convert 150,000 barrels per day (bpd) of bitumen into refined products such as diesel fuel and vacuum gas oil.
- A 96,000 barrel (bpd) gas-to-liquids (GTL) plant that would convert methane into refined products such as diesel fuel and naphtha.

Net economic impacts estimates for these projects are shown in Table 2.[17] Like the impacts presented for potential chemical industry development, only annual operating impacts are included in the table.

[17] The impacts for the NWR refinery with a capacity of 50,000 bpd shown in Appendix Table A.7 were multiplied by 3 to produce the values shown in Table 2.

TABLE 2 – POTENTIAL NET ANNUAL ECONOMIC IMPACTS IN ALBERTA OF BITUMEN REFINING AND GAS-TO-LIQUIDS PROJECTS OVER THE NEXT DECADE

(values are in billions of 2012 Cdn$, employment in person years)

Annual Volume / Products (Feedstock)	GDP	Labour Income	Prov.Gov. Revenue	Employment
150,000 bpd diesel/gas oil (bitumen)	2.00	0.61	0.21	6300
96,000 bpd diesel/naphtha (methane)	1.80	0.36	0.18	3800

As with the chemical industry expansions outlined earlier, both of the value added projects outlined in Table 2 would produce substantial annual net economic impacts in Alberta. Each of the projects would generate around $2 billion in GDP and $200 million in provincial government revenues annually.[18] The refinery and GTL projects would create an additional 6300 jobs and 3800 jobs per year respectively, and about $1 billion annually in labour income between them. Given the capital intensity of these projects in comparison to the chemical industry projects considered earlier, it could be expected that annual construction impacts would be larger than the operating impacts shown in Table 2, especially with respect to employment and labour income.

Table 3 summarizes the overall net annual economic impacts of the value added projects under consideration in this study. It is clear that these projects could generate very significant economic impacts in Alberta over the next decade.

TABLE 3 – POTENTIAL NET ANNUAL ECONOMIC IMPACTS IN ALBERTA OF THE ANALYZED VALUE ADDED PROJECTS OVER THE NEXT DECADE

GDP	$6.2 billion
Labour Income	$1.8 billion
Provincial Government Revenue	$630 million
Federal Government Revenue (generated in Alberta only)	$1.0 billion
Employment	19,000 jobs

[18] In addition, it is estimated that the annual federal government revenues generated in Alberta by the refinery and GTL projects would amount to $350 million and $310 million respectively.

APPENDIX

DESCRIPTIONS AND NET ECONOMIC IMPACTS OF SPECIFIC RESOURCE DEVELOPMENT PROJECTS

Williams Energy Canada's Oil Sands Offgas Processing Expansions

Upgrading bitumen into synthetic crude oil simultaneously produces a by-product (offgas) that is comprised roughly of 40% methane, 20% hydrogen, and 40% olefins (ethylene and propylene) and natural gas liquids (ethane, propane and butane). Williams Energy Canada (Williams) currently extracts natural gas liquids (NGLs) and olefins from the offgas at Suncor's Fort McMurray upgrader. Estimated volumes of NGL/olefin mix from the existing operation are 15,000 barrels per day (bpd), without yet recovering ethylene/ethane. Williams expects to complete an expansion to also recover ethylene/ethane from this offgas in the second quarter of 2013. When that is operational, 25,000 bpd of NGLs/olefins will be recovered.

The company has also recently announced that it has reached an agreement with Canadian Natural Resources Limited (CNRL) to extract, transport, fractionate, and market the NGLs and olefins recovered from the offgas at CNRL's Fort McMurray upgrader. Under the agreement, NGL/olefin volumes are expected to start at 12,000 barrels per day (bpd) by 2015 and grow to roughly 15,000 bpd by 2018.[19]

In addition, Williams has recently completed construction of the Boreal Pipeline which is designed to carry 125,000 bpd of C2+ (ethane, ethylene, propane, propylene, etc.) from Fort McMurray to its fractionation facilities in Alberta's Industrial Heartland.[20] Given the capacity of the pipeline and the current agreements in place, it seems clear that Williams is anticipating further offgas processing.

In fact, Williams provided detailed cost and revenue estimates for more than one expansion of offgas processing facilities, each of which is assumed to be running at full capacity by the end of this decade. Given the confidential nature of this information, the assumed costs, annual production volumes and product prices used in the analysis are not reported here. However, given the assumed volumes of various products and forecast prices of those products, the revenue projections seem well within a reasonable range.

[19] See Williams' online press release at http://www.b2i.us/profiles/investor/NewsPrint.asp?b=630&ID=57431&m=rl&pop=1&cat=1799&G=343. The partner alluded to in the press release was subsequently revealed to be CNRL.
[20] See http://www.lifeintheheartland.com/documents/Williams.pdf.

Net economic impacts associated with the construction and operation of additional offgas processing facilities are summarized in Table A.1. **All the impacts shown in the tables in this section represent the combination of direct, indirect and induced impacts** as defined in Section 3.

TABLE A.1 – NET ECONOMIC IMPACTS IN ALBERTA OF PLANNED EXPANSIONS OF WILLIAMS' OILSANDS OFFGAS PROCESSING FACILITIES

(values are in millions of 2012 Cdn$, employment in person years)

	Overall Construction Impacts	Annual Operating Impacts
GDP	1548	537
Labour Income	1209	197
Provincial Government Revenue	127	54
Employment	8069	2062

The overall construction impacts of the Williams' offgas processing expansions would include $1.5 billion in GDP (all $ values in the impact analysis are 2012 Canadian $), $1.2 billion in labour income and about $130 million in provincial government revenues. Average annual operating impacts, once the expansions were running at full capacity (typically within a year or two of start-up), could be expected to include roughly $540 million in GDP, $200 million in labour income and $55 million in provincial government revenues. Average annual operating employment would amount to 2100 jobs while overall construction employment would be about 8100 person years.

Williams has indicated that the construction expenditures would be spread out over roughly a 3 year period for each of the expansion projects. The average annual impacts over the construction phase would in that case be about $500 million annually in GDP, $400 million in labour income, $40 in provincial government revenues and 2700 jobs. As will be reflected in tables below for other projects, average annual labour income and employment tend to be higher in the construction phase of these types of projects, while average annual GDP and government revenue tend to be higher in the operating phases. In addition, given the very significant

proportion of capital costs that usually is associated with direct labour income, the labour income to GDP ratio during the construction phase is typically twice as high as during the operating phase.

Williams' Propane Dehydrogenation (PDH) Facility

Williams has also recently sanctioned construction of a propane dehydrogenation (PDH) facility in Strathcona County.[21] The plant will be capable of producing up to 1.1 billion pounds or 500 kilotonnes (kt) annually of polymer-grade propylene. The PDH facility is expected to be operational in 2016 subject to the necessary permitting approvals. Williams has also indicated that the capacity of the plant could potentially be doubled in a future expansion.

The PDH plant will primarily use propane recovered from its expanding oil sands offgas processing operations (described above), along with local propane purchases as feedstock for the new PDH facility. In addition, the propylene produced by Williams could serve as a feedstock for propylene derivatives such as polypropylene. The economic impacts of potential polypropylene production in Alberta are explored later in this section.

Williams provided detailed cost and revenue estimates for its PDH facility and these have been used to calculate the net economic impacts shown in Table A.2 below. Given the confidential nature of this information, the assumed costs, annual production volumes and propylene prices used in the analysis are not reported here. However, the assumed volume is below nameplate capacity and the propylene prices are well within the range of current forecasts.

On an annual basis in its operating phase, the PDH project would produce about $200 million in GDP, $90 million in labour income, $25 million in provincial government revenues and 950 jobs. As with Williams' offgas expansions, roughly a 3 year construction period is expected and the average annual construction impacts would then be higher than the operating impacts in terms of labour income and employment, but lower in terms of provincial government revenues.

[21] See Williams' online press release at http://www.b2i.us/profiles/investor/NewsPrint.asp?b=630&ID=61124&m=rl&pop=1&cat=1799&G=343.

TABLE A.2 – NET ECONOMIC IMPACTS IN ALBERTA OF WILLIAMS' PROPOSED PROPANE DEHYDROGENATION (PDH) PLANT

(values are in millions of 2012 Cdn$, employment in person years)

	Overall Construction Impacts	Annual Operating Impacts
GDP	631	199
Labour Income	493	87
Provincial Government Revenue	52	23
Employment	3268	945

NOVA Chemicals' Polyethylene Expansion

NOVA Chemicals is currently planning an expansion of its polyethylene facilities at Joffre. The company expects to add a third polyethylene reactor, with the capacity to produce between 950 million pounds and 1.1 billion pounds of linear, low-density polyethylene annually.[22] It would utilize existing ethane cracking capacity at Joffre to produce ethylene which, in turn, would serve as feedstock for polyethylene production. Construction is expected to be completed in 2015 and operations are anticipated to begin in that year as well.

NOVA Chemicals provided detailed cost and revenue estimates for its polyethylene expansion and these have been used to calculate the net economic impacts shown in Table A.3 below. Given the confidential nature of this information, the assumed costs, annual production volumes and ethylene prices used in the analysis are not reported here. However, the assumed volume is below nameplate capacity and the ethylene prices are well within the range of current forecasts.

The overall construction impacts of the NOVA Chemicals polyethylene expansion would include roughly $840 million in GDP, $670 million in labour income and about $70 million in provincial government revenues. The average annual operating impacts could be expected to be

[22] See NOVA Chemicals Proposed Polyethylene 1 (PE1) Expansion Project – Project Fact Sheet 2 at http://www.novachem.com/ExWeb%20Documents/joffre/PE1%20Expansion%20Fact%20Sheet.pdf.

approximately $360 million in GDP, $120 million in labour income and $35 million in provincial government revenues. Average annual operating employment would amount to about 1300 jobs while overall construction employment would be roughly 4100 person years.

TABLE A.3 – NET ECONOMIC IMPACTS IN ALBERTA OF NOVA CHEMICALS' PROPOSED POLYETHYLENE EXPANSION

(values are in millions of 2012 Cdn$, employment in person years)

	Overall Construction Impacts	Annual Operating Impacts
GDP	836	356
Labour Income	670	118
Provincial Government Revenue	68	36
Employment	4067	1271

NOVA Chemicals expects that the bulk of the construction expenditures would be spread out over the 2013-2015 period. Given that time frame, and similar to the Williams projects, there would be higher average annual labour income and employment impacts during the construction phase and higher average annual GDP and government revenue impacts during the operating phase

Potential 900 kt/year Methanol Plant in the Alberta Industrial Heartland

The projects described so far in this section would largely involve either C2 (ethane/ethylene) or C3 (propane/propylene) feedstock. The study commissioned by AIHA investigating hydrocarbon processing possibilities suggests that there may also be opportunities in Alberta to develop additional value added processing using methane as a feedstock.

It can be argued that the 2011 re-opening of the Methanex methanol plant in Medicine Hat after years of being shut down supports that position. The profitability of methanol production in North America has improved considerably given lower gas prices in the last few years. So much so, in

fact, that Methanex is proposing a debottlenecking of its Medicine Hat facility that would increase capacity by 10-20%.[23]

Clearly the re-opening and debottlenecking of an existing plant is much more economically justifiable than building a new plant. However, there is other evidence to suggest that a new methanol plant in Alberta may be economically viable. For example, a chemical industry consultant study in 2011 examined the relative profitability of various petrochemical and fertilizer plants in different areas of the world.[24] Although the analysis done at that time indicated that a methanol plant in Alberta would be marginally unprofitable, it was based on feedstock (methane) price forecasts that are significantly higher than current price forecasts. When an adjustment is made to the feedstock costs to account for more recent forecasts, the results indicate that a plant could in fact be profitable.

In addition, AIHA and the Edmonton Economic Development Association recently commissioned Stantec Consulting Ltd to study the profitability of petrochemical plants in the Alberta Industrial Heartland versus the US Gulf Coast.[25] The study contains an analysis of the economics of building and constructing a 300 million US gallon/year (900 kt/year) capacity methanol plant in both areas. Cost, product volume and price projections from that analysis were used to estimate the net impacts in Alberta of such a plant. These are summarized in Table A.4 below.

Roughly $800 million in GDP, $640 million in labour income, $65 million in provincial government revenue and 4000 person years of employment would be created during the construction of the assumed 900 kt/year methanol plant. Annual operating impacts would include $270 million in GDP, $50 million in labour income, $20 million in provincial government revenue and 540 jobs. The cost structure for the methanol facility is more capital intensive than the other projects considered in this report, resulting in relatively larger construction phase versus operating phase impacts than those shown for the other projects.

[23] See http://www.medicinehatnews.com/local-news/methanex-announces-expansion.html. By spending $30 million, Methanex expects to increase production capacity from 470 kt/year to 560 kt/year.
[24] See Chemical Market Associates Inc. (CMAI – now IHS Consulting) *Natural Gas Value Chain Derivative Cost Analysis* (September 2011).
[25] See Stantec Consulting Ltd., *Profitability of Petrochemical Plants in Alberta Industrial Heartland vs Gulf Coast* (February 2013).

TABLE A.4 – NET ECONOMIC IMPACTS IN ALBERTA OF A 900 KT/YEAR METHANOL PLANT IN THE ALBERTA INDUSTRIAL HEARTLAND

(values are in millions of 2012 Cdn$, employment in person years)

	Overall Construction Impacts	Annual Operating Impacts
GDP	799	270
Labour Income	644	53
Provincial Government Revenue	65	21
Employment	3986	541

Potential 600 kt/year Urea Plant in the Alberta Industrial Heartland

The study commissioned by AIHA that analyzed hydrocarbon processing opportunities identified urea and ammonia as two products that represented some of the most favourable investment opportunities in hydrocarbon derivatives in Alberta.[26] In addition, the 2011/2012 CMAI/IHS study for AIHA regarding the relative profitability of various petrochemical and fertilizer plants in different areas of the world also indicated that urea might be profitably produced in Alberta given slightly more favourable feedstock costs than those employed in the study.[27] Like with methanol, the projections of future gas prices have declined since that study was put together and it appears that under current gas price forecasts a new urea plant could be economically viable.

Consequently, information from the CMAI/IHS report was used to estimate the net economic impacts associated with a 600 kt/year urea plant. Feedstock (methane) costs were adjusted as per long-term Sproule gas price forecasts for Alberta while the operating cost and product price forecasts were taken directly from the CMAI/HIS report.[28] The forecast of urea price in that report is in the range of current forecasts. The study did not specify capital costs so, in Table A.5 below which shows the net economic impacts of a 600 kt/year urea plant in Alberta, only operating impacts are included. Annual impacts would include about $80 million in GDP, $35 million in

[26] See *Alberta's Hydrocarbon Processing Opportunities, Prospects and Marketing Approaches* by IHS Consulting – Chemical Group New York (February 2012).
[27] See Chemical Market Associates Inc. (CMAI – now IHS Consulting) *Natural Gas Value Chain Derivative Cost Analysis* (September 2011).
[28] See http://www.sproule.com/forecasts for the most recent Sproule and Associates energy price forecasts.

labour income, $10 million in provincial government revenue and 340 jobs.[29]

TABLE A.5 – NET ECONOMIC IMPACTS IN ALBERTA OF A 600 KT/YEAR UREA PLANT IN THE ALBERTA INDUSTRIAL HEARTLAND

(values are in millions of 2012 Cdn$, employment in person years)

	Overall Construction Impacts	Annual Operating Impacts
GDP		78
Labour Income		34
Provincial Government Revenue		10
Employment		343

Potential 300 kt/year Polypropylene Plant in the Alberta Industrial Heartland

The hydrocarbons processing opportunities study commissioned by AIHA also identified propylene derivatives such as polypropylene, propylene oxide and propylene glycol as products which offered favourable investment opportunities in Alberta.[30] As with analysis of urea potential in the province shown previously, information from another chemical industry consultant study was used to make net economic impact estimates.[31] Estimates for a 300 kt/year polypropylene plant (as modeled in that study) were developed, once again making an adjustment for more recent feedstock (propylene) prices. The polypropylene prices used in that analysis were found to be in the range of current forecasts and were not adjusted.

As with the previous impact estimates for a urea plant, no information was available for capital costs so only operating impacts are shown in Table A.6. A 300 kt/year polypropylene plant could be expected to generate roughly $130 million in GDP, $35 million in labour income, $10 million in

[29] The CMAI/IHS study does provide estimates of implicit annual depreciation and return on investment amounts and, although no specific capital cost is quoted, a urea facility could be expected to have a significantly lower capital cost relative to annual revenue versus a methanol plant.
[30] See *Alberta's Hydrocarbon Processing Opportunities, Prospects and Marketing Approaches* by IHS Consulting – Chemical Group New York (February 2012). derivative rankings.
[31] See Chemical Market Associates Inc. (CMAI – now IHS Consulting) *Propylene Derivatives Cost Analysis* (March 2011).

provincial government revenues and 370 jobs per year. It can be noted that production from the Williams' PDH plant described earlier could provide enough feedstock for about 450 kt/year of polypropylene production.

TABLE A.6 – NET ECONOMIC IMPACTS IN ALBERTA OF A 300 KT/YEAR POLYPROPYLENE PLANT IN THE ALBERTA INDUSTRIAL HEARTLAND

(values are in millions of 2012 Cdn$, employment in person years)

	Overall Construction Impacts	Annual Operating Impacts
GDP		132
Labour Income		34
Provincial Government Revenue		11
Employment		371

Northwest Redwater Partnership Bitumen Refinery

Northwest Redwater Partnership (NWR) has sanctioned the construction of a bitumen refinery in Alberta's Industrial Heartland. In the initial phase, the refinery will process 50,000 barrels per day (bpd) of bitumen and convert it into various value added refined products, primarily ultra-low sulphur diesel but also low sulphur vacuum gas oil and other products.[32] Construction of the first phase of the project is expected to begin this spring and operations are scheduled to start in 2015. Future expansion anticipated by NWR would bring the capacity of the refinery to 150,000 bpd of bitumen.

NWR provided forecasts for product volumes and overall capital and operating costs. Information from some of the other projects described above was used to roughly estimate capital and operating cost composition. Product price forecasts, required to estimate revenues and feedstock costs, were based on information provided by Sproule and AIHA. Net economic impacts associated with the first phase (50,000 bpd of bitumen) of the NWR refinery project are shown in Table A.7.

NWR's 50,000 bpd bitumen refinery could be expected to generate roughly $670 million in GDP, $200 million in labour income, $70 million in

[32] See Northwest Redwater Partnership (NWR) Partnership Profile – April 2012.

provincial government revenues and 2100 jobs per year when in operation. Should the refinery ultimately be expanded to its planned long-term capacity of 150,000 bpd of bitumen, the operating impacts would be triple those shown in Table A.7.

Construction of the initial phase is expected to occur over a 3 year period and the average annual impacts during construction would be larger than during operations. If the refinery were expanded to 150,000 bpd, the overall construction impacts would be 2-3 times larger than those shown in Table A.7.

TABLE A.7 – NET ECONOMIC IMPACTS IN ALBERTA OF THE NORTHWEST REDWATER (NWR) PARTNERSHIP'S PROPOSED 50,000 BARRELS PER DAY BITUMEN REFINERY

(values are in millions of 2012 Cdn$, employment in person years)

	Overall Construction Impacts	Annual Operating Impacts
GDP	5000	670
Labour Income	3900	200
Provincial Government Revenue	400	70
Employment	26000	2100

Potential 96,000 bpd Gas-to-Liquids (GTL) Plant in Alberta

Methane can be converted into products such as diesel fuel and naphtha in a GTL plant. Sasol was contemplating the initiation of engineering and design for a 96,000 barrels per day GTL plant in Alberta, but recently delayed those plans given their proposed development of GTL facilities on the US Gulf Coast.[33] It remains possible that Sasol or some other company may one day pursue such development and AIHA requested that rough net economic impact estimates be made for such a facility.

[33] See http://www.calgaryherald.com/business/Sasol+delays+billion+natural+liquids+plant/7644706/story.html.

A similar approach to that employed in the estimation of the NWR refinery impacts shown above was taken, albeit with even less project specific information available. The net impact estimates are summarized in Table A.8.

TABLE A.8 – NET ECONOMIC IMPACTS IN ALBERTA OF A 96,000 BARRELS PER DAY GAS-TO-LIQUIDS (GTL) PLANT

(values are in millions of 2012 Cdn$, employment in person years)

	Overall Construction Impacts	Annual Operating Impacts
GDP	7100	1800
Labour Income	5500	360
Provincial Government Revenue	580	180
Employment	36000	3800

A 96,000 bpd GTL plant could be expected to generate roughly $1.8 billion in GDP, $360 million in labour income, $180 million in provincial government revenues and 3800 jobs per year when in operation. Average annual construction phase impacts would likely be larger, as might be expected given the capital intensity of the project.