ECONOMIC IMPACTS OF CANADIAN OIL AND GAS SUPPLY IN CANADA AND THE US (2017-2027)

Economic Impacts of Canadian Oil and Gas Supply in Canada and the US (2017-2027)

Authors: Ganesh Doluweera
Paul Kralovic
Dinara Millington

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CANADIAN ENERGY RESEARCH INSTITUTE
150, 3512 – 33 Street NW
Calgary, Alberta T2L 2A6
Email: info@ceri.ca
Phone: 403-282-1231

Table of Contents

List of Figures

List of Tables

Executive Summary

The longest undefended border on the planet runs 8,891 kilometers and is shared between Canada and the United States (US), the second- and fourth-largest countries, respectively. The two countries not only share the longest international boundary, but also have the second-largest bilateral trading relationship in the world with trade totaling CAD$752 billion at the end of 2016.

In many respects, this interregional interdependence grew with the signing of the North American Free Trade Agreement (NAFTA), a trilateral trading agreement between Canada, Mexico and the US. The agreement came into effect on January 1, 1994 and was a natural expansion of the predecessor agreement, the Canada-United States Free Trade Agreement, signed in 1988.

Both the US and Canada are important oil and natural gas producers. On a global scale, both rank in the top 5. But what is more important is that both countries form an integrated North American system, linked together physical and economic infrastructure. While Canada is currently a net exporter of both commodities, natural gas and oil flow in both directions, as do other goods and services critical to produce oil and gas in Canada.

This study examines the economic impacts of the Canadian oil and natural gas industry on both Canadian and US economies, down to the provincial and state levels, utilizing CERI's proprietary Canada Multi-Regional Input-Output (CMRIO) model and the US IMPLAN® model. This study is timely, particularly as the first round of North American Free Trade Agreement (NAFTA) renegotiations will be held in Washington on August 16-20, 2017.

Canadian Economic Impacts

The Canadian oil and gas industry is a significant contributor to the provincial and national economies in Canada. For the foreseeable future, natural gas and crude oil will be important elements in many economic sectors in Canadian and North American economies. This section summarizes the Canadian economic impacts from the sectors that produce natural gas, crude oil and oil sands.

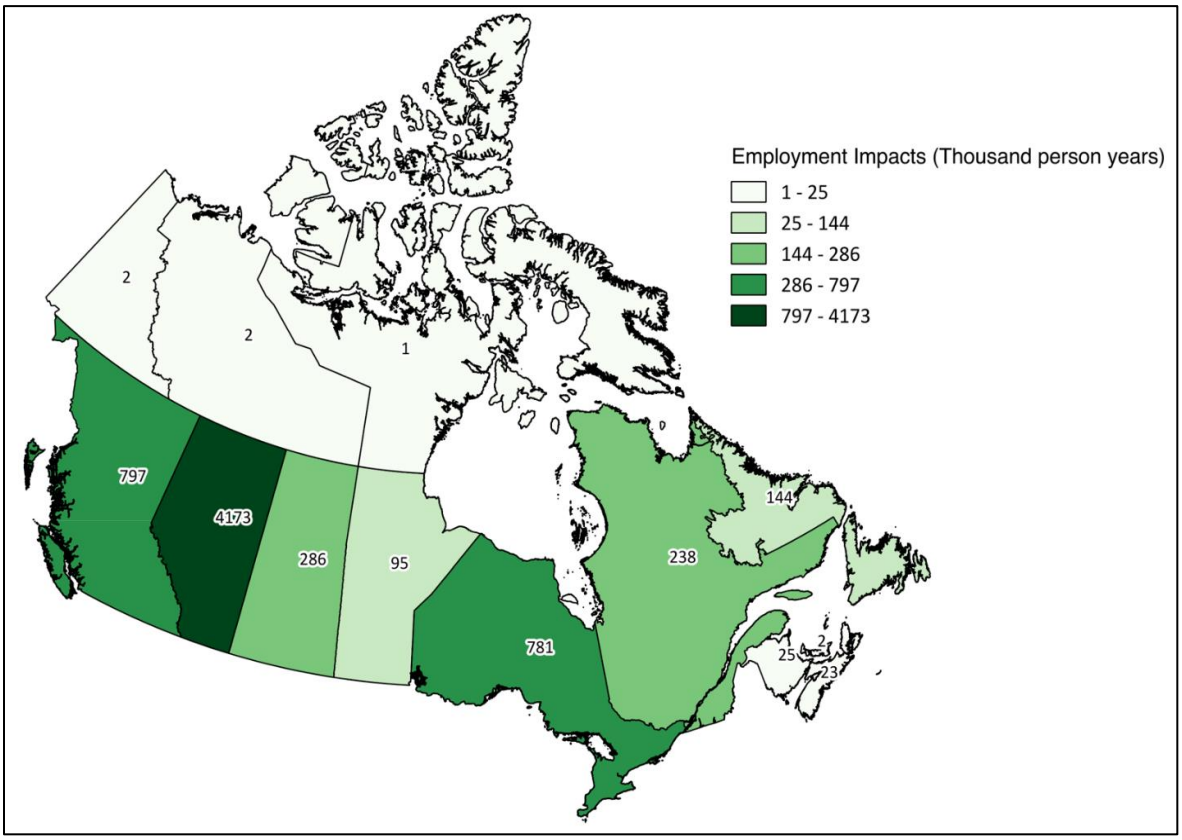
Total GDP impact from investment and operations in oil sands projects throughout the forecast period of 2017-2027 is almost CAD$1.7 trillion or 61 percent of total GDP impact, in comparison to GDP impact from crude oil – CAD$630 billion or natural gas – CAD$422.5 billion.

Total employment impacts from all Canadian oil and gas development will materialize in every province and territory (Figure E.1). The largest labour impact will be felt in Alberta (4,173 thousand person-years). However, companies that are suppliers of goods and services, such as machinery, manufacturing, trade, legal, environmental, financial services, often located outside of Alberta, will also benefit. While Alberta's share of total employment is 64 percent, British Columbia and Ontario will also see employment impacts (each province's share at 12 percent).

This is expected because while many oil and gas companies are committed to supporting local businesses and workers by purchasing goods and services from local suppliers and hiring local residents in the areas of oil and gas development, in some cases, it is either in the best interest of the company or their only option to seek goods and services from outside of the province where development is happening. Certain specialized goods and services must come from outside a specific province and even outside Canada. This out of province spending implies an increased spill-over effect or economic leakages from a base province to other provinces and even other countries.

Figure E.1 illustrates employment impacts from all oil and gas activity in the provinces of British Columbia, Alberta, Saskatchewan, Manitoba, and Newfoundland, but also in the provinces that supply goods and services to the producing regions.

Figure E.1: Total Canadian Employment Impacts of Conventional Oil, Oil Sands and Natural Gas Development (2017-2027)

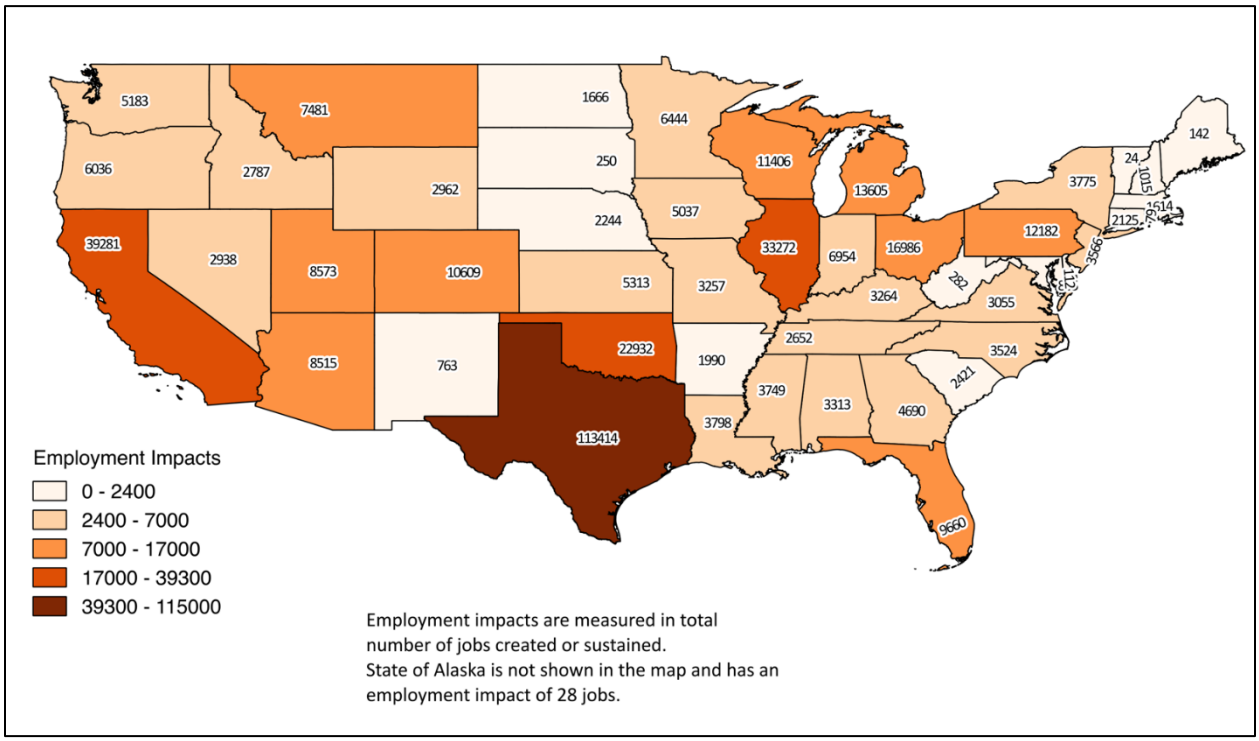


US Economic Impacts

Any out-of-Canada spending by the Canadian oil and gas sector implies a spill-over effect, where economic impacts accrue outside of Canada but they can be attributed to the development of Canadian oil and gas resources. This section summarizes the economic impacts of Canadian purchases of goods and services in the US only. Any spending done outside of Canada or the US is not covered here.

The contribution to the US economy as a result of Canadian oil and gas firms purchasing goods and services in the US in order to develop their projects is positive and significant. For the forecast period of 2017-2027, it is estimated that the total economic impact on US gross state product (GSP)[1] from goods and services supplied by US firms to Canada will amount to almost US$45.6 billion, comprised of US$29.6 billion (or 65% of total) GSP impacts from conventional oil and gas and US$16 billion GSP impacts from Canadian oil sands. The total employment impact is measured in creating or sustaining 405,833 full-time equivalent jobs in the 11-year period (Figure E.2), with 64 percent or 260,490 jobs created or sustained in the US economy due to the Canadian conventional oil and gas sector's purchases of US goods and services, and 145,347 jobs due to Canadian oil sands' purchases.

Figure E.2: Total US Employment Impacts of Conventional Oil, Oil Sands and Natural Gas Development (2017-2027)



The top ten states that benefit the most from Canadian oil and gas development are, in descending order, Texas, California, Illinois, Oklahoma, Ohio, Pennsylvania, Colorado, Wisconsin, Wyoming, and Florida (Table E.1). Together the top ten states make up 70 percent of the total GSP impact and 67 percent of total employment impact. Again, Texas is the largest beneficiary in terms of GSP and employment; GSP impact is estimated to be US$14.3 billion over the 2017-2027 period; the number of jobs created or sustained is estimated to be 113,414 over the same period.

[1] In the US, the definition of gross state product (GSP) is equivalent to the provincial gross domestic product (GDP) in Canada. Total GSP is referred to as a sum of all state GSP values.

Table E.1: Total US Economic Impacts of Conventional Oil, Oil Sands and Natural Gas Development (2017-2027)

State	Total Jobs	Total GSP
Name	# of Jobs	Mln 2016 US$
Texas	113,414	$ 14,270
California	39,281	$ 4,814
Illinois	33,272	$ 3,133
Oklahoma	22,932	$ 2,156
Ohio	16,986	$ 1,899
Pennsylvania	12,182	$ 1,438
Colorado	10,609	$ 1,257
Wisconsin	11,406	$ 1,134
Wyoming	2,962	$ 995
Florida	9,660	$ 925

Summary of Economic Impacts

In summary, total economic impacts from investment and operations of Canadian oil and gas projects contribute to economic growth and employment in both countries. The capital investment of CAD$380 billion and operational revenues of CAD$1.8 trillion from Canadian oil and gas projects over the 11-year period will generate CAD$2.7 trillion in Canadian GDP and 6,572 thousand person-years in Canada, and US$45.6 billion in US GSP and 406 thousand jobs in the US (Table E.2).

Table E.2: Summary of Economic Impacts and Investments (2017-2027)

Total Capital Investment	*Mln 2016 CAD$*	**$380,133**
Total Operations	*Mln 2016 CAD$*	**$1,832,568**
Canada		
GDP	*Mln 2016 CAD$*	**$2,715,497**
Employment	*Person-years*	**6,572,030**
US		
GSP	*Mln 2016 US$*	**$45,592**
Employment	*# of Jobs*	**405,833**

For every direct job created in the Canadian oil and gas sector, 2 indirect and 3 induced jobs in other sectors are created in Canada on average. For every Canadian million dollars invested and generated in the Canadian oil and gas sector, the Canadian GDP impact is CAD$ 1.2 million.

For every direct job created or sustained in the US, one indirect and one induced jobs are created or preserved in the US. For every US million dollars spent by the Canadian oil and gas and related service sectors in the US, US$0.6 million is generated in the US GSP.

Chapter 1: Introduction

Canada and the US share the world's second-largest trading relationship, with trade totaling CAD$752 billion at the end of 2016.[1] Canada is the United States' second-largest trading partner – after China.[2] Canadian exports to the US at end-2016 were CAD$392 billion and imports from the US were CAD$360 billion.[3]

In 2016, approximately 75 percent of Canada's total exports were destined south of the border and 66 percent of imported products came from the US.[4] A significant component of Canada's exports to the US are its exports of crude oil, crude bitumen and natural gas. The top import categories into the US (2-digit HS code) in 2016 were vehicles (US$58 billion), mineral fuels (US$54 billion), machinery (US$19 billion), special other (returns) (US$15 billion) and plastics (US$10 billion).[5]

Canadian foreign direct investment in the US was $474 billion in 2016 while the US' foreign direct investment in Canada totaled $392 billion in the same year.[6] US and Canadian bilateral investment stock totaled $866 billion.

Canada and the US share a deeply integrated economic relationship. In many respects, this interregional interdependence was formalized with the signing of the North American Free Trade Agreement (NAFTA), a trilateral trading agreement between Canada, Mexico and the US. The agreement came into effect on January 1, 1994 and was a natural expansion of the predecessor agreement, the Canada-United States Free Trade Agreement, signed in 1988.

The industrial sectors of both nations are inextricably linked. As such, changes in the relationship, whether commodity flows, changes in prices or policies, will have macro-level implications for both nations.

This study examines the economic impacts of the Canadian oil and natural gas industry on both the Canadian and US economies, down to the provincial and state levels. This study is timely,

[1] Statistics Canada, Imports, exports and trade balance of goods on a balance-of-payments basis, by country or country grouping, http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/gblec02a-eng.htm
[2] Office of the United States Trade Representative, Trade Agreements, US-Canada Trade Facts, https://ustr.gov/countries-regions/americas/canada
[3] Ibid. These totals do not include the foreign direct investment between Canada and the US.
[4] ibid
[5] ibid
[6] Statistics Canada, Table 376-0052, International investment position, Canadian direct investment abroad and foreign direct investment in Canada, by North American Industry Classification System (NAICS) and region, http://www5.statcan.gc.ca/cansim/a47

particularly as the first round of the North American Free Trade Agreement (NAFTA) renegotiations will be held in Washington on August 16-20, 2017.[7]

Both the US and Canada are important oil and natural gas producers. On a global scale, both rank in the top 5. However, what is more important is that both countries form an integrated North American system, linked together by dozens of gas and liquids pipelines. While Canada is currently a net exporter of both commodities, natural gas and oil flow in both directions, as do other goods and services critical to produce oil and gas in Canada.

It is the latter that is often overlooked – *Intermediary goods*. The US benefits from not only importing and refining petroleum products from western Canada, but also from supplying products and services used by the Canadian oil and gas industry. For example, components for trucks, gauges and valves are produced in central Canada or imported from the US. Products such as condensate, an ultra-light oil to help dilute bitumen from the oil sands, is an important commodity in Alberta and is also primarily imported from the US.

Utilizing the oil and gas production forecasts from CERI Study 159: "Canadian Crude Oil and Natural Gas Production and Supply Costs Outlook (2016-2036)" and Study 163: "Canadian Oil Sands Supply Costs and Development Projects (2016-2036)", economic impacts of Canadian oil and gas supply on the Canadian and US economies will be developed. The impacts on major macroeconomic variables in Canada will be determined using CERI's Canada Multi-Regional Input/Output model (CMRIO 4.0) in conjunction with the IMPLAN® (IMpact analysis for PLANning) Input/Output model for the state-level impacts of the US economy. Both I/O models are well-documented and well-respected tools utilized in many studies measuring economic impacts. Available from the Minnesota IMPLAN® Group, the IMPLAN® software package and database is commonly used by academia, industry and decision-makers alike.

The economic impacts will be shown at the provincial and state levels, as well as at the national levels; they will also be shown at the total impact level in conjunction with disaggregated level of direct, indirect and induced impacts.

It is important to note that the scope of this study is limited to the evaluation of upstream crude oil (including oil sands) and natural gas production and the resulting supply available for exports to the US. The scope does not, however, include economic impacts of building and operating infrastructure such as Keystone XL or expansion of the Trans Mountain system, nor any new construction of downstream facilities, such as refineries in the US that would process Canadian crude. This study does not employ a scenario-based analysis.

[7] The Globe and Mail. "What the U.S. wants from NAFTA talks". https://www.theglobeandmail.com///news/politics/what-the-us-wants-from-naftatalks/article35714358/?cmpid=rss1/?567

Background

This section provides a brief background on natural gas and crude oil in Canada, including a review of the current flow of crude oil and natural gas exports and imports between the two nations.

Natural Gas

Canada is an important player in natural gas production and is one of the largest natural gas producers in the world. Per the 2017 BP statistical review, Canada is ranked fifth in the world, producing 4.3 percent of world production, up 1.5 percent in 2016 over 2015,[8] ranking behind only the US (21.1 percent), Russia (16.3 percent), Iran (5.7 percent) and Qatar (5.1 percent).[9]

Canada's total annual average production in 2016 was 15.4 billion cubic feet per day (Bcfpd), up from 14.4 in 2015.[10] Natural gas production in Alberta (including conventional marketable natural gas, coalbed methane and shale gas) is the largest in Canada at 10.9 Bcfpd in 2016, up from 10.3 Bcfpd in 2015. Production is, however, down from 14.1 Bcfpd in 2006.[11]

In 2016, US total production averaged 77.3 Bcfpd, down from a record high of 78.8 Bcfpd in 2015 and up from 75.3 Bcfpd in 2014. According to the US Energy Information Administration (EIA),[12] leading the way in production in the US are Texas, Pennsylvania (reaping the rewards of shale gas), Oklahoma, Louisiana and Wyoming.

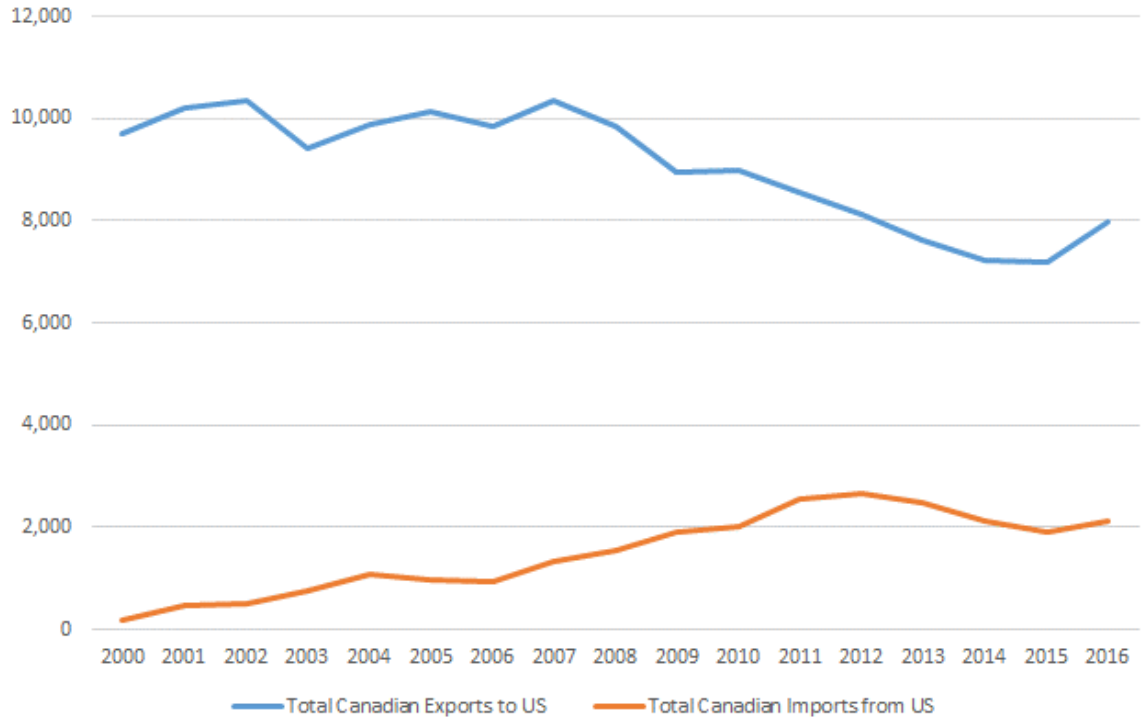
The growth of shale gas production has not only changed the flows of natural gas within the US but also on a continental scale. Flows of natural gas between Canada and the US are changing rapidly, directly impacting western Canadian producers, who are increasingly being displaced from traditional export markets.

Surplus natural gas is exported to the United States through an integrated pipeline network. Canada is ranked *fourth* globally, accounting for approximately 7 percent of the *world's total exports*, ranked behind Russia (19 percent), Qatar (11 percent) and Norway (11 percent).[13] In recent years, however, natural gas exports to the United States have declined.

[8] BP website, BP Statistical Review of World Energy June 2017, http://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/downloads.html, pp. 28.
[9] ibid
[10] Statistics Canada, Table 131-0001 Supply and disposition of natural gas, http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=1310001&paSer=&pattern=&stByVal=1&p1=1&p2=-1&tabMode=dataTable&csid=
[11] Finance Alberta, Marketable Natural Gas Production in Alberta, http://www.finance.alberta.ca/aboutalberta/osi/aos/data/Marketable-Natural-Gas-Production-AB.pdf
[12] US Energy Information Administration, Natural Gas, Natural Gas Gross Withdrawals and Production (Volumes in Million Cubic Feet converted to Bcfpd), Marketed Production, http://www.eia.gov/dnav/ng/ng_prod_sum_a_EPG0_VGM_mmcf_m.htm
[13] Natural Resources Canada, Energy Markets Fact Book 2016-2017, Natural Gas: International Context, https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/EnergyFactBook_2016_17_En.pdf, pp. 52.

Canada exports more natural gas than it imports, but the gap between the two is diminishing as a result of decreasing western Canadian gas exports to the US and increasing imports from the US to eastern Canada. This is due to lower cost Marcellus gas being closer to markets in central Canada, the US Northeast and US Midwest, giving it cost advantages over western Canadian gas.[14] While the rapid increase in production of the Marcellus is good news for gas producers and supporting industries in Pennsylvania and nearby states, the flood of lower cost Marcellus gas, and to a lesser extent the Utica Shale, has had a profound effect on North American gas flows. Western Canadian gas is being displaced in central Canada and the US Northeast.[15] This dynamic is illustrated in Figure 1.1.

Figure 1.1. Canadian Gas Exports and Imports with US (MMcfpd)



Source: EIA[16,17] and CERI

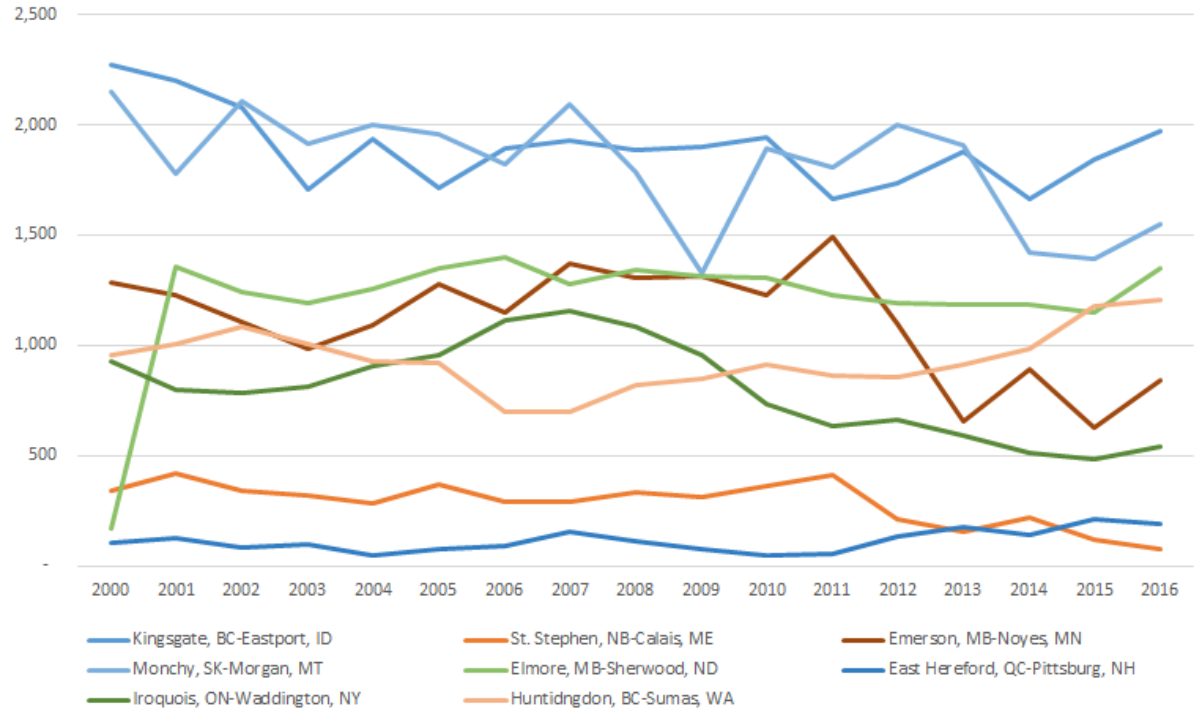
Exports to the US reached 10,370 MMcfpd in 2002 and 10,364 MMcfpd in 2007, but decreased dramatically between 2008 and 2015, from 9,833 MMcfpd to 7,193 MMcfpd, respectively. Exports, however, rebounded slightly in 2016 (7,976 MMcfpd). This decrease coincides with the shale boom in the US, particularly with the rapid increase in natural gas production of

[14] Platt's website, Gas Daily, Marcellus to displace Rockies, Canada gas: Bernstein, May 13, 2015, https://online.platts.com/PPS/P=m&e=1431562255713.2709137032677465172/GD_20150513.xml?artnum=c60d69e2f-ba44-469e-9feb-4b069e58d1ba_16 (Accessed on February 14, 2016)
[15] ibid
[16] US Energy Information Administration, US Natural Gas Exports and Re-Exports by Point of Exit (Million Cubic Feet), https://www.eia.gov/dnav/ng/ng_move_poe2_a_EPG0_ENP_Mmcf_a.htm
[17] US Energy Information Administration, US Natural Gas Imports by Point of Entry (Million Cubic Feet), https://www.eia.gov/dnav/ng/ng_move_poe1_a_EPG0_IRP_Mmcf_a.htm

unconventional sources. In 2007, Canadian imports were at 1,321 MMcfpd, increasing dramatically to 2,660 MMcfpd in 2012, where the imports decreased to 2,113 MMcfpd in 2016.

The largest exporting pipelines by point of exit (and the name of the operator in Canada-US) are: Kingsgate, BC-Eastport, ID (TransCanada Pipelines & Westcoast Energy-Gas Transmission Northwest), Monchy, SK-Morgan, MT (Foothills Pipe Lines-Northern Border Pipeline), Elmore, MB-Sherwood, ND (Alliance Pipeline Canada and Alliance USA), Huntingdon, BC-Sumas, WA (Westcoast Energy-various pipelines[18]), Emerson, MB-Noyes, MN (TransCanada Pipelines-Great Lakes Gas Transmission Company & Viking Gas Transmission), Iroquois, ON-Waddington, NY (TransCanada Pipelines-Iroquois Gas Transmission), East Hereford, QC-Pittsburg, NH (Trans Quebec & Maritimes-Portland Natural Gas Transmission System) and St. Stephen, NB-Calais, ME (Maritimes & Northeast Pipeline Canada & US).[19] The export volumes of the various points of entry/exit are illustrated in Figure 1.2.

Figure 1.2. Canadian Export Volumes by Point of Exit/Entry (MMcfpd)



Source: EIA[20] and CERI

[18] Pipelines include: Northwest Pipeline, Sumas Pipeline USA, Sumas International Pipeline, Sumas-Cascade Pipeline and Ferndale Pipeline

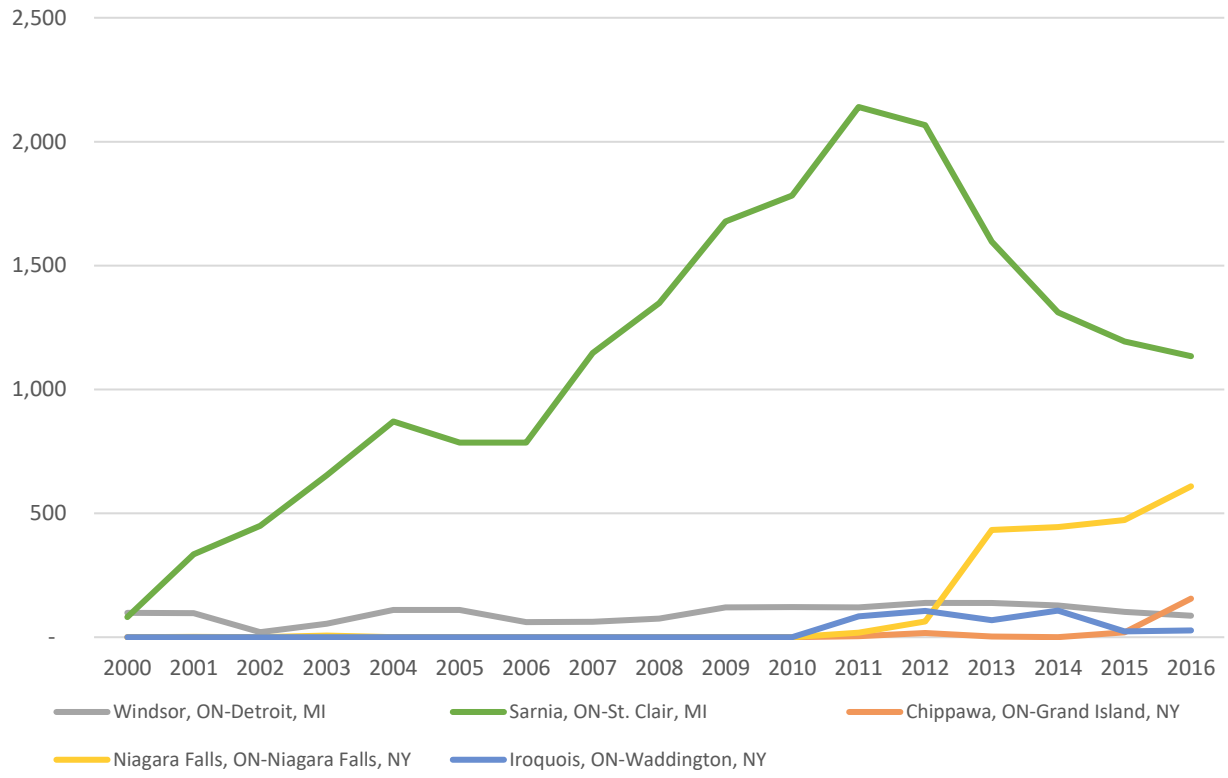
[19] US Department of Energy website, Fossil Energy, Table 1, Natural Gas Pipeline Points of Entry/Exit and Transporters, http://www.fe.doe.gov/programs/gasregulation/analyses/qrsections/pdf/Table_1_POEE-Trasporters__Rev_8-27-12.pdf

[20] US Energy Information Administration, US Natural Gas Imports by Point of Entry (Million Cubic Feet), https://www.eia.gov/dnav/ng/ng_move_poe1_a_EPG0_IRP_Mmcf_a.htm

The largest importing pipelines by point of entry are: Sarnia, ON-St. Clair, MI, Niagara Falls, ON-Niagara Falls, NY, Chippawa, ON-Grand Island, NY, Windsor, ON-Detroit, MI and Iroquois, ON-Waddington, NY. It is interesting to note that the flow at Iroquois-Waddington has reversed over the past decade, primarily exporting natural gas until 2010. The same is true for the Niagara Falls border point. The pipeline primarily exported natural gas to the US until 2010.

Import volumes by point of entry/exit are shown in Figure 1.3.

Figure 1.3: Canadian Import Volumes by Point of Entry/Exit (MMcfpd)

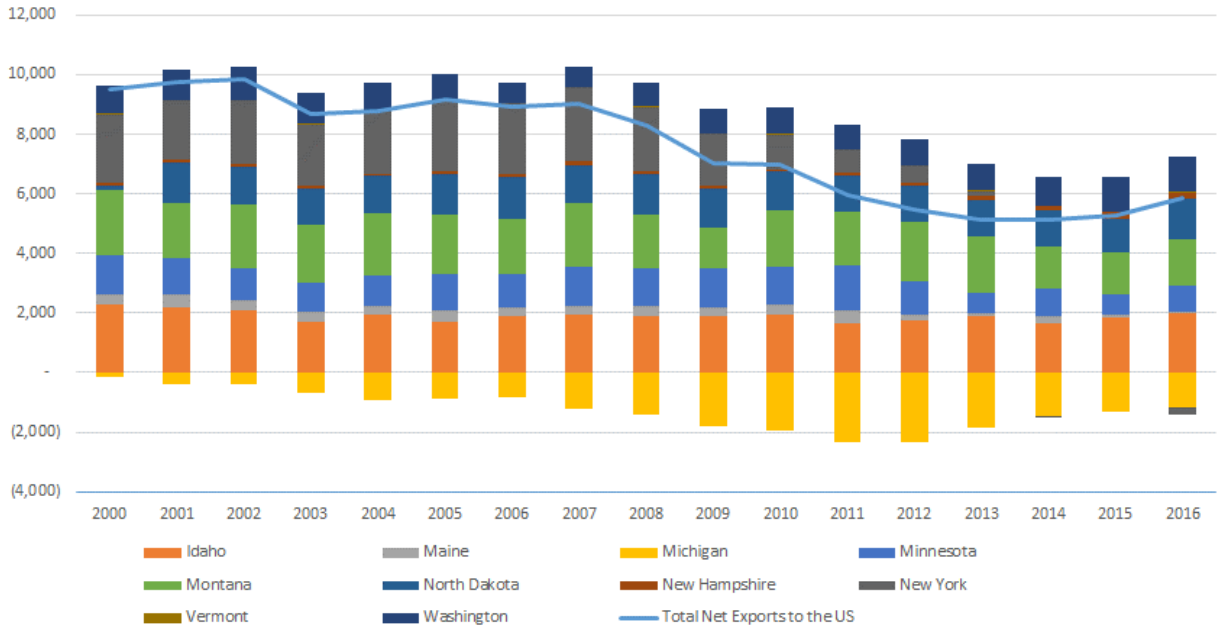


Source: EIA[21] and CERI

Figure 1.4 illustrates Canadian natural gas net exports to the US by state. The largest net exports by state in 2016 include Idaho (1,975 MMcfpd), followed by Montana (1,351 MMcfpd), North Dakota (1,351 MMcfpd) and Washington (1,189 MMcfpd). Most natural gas entering Canada comes in from Michigan and New York. There are several large pipelines in the Sarnia, Ontario area, delivering natural gas to the Dawn, Ontario market hub. These include Courtright (Vector Pipeline), Niagara Falls (TransCanada Pipelines), Ojibway (Windsor) (Union Gas) and Sarnia (TransCanada Pipelines).

[21] US Energy Information Administration, US Natural Gas Exports and Re-Exports by Point of Exit (Million Cubic Feet), https://www.eia.gov/dnav/ng/ng_move_poe2_a_EPG0_ENP_Mmcf_a.htm

Figure 1.4. Canadian Natural Gas Net Exports to the US (Entry by State) (MMcfpd)



Source: EIA[22,23] and CERI

Crude Oil

World oil proved reserves are 1,706.7 billion barrels as of the end of 2016; of that total, Canada is ranked third, at 171.5 billion barrels, or 10.0 percent of the world's share of proved reserves.[24] Canada's proved reserves are only behind Venezuela (300.9 billion barrels) and Saudi Arabia (266.6 billion barrels).[25] Canada is also the fifth largest oil producer in the world, accounting for 4.8 percent of world production in 2016, ranking behind the US (13.4 percent), Saudi Arabia (13.4 percent), Russia (12.2 percent) and Iran (5.0 percent).[26] Iraq and China also account for 4.8 and 4.3 percent of world production, respectively.

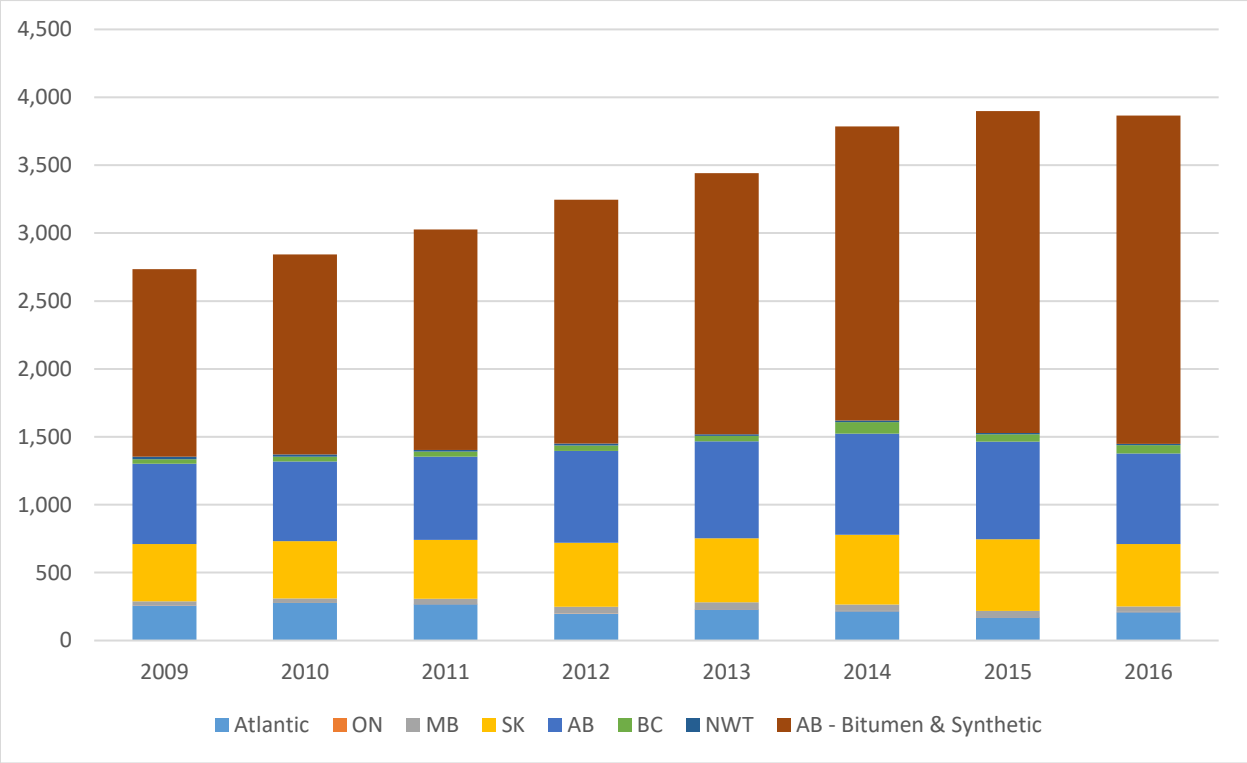
Canada's total oil production in 2016, including bitumen and synthetic, was 3,872 thousand barrels per day (Mbpd), slightly higher from 3,869 Mbpd in 2015 and up from 2,698 Mbpd in 2009.[27] Canada's total conventional (including light, C5+/condensate and heavy) oil production in 2016 was 1,448 Mbpd, led by 666 Mbpd in Alberta, 461 Mbpd in Saskatchewan and 210 Mbpd in Atlantic Canada.[28] Alberta oil sands production, including bitumen and synthetic production,

[22] ibid
[23] US Energy Information Administration, US Natural Gas Imports by Point of Entry (Million Cubic Feet), https://www.eia.gov/dnav/ng/ng_move_poe1_a_EPG0_IRP_Mmcf_a.htm
[24] BP website, BP Statistical Review of World Energy June 2017, http://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/downloads.html, pp. 12.
[25] ibid
[26] ibid
[27] NEB, Crude Statistics
[28] ibid

totals 2,418 Mbpd, slightly higher from 2,381 Mbpd in 2015 but still up from 1,335 Mbpd in 2009.[29]

Figure 1.5 illustrates total oil production in Canada from 2009 to 2016. Canadian conventional production includes light, C5+/condensate and heavy crude oil production and is indicated by producing province while Alberta's oil sands production (dark red) includes bitumen and synthetic.

Figure 1.5: Canadian Crude Oil Production by Province (Conventional + Oil Sands) (Mbpd)

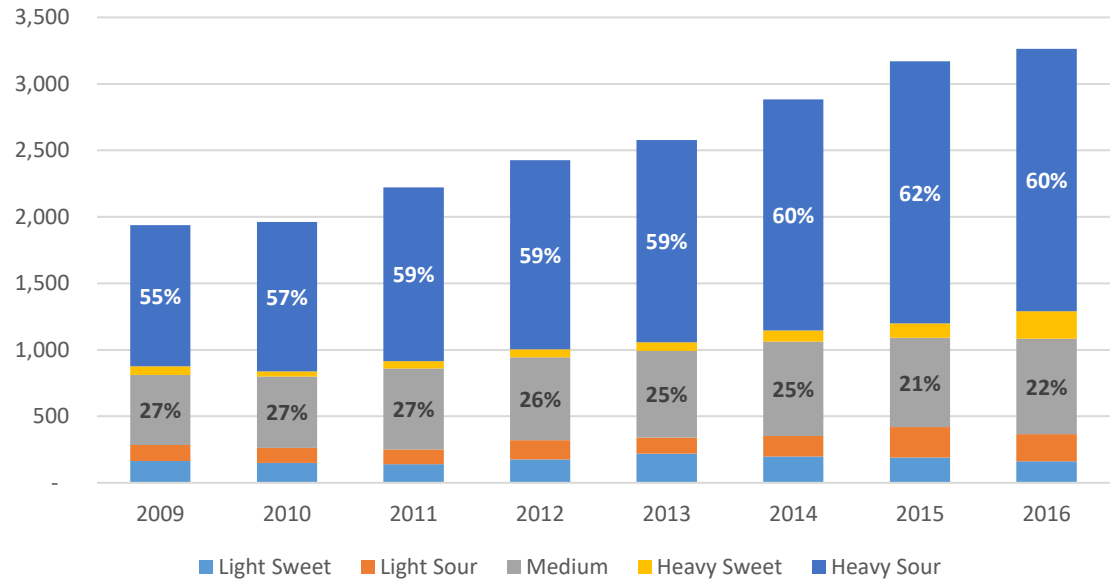


Source: NEB[30] and CERI

Canada is a significant exporter of crude oil, with most oil exported to the US. Figure 1.6 illustrates US imports from Canada by type. Total imports from Canada in 2016 are 3,264 Mbpd, up from 3,169 Mbpd in 2015 and up from 1,939 Mbpd in 2009.[31] The largest share is from heavy sour bitumen, accounting for 60 percent of type of crude imported. Heavy sour imports increased from 1,063 Mbpd in 2009 to 1,970 Mbpd in 2016.[32]

[29] ibid
[30] National Energy Board, Estimated Production of Canadian Crude Oil and Equivalent, https://www.neb-one.gc.ca/nrg/sttstc/crdlndptrlmprdct/stt/stmtdprdctn-eng.html
[31] ibid
[32] ibid

Figure 1.6: US Imports from Canada by Crude Type (Mbpd)

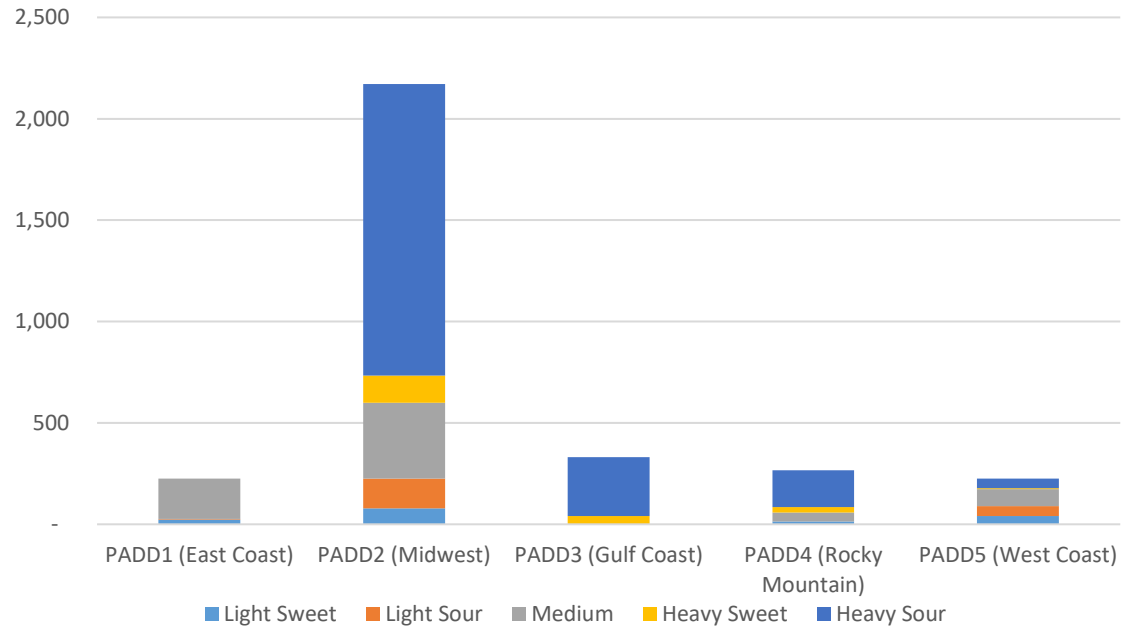


Source: EIA[33]

Figure 1.7 shows which US regions import crude from Canada by type of crude. Most Canadian exports are destined for the US Midwest. In 2016, PADD 2 imported a total of 2,172 Mbpd, including 1,438 Mbpd of heavy sour, 73 percent of the total imported in 2016.[34] Interestingly, 71 percent of the total light sour imported into the US from Canada is destined for PADD 2 refineries while 64 percent of heavy sweet is imported into PADD 2.

[33] US Energy Information Administration, Crude Imports, https://www.eia.gov/petroleum/imports/browser/#/?vs=PET_IMPORTS.WORLD-US-ALL.A
[34] ibid

Figure 1.7: US Imports from Canada by Region, 2016 (Mbpd)



Source: EIA[35]

In 2016, while 290 Mbpd of Canadian heavy sour was imported into PADD 3, currently most of the Gulf Coast refining demand is met with heavy sour from South and Central America, 659 Mbpd from Venezuela, 557 Mbpd from Mexico and 202 Mbpd from Colombia.[36]

It is interesting to note that until recently, most heavy barrels from Alberta and Saskatchewan moved to refineries in the US Midwest, but pipeline construction and reversals (Seaway twin, TCPL's Gulf Coast extension and Flanagan) have opened more than 1,200 Mbpd of transport capacity from the Midwest – especially Cushing, Oklahoma – and the Gulf Coast to support market access for western Canadian crude oil to the Gulf Coast refining hub.

This substantially alleviated the "Cushing congestion" and the differential between WTI and Western Canadian Select (WCS), a benchmark for Canadian heavy output, has returned to historical values, dropping from an all-time high of US$40/bbl to around US$15/bbl. The latter historically represents the crude quality difference. The "Cushing congestion" occurred in part as US tight oil production increased. The oil flooded the US with extra crude supply, squeezing the outflow pipeline capacity at the Cushing hub. The price for WTI at the hub, which had historically run in close parity with an international benchmark, North Sea Brent, became depressed and started to disconnect from the global benchmark. Discounts deepened, affecting essentially all inland lower-48 crude grades, as well as WCS (since it is priced off WTI).

[35] ibid
[36] ibid

Canadian crude oil imports rose slightly in 2016 to reach 759 Mbpd.[37] Total imports from the US in 2016 were 411.8 Mbpd, with the majority destined for Quebec (91.0 Mbpd), followed by Ontario (85.0 Mbpd), Alberta (56.3 Mbpd), Saskatchewan (50.0 Mbpd), Newfoundland (49.0 Mbpd) and New Brunswick (34.4 Mbpd).[38] Eastern Canadian provinces utilize the oil for their local refineries, but that is where the similarities stop. Each province has very different dynamics as to the origin of crude oil used for feedstock. For example, in 2016, Quebec received crude from Algeria (83.9 Mbpd), Kazakhstan (19.2 Mbpd) and Nigeria (10.5 Mbpd) while New Brunswick received crude from Saudi Arabia (86.7 Mbpd), Nigeria (45 Mbpd) and Norway (26.4 Mbpd).[39] Western Canadian crude oil imports, all from the US, increased 152 Mbpd in 2016.[40] Most of this is attributable to increased imports of diluent, or condensate, a natural gas liquid or light oil. Condensate is mixed with oil sands bitumen to dilute the latter, better facilitating transportation by pipeline.

Organization of the Report

Chapter 1 highlights the background of the study and presents the objective and scope, as well as introduces the key statistics of upstream natural gas and oil activities. The structure of the study is also discussed.

Chapter 2 is divided into two parts. The first reviews the methodology and assumptions used in modeling economic impacts, including those utilized in CERI's proprietary CMRIO 4.0 model and the IMPLAN® model. The second part reviews production forecasts and capital and operations investment forecasts, for all three commodities (crude oil, oil sands and natural gas). These assumptions are inputs into CERI's I/O model.

Chapters 3 and 4 discuss the results of the various models for the Canadian and US economies, respectively. The results illustrate the impacts of the Canadian oil and gas industry on Canada and the US over the 11-year period (2017-2027). Economic impacts for Canada under consideration include economy-wide impacts such as value-added gross domestic product (GDP), jobs created (given in person-years, one person year being one person working for one year), as well as various forms of government revenue, including indirect, personal and corporate taxation revenues. Royalty revenues and revenues from land sales are not included in the impact assessment. Economic impacts for the US include impacts on gross state product (GSP) and jobs created or sustained (given in full-time equivalent job count). Economic impacts are broken down to the provincial and state level.

[37] National Energy Board, Market Snapshot: Canadian crude oil imports from the U.S. decline in 2016, overseas imports increase, February 21, 2017, https://www.neb-one.gc.ca/nrg/ntgrtd/mrkt/snpsht/2017/02-04cndncrlmprtsdcln-eng.html?=undefined&wbdisable=true

[38] Statistics Canada, Canadian International Merchandise Trade Database, http://www5.statcan.gc.ca/cimt-cicm/home-accueil?lang=eng

[39] ibid

[40] ibid

Chapter 5 summarizes the results and Appendices A and B present more detailed information on the models and detailed US results, respectively.

Chapter 2: Methodology and Assumptions

This chapter is divided into two parts. The first part reviews the methodology used in modeling economic impacts, including those utilized in CERI's proprietary CMRIO 4.0 and the IMPLAN® model (IMPLAN® Pro Version 3.1), and is subsequently divided into two sections: 1) discussing the methodology of CERI's CMRIO model and the IMPLAN® model, and 2) reviewing various general assumptions and constraints of the I/O model in general. The former measures the economic impacts of Canada and its provinces while the latter measures the economic impacts of the US, down to the state-level. This study integrates the two separate models.

The second part reviews the assumptions regarding the relevant capital investments and operations for three production forecasts (crude oil, oil sands and natural gas). This section also reviews capital and operations forecasts: Canadian oil and natural gas production forecast, the investment forecast, the operations forecast and price forecasts for natural gas and oil. These assumptions are inputs into the two aforementioned I/O models.

CERI's Canada Multi-Regional Input-Output Model and the IMPLAN® Model

Methodology

There are several ways to estimate the impact of the Canadian oil and gas industry on the Canadian economy as well as the US economy. This type of analysis is usually done using some form of a General Equilibrium model, useful models to evaluate the impact of economic or policy shock in the economy as a whole.[1] The results of this study are computed using CERI's CMRIO 4.0 Model, a computable version of the Walras General Equilibrium model, as well as the IMPLAN® model.

Input/Output analysis in general addresses the way economic circumstances in one part of an economy can ripple through the rest of it. In particular, it is concerned with inter-industry relationships, notably the use of output from industry as an input into another industry's production process. The model determines an approximate impact on various economic variables due to the introduction to the economy of a particular set of expenditures or 'shocks'. In the case of resource or infrastructure developments, the expenditures include those for the investment and operation phases of the project. An I/O model is one way to estimate the economic impact of a set of expenditures.

[1] General equilibrium modeling reproduces the structure of the whole economy and therefore the nature of all existing economic transactions among diverse economic agents (productive sectors, households, and the Government, among others). Moreover, computable general equilibrium (CGE) analysis, in comparison to other available techniques, captures a wider set of economic impacts derived from a shock or the implementation of a specific policy reform. In that sense, the CGE approach is especially useful when the expected effects of economic activity implementation are complex and materialize through different transmission channels.

Any activity that leads to increased production capacity in an economy has two components or phases: a) the construction or development of the capacity, and b) the operation of the capacity to generate outputs. The first component is referred to as the investment phase, while the second is referred to as the operation phase. Both activities affect the economy through purchases of goods and services, as well as labour. The construction phase represents short-term activity and hence leads to short-term temporary impacts; whereas, operations and management of a facility are typically continuous. Because of the differing lifespan of these phases, the construction and operations are evaluated and entered into the model separately.

The first step is to estimate and forecast the value of investment (i.e., construction or development expenditure) and operations. The total investment is then disaggregated into purchases of various goods and services directly involved in the production process (i.e., manufacturing, fuel, business services, etc.) as well as labour required, using the expenditure shares. Hence, these are the economic impacts on value-added GDP, jobs and tax revenues that occur during the construction of the energy producing facilities (i.e., pipelines).

The second step is to estimate and forecast the value of total operations from an economic activity (i.e., conventional oil or gas production, petroleum refinery, etc.) that is allocated to the purchase of goods and services, payment of wages, payments to government (i.e., royalty and taxes), and other operating surplus (profits, depreciation, etc.). Likewise, these are the economic impacts on value-added GDP, jobs and tax revenues that occur during the operation of the energy producing facilities. It is important to note that CERI utilizes producer's gross revenues as proxy for operations.

The forecasted values of investment and operations are then used to estimate demand for the various goods and services and labour used in both phases. These demands are met through two sources: a) domestic goods production, and b) goods and imports. Domestic contents of the goods and services are calculated using Statistics Canada's data.

Impacts are calculated for Canada and the US, broken down to the provincial- and state-level. As mentioned, economic impacts under consideration include economy-wide impacts such as value-added GDP, jobs created and preserved (given in thousands of person-years) and various forms of government tax revenues. The latter includes indirect, personal and corporate taxation revenues, on the provincial level and the Federal level.

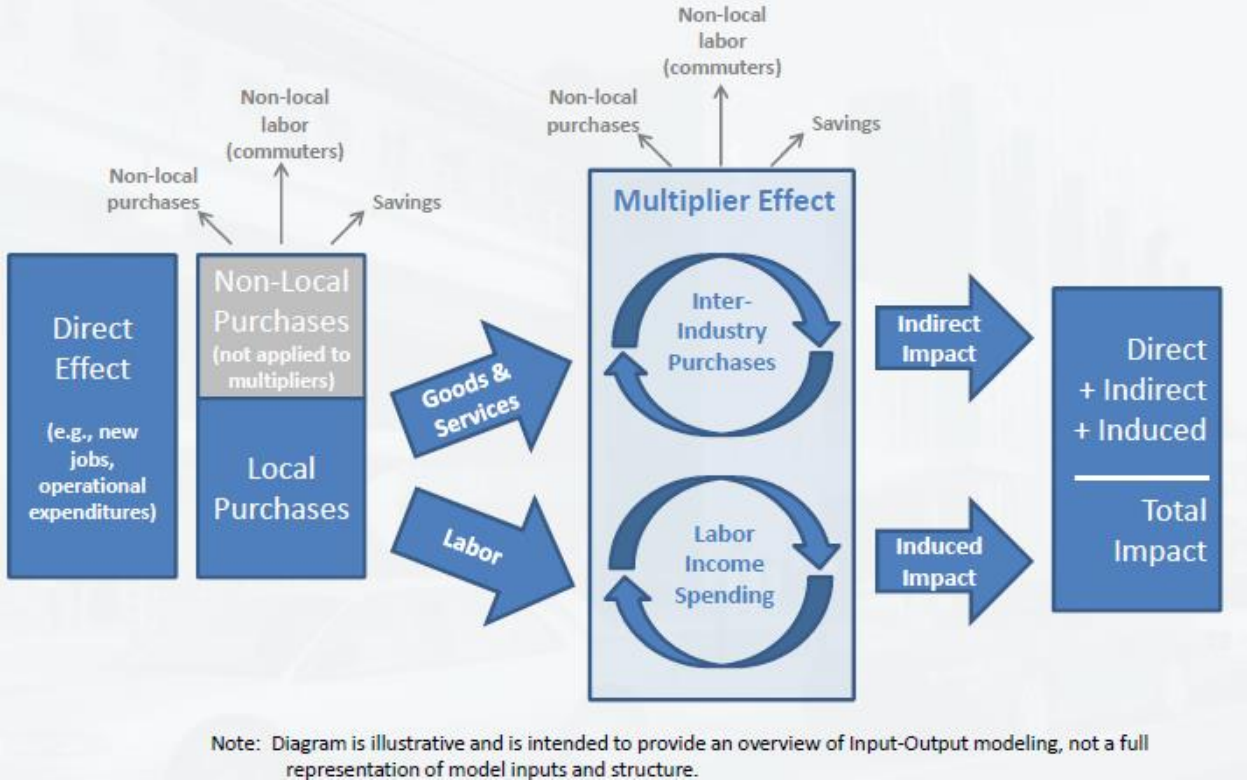
An important part of the I/O models are the multipliers as well as their three effects or components: direct, indirect and induced. Multipliers are at the core of I/O analysis, whether utilizing the CMRIO 4.0 or the IMPLAN® software. They essentially describe a rate of change, how a change in one industry, whether a change in policy or an injection or shock, impacts the overall economy.[2] In other words, how changes in final demand for a particular industry impacts other

[2] IMPLAN website, General Information About Multipliers, http://support.implan.com/index.php?option=com_content&view=article&id=212:212&catid=222:222

industries, in terms of measuring changes in GDP, tax revenue or employment. These multipliers "assess the level of linkages between cooperatives and the larger economy".[3]

Figure 2.1 illustrates the general I/O modeling approach.

Figure 2.1. I/O Modeling Approach: Conceptual Overview



Source: AKRF[4]

The effects of the multipliers can be captured by three separate effects: direct, indirect and induced. Direct impacts are quantitative estimations of the main impact of the program, in the form of an increase in final demand (increase in public spending, increase in consumption, increase in infrastructure investment, etc.). An example of direct effects would be how many jobs are created by a $5 million increase in production in the oil and gas sector, measured by the number of employees in the particular sector. Indirect effects measure the effects of the $5 million increase in production in the oil and gas sector created by the producers of intermediate goods and services. The number of jobs created associated with the industries that provide goods and services in industries ranging from engineering firms to finance and insurance. Rather than employees in the oil gas sector, they are employees of suppliers to the oil and gas sector. Induced effects are generally spending in the local economy by the households or employees of direct and indirect effects. Induced employment manifests in industries such as wholesale and retail

[3] University of Wisconsin Center for Cooperatives, IMPLAN Methodology, http://reic.uwcc.wisc.edu/implan/
[4] IMPLAN, RIMS-II, and REMI Economic Impact Models: Comparisons, in Context of EB-5 Analysis, Prepared by AKRF, Inc. May 2013, pp. 4.

trade, education or medical services, or activities that are generated more by household spending on additional goods and services.[5] This is illustrated in Figure 2.1.

Both CERI's CMRIO 4.0 and the IMPLAN® model allow the user to measure or estimate economic impacts, identifying direct impacts by sector, followed by developing indirect and induced impacts by sector.[6]

Similar to CERI's CMRIO 4.0, the IMPLAN® model is also used to estimate economic impacts. Originally developed by the US Forest Service, in cooperation with the Federal Emergency Management Agency and the US Department of the Interior's Bureau of Land Management, the IMPLAN® model has been offered by the Minnesota IMPLAN® Group since 1993.[7] It has been utilized by universities, companies and governments to estimate economic and fiscal impacts of investments or changes in various industries, and their subsequent impact on GSP, tax revenue and employment.

IMPLAN® (IMpact analysis for PLANning) is a computer software package that provides data and tools to measure economic impacts.[8]

The database stems from the system of national accounts for the US and is based on data collected by the US Department of Commerce, the US Bureau of Labour Statistics, the US Census Bureau and other federal and state government agencies.[9] The IMPLAN® database consists of: 1) a US-level technology matrix, and 2) estimates of sectoral activity for final demand, final payments, industry output and employment for each county in the US, along with state and national totals.[10] The data is collected for 528 producing industry sectors, following the Standard Industrial Categories (SICs).[11] Data is available from the zip code level up to the national level.

This study utilizes the IMPLAN® Pro Version 3.1 with 2015 Input-Output dataset. National and state data are used, comparable to the national and provincial data used for CERI's model.

This study is unique in that it integrates the two models, reflecting the idea that not only are the US and Canada important oil and natural gas producers, but that both countries form a North American system, linked together by thousands of transactions of goods and services purchases. While Canada is currently a net exporter of both commodities, natural gas and oil flow in both directions, as do other commodities critical to produce oil and gas in Canada.

[5] IMPLAN website, General Information About Multipliers, http://support.implan.com/index.php?option=com_content&view=article&id=212:212&catid=222:222
[6] ibid
[7] http://edis.ifas.ufl.edu/fe168
[8] Frances Day, Principles of Impact Analysis and IMPLAN Applications, First Edition, pp. 7.
[9] IMPLAN website, United States Data, http://www.implan.com/data/
[10] IMPLAN, Economic Models: Input-Output Modeling (with IMPLAN), Tools and Documents: MIG Inc.
[11] David Mulkey and Alan W. Hodges, University of Florida IFAS Extension, Using IMPLAN to Assess Local Economic Impacts, http://edis.ifas.ufl.edu/fe168

While the benefits of the Canadian oil and gas industry across Canadian provinces is relatively straightforward and well documented, the benefits of the Canadian oil and gas industry across *both* Canadian provinces and US states are lesser reported. The US benefits from not only importing and refining petroleum products from western Canada, but also from supplying products and services used by the Canadian oil and gas industry in order to maintain or grow oil and gas production.

In 2013 (which is used as a base year as it is the most recent data available from Statistics Canada), the Canadian oil and gas production sector imported CAD$6.5 billion worth of products and services from the US, which include goods that the US imported from other countries and then re-exported to Canada. Supply of those products and services spur economic activities and create jobs in respective exporting US states. In this research, CERI quantifies those economic benefits by using the input-output tables of Canadian provinces and US states. The following describes the methodology utilized in this study.

In addition to Statistics Canada I/O tables, CERI also uses international trade data provided by Statistics Canada and Industry Canada.[12] The trade data is used to identify the value of imports from different US states by the Canadian conventional oil and gas sector, the Canadian unconventional oil production sector, the oil and gas support sector, as well as the oil and gas engineering construction sector.

Using the 2013 detailed-level provincial supply and use tables,[13] CERI identified the products and services used by each of the aforementioned sectors. Using the supply table, CERI then estimated the amount sourced through international imports. However, in order to quantify US state-level economic impacts, the amount imported from suppliers in different US states needs to be estimated. An important tool is the Harmonized System (HS) code of different products and services. This was done by using a concordance table obtained from Statistics Canada. This provided the linkage between Canadian input-output product codes (IUPC) and the HS codes.

CERI then uses the international trade database to estimate the fraction of imports from individual states by product or service and by importing industry sector (i.e., conventional oil and gas extraction, unconventional oil extraction, etc.). Using the estimated fractions, CERI calculated the total exports to a Canadian industry sector by industries (categorized by North American Industry Classification system or NAICS code) in a given US state.

This baseline dataset, along with capital and operations forecasts are then used with the IMPLAN® model to estimate the economic impacts pertaining to production of products and services imported by Canadian oil and gas operations from individual states.

[12] Government of Canada, Trade Data Online, http://www.ic.gc.ca/eic/site/tdo-dcd.nsf/eng/Home

[13] Statistics Canada, Supply and Use and Input-Output Tables; http://www.statcan.gc.ca/eng/nea/list/io. Tables were obtained from Industry Accounts Division of Statistics Canada.

Assumptions and Limitations

While the I/O model is useful, no model is ideal. The I/O modeling approach does suffer from several shortcomings. This section discusses various assumptions and limitations to the I/O analysis in general.

There are two main assumptions. The first assumption of any I/O analysis is that the economy is in equilibrium. Despite partial equilibrium analysis, it is assumed in the general equilibrium approach that the economy as a whole is in equilibrium. This is a realistic assumption in the long run, as it is difficult to imagine an economy remaining in disequilibrium for a long period of time.

A second important assumption in the I/O analysis is the linear relationship between inputs and outputs in the economy. Each sector uses a variety of inputs in a linear fashion in order to produce various final products under the assumption of fixed proportions. Though the form of the "Leontief production function" is simple, it could be viewed as an approximation of the real world's production function. Unlike other production functions, the Leontief production function contains no provision for substitution among inputs. A very interesting aspect of this assumption is the constant return to scale property of the Leontief production function, which turns out to be a proven property in the real-world economy. Though the linearity of the production function gives a constant average and marginal products, these are justified if the analysis focuses on the medium term. Long run changes in the economy (beyond 20 years) may affect the fixed relationship between sectors.

Although the I/O approach has been widely used around the world for economic impact assessment, there are certain limitations that should be noted. Several other well-known limitations of the I/O approach are discussed below.

Static relationships

I/O coefficients are based on value relationships between one sector's outputs to other sectors. The relationship and, thus, the stability of coefficients, could change over time due to several factors including:

- Change in the relative prices of commodities;
- Technological change;
- Change in productivity; and
- Change in goods production scope and capacity utilization.

Since these attributes cannot be incorporated in a static I/O model, these models are primarily used over a short-run time horizon, where relative prices and productivity are expected to remain relatively constant.

Because the most recent data for I/O tables is 2013 data, the model, due to its static nature, estimates the future economic impacts based on the 2013 relationships and general state of the economy. If significant structural changes have happened or will happen between 2013 and other

years going forward, these elements will not be captured by the model and hence the results could be either over- or under-estimated.

Unlimited resources or supplies

The I/O approach simplistically assumes that there are no supply or resources constraints. In reality, increasing economic activities in a particular sector of the economy may put pressure on wages and energy prices in the short run. However, in the long run, the economy adjusts through the mobility of the factors of production (i.e., labour and capital).

Lack of capacity to capture price, investment, and production interactions

An I/O model is incapable of representing the feedback mechanism among price change, investment, and operations. For example, an increase in oil price provides a signal to drivers to consume less gasoline or drive a more fuel-efficient car. This response would in turn impact car manufacturing, the oil refining industry and tourism. However, this type of interaction cannot be modeled in a simple I/O model.

Lack of supporting data

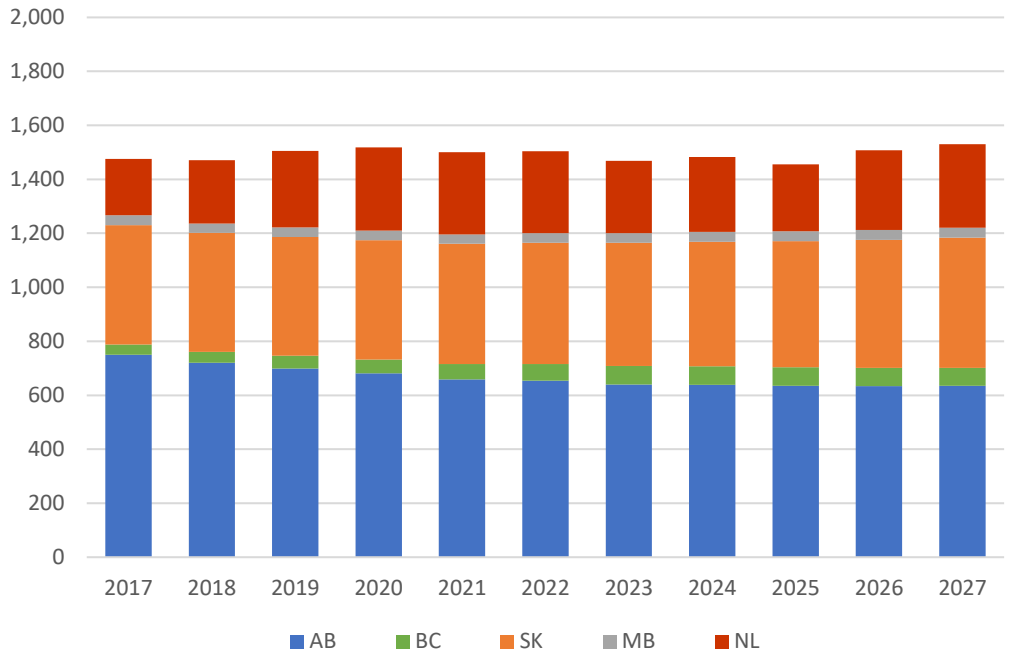
There are segments of energy information that cannot be quantified due to lack or confidentiality of Statistics Canada data. These data are either estimated by using other sources or have been incorporated in aggregate levels without damaging the Input-Output model's integrity or functionality. Therefore, several assumptions have been made on a case-by-case basis for every province or the US. The energy data from Statistics Canada in many cases are incomplete and energy tables are imbalanced due to lack of, or confidentiality of, data. Also, energy definitions used by Statistics Canada are not necessarily consistent with provincial and company sources. For instance, pentanes plus in Statistics Canada's Energy Supply and Demand tables (57-003-X) is included under oil, while in provincial sources it is under Natural Gas Liquids (NGLs).

Modeling Assumptions for Impact Modeling

This section reviews the assumptions regarding the relevant capital investments and operations for oil and gas activities in Canada, providing three production forecasts (for crude oil, oil sands and natural gas) as well as capital and operations forecasts by province. The latter includes Alberta, British Columbia, Saskatchewan, Manitoba and Newfoundland & Labrador. Nova Scotia, New Brunswick, Quebec, Ontario and the Territories are not included due to their small or rapidly dwindling production levels. The former is the case of dwindling gas production, as the Sable Offshore Energy Project and Deep Panuke will be decommissioned in 2022, but likely earlier.

Figure 2.2 shows the conventional crude oil production forecast in Canada between 2017 and 2027 taken from CERI Study 159: "Canadian Crude Oil and Natural Gas Production and Supply Costs Outlook (2016-2036)".

Figure 2.2: Canadian Crude Oil Production Forecast (Mbpd)



Production levels are not expected to reach the highs seen in 2014, prior to the decline in oil price, from a WTI market price of US$105 per barrel ($/bbl) in June 2014, down to a low point of US$30/bbl in February 2016, before settling out between US$45-55/bbl.[14] The declines in commodity prices have certainly had a negative effect on conventional oil production. Total production, however, will remain fairly stable through the remainder of the study period, with slight declines in Alberta being offset from an increase in production from Saskatchewan. The latter is expected to focus on drilling in the Bakken, a tight oil formation. The Bakken is primarily located in Montana and North Dakota, but it extends into southern Saskatchewan and into the southwestern corner of Manitoba. While the Bakken Shale is the most prolific, other tight oil plays in the Western Canadian Sedimentary Basin (WCSB) include Cardium, the Viking Formation and Slave Point.

Offshore Newfoundland oil production will also increase – albeit slightly – over the study period. Total crude oil production will increase until 2019 as the Hebron asset is added and starts to produce. After 2019, Hebron's annual production is set to decline steadily throughout the length of the study period, with Terra Nova set to come offline in 2030.

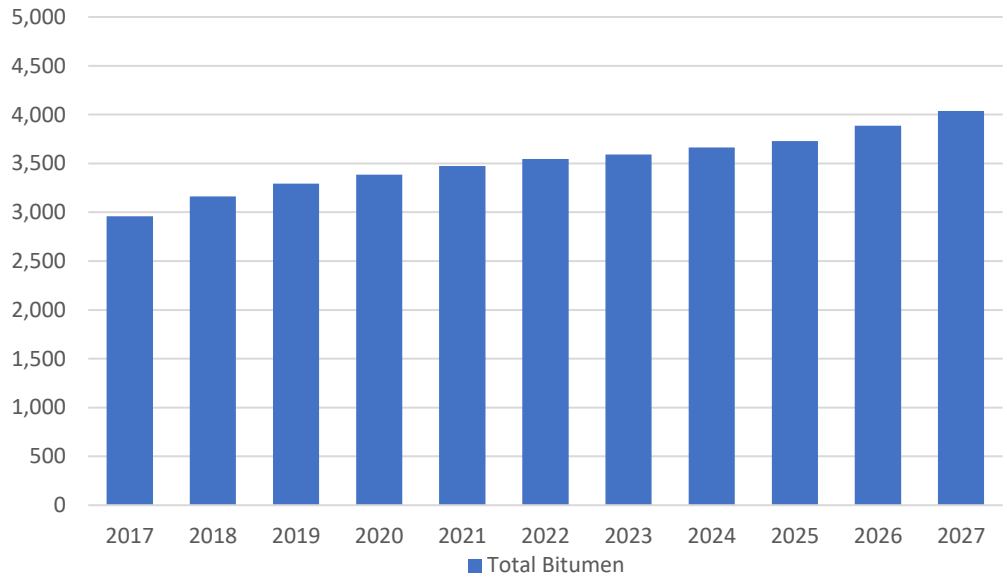
CERI predicts continuously declining levels of crude production out of British Columbia owing to the generally unfavourable well supply costs and a preference for targeting natural gas rather

[14] US Energy Information Administration, Crude Oil, WTI Spot Price FOB, Monthly, June 29, 2016, http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=rwtc&f=m

than crude oil. Production of C5+/condensate is expected to rise through 2023 and then remain stable.

Recall, total production from the oil sands areas totaled 2,365 Mbpd in 2016, up from 1,265 Mbpd in 2007. In 2016, this is comprised of in situ (thermal and cold bitumen) production of 1,364 Mbpd and mining production of 1,002 Mbpd (810 Mbpd integrated mining and extraction and 192 Mbpd of mining and extraction). Production from oil sands includes an increasing share of Alberta's and Canada's crude oil production. The extraction of Alberta's oil sands is currently based on two methods: in situ and mining. In situ recovery consists of primary recovery, thermal recovery, solvent-based recovery, and hybrid thermal/solvent processes. Surface mining and extraction[15] could be either a stand-alone mine or integrated with an upgrader. Within in situ and mining methods, various technologies to extract valuable bitumen from the oil sands are utilized.[16] Figure 2.3 illustrates the oil sands production forecast from 2017 to 2027 from CERI Study 163: "Canadian Oil Sands Supply Costs and Development Projects (2016-2036)".

Figure 2.3: Oil Sands Production Forecast, Total Bitumen (Mbpd)



It is important to note that the oil sands forecast utilized in this study is the reference case scenario from CERI's Oil Sands Update 2016, published in February 2017. In the current lower price environment, this is a more plausible view of the oil sands production. Projected production volume will increase to 3,385 Mbpd by 2020 and 4,038 Mbpd by 2027, the end of the study period.

[15] Within mining and extraction, various technologies are used to support the extraction process and transportation of oil sands. While each technology has some advantages and disadvantages, they have all been categorized as mining and extraction for this report and are treated as one technology type.

[16] The reader is assumed to have some familiarity with each extraction method. Detailed descriptions of the extraction technologies are available from CERI Study 122 & 126.

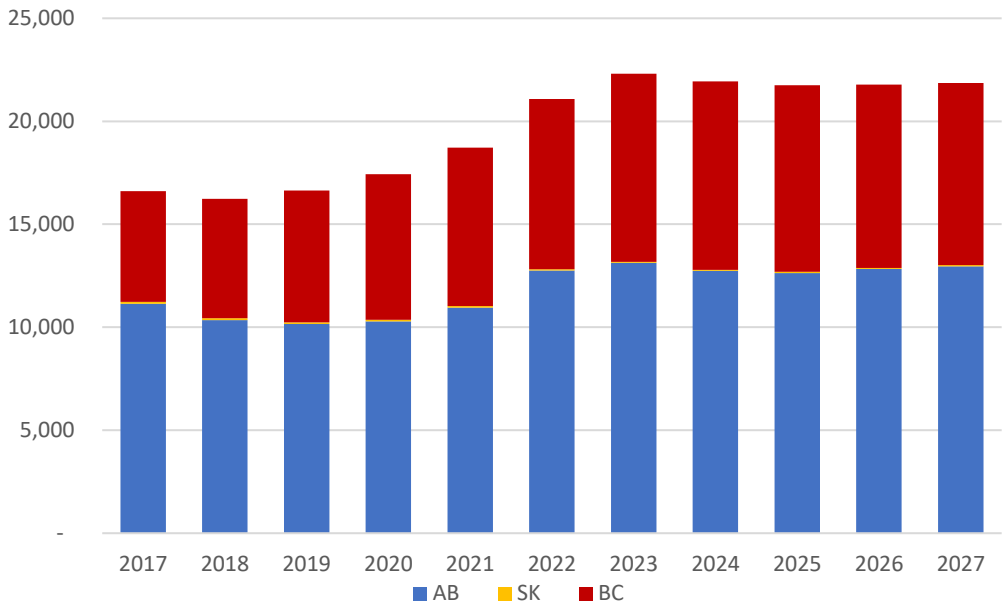
This graphic does not illustrate the dip in oil sands production from 2015 to 2016, due to the wildfires in the Fort McMurray area.

Commodity prices have also negatively impacted natural gas producers, as has the "shale revolution" in the US, pushing the country from a new importer to a net exporter. As previously mentioned, with Canada being the main exporter of natural gas to the US, it is no surprise that there are negative consequences for Canadian natural gas producers.

This study only examines natural gas production from Alberta, British Columbia and Saskatchewan. While there is production in Ontario, New Brunswick and Nova Scotia, it is either small or dwindling. This is particularly the case for offshore Nova Scotia. Production from the Sable Offshore Energy Project and the Deep Panuke are scheduled to be decommissioned by 2022, but likely earlier.

Figure 2.4 illustrates the natural gas production forecast from 2017 to 2027. It is important to note that the production forecast utilized in this study is from CERI Study 159: "Canadian Crude Oil and Natural Gas Production and Supply Costs Outlook (2016-2037)".

Figure 2.4: Canadian Natural Gas Production Forecast (MMcfpd)



The vast majority of natural gas production will continue to come out of British Columbia and Alberta. Both provinces will see declining natural gas production from 2016 through 2018, as the market adjusts to the reduction in drilling due to the current lower price environment. It is,

however, assumed that both provinces will see an uptick in production leading to Liquefied Natural Gas (LNG) projects, the first of which CERI predicts will come online in 2022.[17]

Once production has risen to accommodate the increase in demand that the LNG projects will cause, production remains fairly stable with marginal increases through the remainder of the study period. In 2036, production of natural gas will be slightly above 20,000 MMcfpd.

When looking at the drilling forecast for gas wells in Alberta, production lags drilling in the years until 2022. This is due to the preemptive drilling of wells meant to compensate for reduced flow from British Columbia as upcoming LNG projects increase its demand. These wells will not start to produce until 2022 when the first of the LNG projects is set to come online. Post-2024, natural gas production in Alberta remains stable with slight increases to just below 14,000 MMcfpd through the duration of the study period.

British Columbia has been a more significant player in the production of natural gas over crude oil, particularly with the increase in shale and tight gas production in the Horn River Basin and the Montney Basin. British Columbia's production of natural gas accounts for an increase in demand of approximately 5,000 MMcfpd due to LNG projects coming online in 2022. Consistent increases in production are expected until 2023, at which point production will stabilize through the remainder of the study period at approximately 9,000 MMcfpd.

Saskatchewan's natural gas production is the lowest of the three provinces indicated in Figure 2.4 and will likely decline further, with production expected to decline throughout the study period.

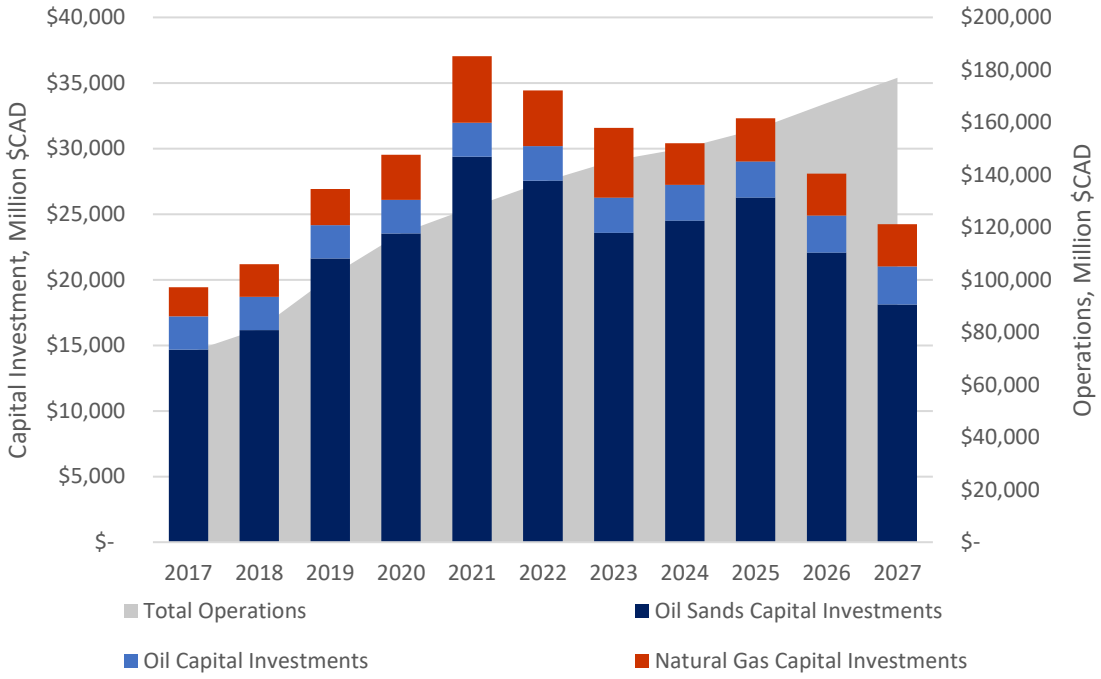
The following section reviews the capital investments and producer's gross revenues (operations). These are, as previously mentioned, used as inputs, or injections, into CERI's I/O model. This model, in turn, calculates the various economic impacts associated with the level of activity stemming from the outlook models over the 2017-2027 period.

The capital investment and operations forecasts are discussed by province: Alberta, British Columbia, Saskatchewan, Manitoba and Newfoundland. The capital investments are further illustrated by commodity (i.e., crude oil, natural gas and oil sands), whereas the operations are aggregated. ***All monetary values are in real 2016 Canadian dollars, unless stated otherwise***.

Figure 2.5 illustrates operations and capital investments in Alberta. Total capital investments are divided by type of commodity, whether oil sands, crude oil or natural gas.

[17] At the time of estimating natural gas production forecast, the Petronas LNG project was assumed to be going online by 2022. The project was recently cancelled, however the gas forecast here does not reflect that.

Figure 2.5: Alberta Operations and Capital Investment (million $CAD)



For Alberta, capital investments in the oil sands over the 2017 to 2027 period account for $247.4 billion, followed by a total capital investment of $38.4 billion in natural gas and $29.3 billion in crude oil. Capital investments in the oil sands increases from $14.7 billion in 2017 to $29.3 billion in 2021, the growth in capital spending is reflective of an assumption of higher oil prices in the future. Post-2021, investment declines to $18.1 billion by the end of the study period. This does not reflect a slowdown in the oil sands, merely a lack of new capacity coming on-stream, and relates back to CERI's assumptions for project start dates and announcements from the oil sands proponents. Over the forecast period, total operating costs are expected to increase in line with increasing production levels, averaging $28 billion per year. Oil sands data is provided by the CanOils database.

It is expected that capital investment in in situ projects surpasses the capital spent for mining projects, which is consistent with the ongoing trend to invest more into in situ projects rather than mining. From 2017 to 2027, it is projected that almost $79.1 billion (initial and sustaining) will be invested into mining projects and $171.4 billion in in situ thermal and solvent as well as primary and EOR cold bitumen projects. Upgrading projects see the least amount of capital spent, amounting to $29.8 billion.

It is also important to note that the nature of new project development in the oil sands has changed. A decade ago, the industry was dominated by megaproject mines and upgraders each built by several thousand people; the sector has now transformed into smaller, more manageable in situ projects. Notwithstanding the uncertainties around market access and lower crude oil prices due to excess supply globally, oil sands production is expected to grow.

Natural gas and crude oil capital investments in Alberta peak at $5.3 billion in 2022 and $2.9 billion in 2027, respectively. Annual capital costs for drilling and the connection of new natural gas and crude oil wells including infrastructure costs plus geological and geophysical costs make up the capital expenditures for natural gas and crude oil. Investments include costs of drilling wells, gathering pipelines and the associated capital to construct new and sustain existing projects. The capital requirements are determined by using the drilling profile converted to investment dollars by means of the Petroleum Services Association of Canada (PSAC) Well Cost Study and the Canadian Association of Petroleum Producers (CAPP) Statistical Handbook.

Operations are, on the other hand, driven by the amount of oil and gas produced and the pricing for each producing asset. The shaded area in Figure 2.5 illustrates the operations investments, representing the forecast of producer revenue from all crude oil natural gas and oil sands production (existing wells plus future new well additions). These are based on the oil and natural gas price forecast in CERI Study 159 and 163. This revenue stream will cover operating costs, taxes, royalties, etc. The oil and natural gas price forecasts from the EIA, Annual Energy Outlook 2016 have been modified by CERI for the years 2016 and 2017 to reflect a continuing low market situation allowing time for global demand to catch up with global supply. Prices were adjusted for quality, transportation, exchange rate and are in real 2016 Canadian dollars.

Total operation investment in Alberta between 2017 and 2027 is $1,434.6 billion (or $1.4 trillion), peaking at $177.0 billion in 2027, the end of the study period. Total operations related to the oil sands is $1,053.9 billion (or $1.1 trillion), the largest component of oil and gas activity in Alberta.

Between 2017 and 2027, operations investment in natural gas and crude oil are $163.6 billion and $217.1 billion, respectively.

Figure 2.6 illustrates operations and capital investments in British Columbia. In the case of British Columbia, crude oil and natural gas are included. Over the study period (2017-2027), natural gas and crude oil capital investments in British Columbia total $32.2 billion and $65 million, respectively. The clear majority of capital investments in British Columbia are in the natural gas sector. Natural gas capital investments peak at $3.8 billion in 2017, declining gradually until 2021, where capital investments increase to $3.4 billion. Capital investments in crude oil peak at only $8.13 million in 2017 and subsequently decline. Total operation investment in British Columbia between 2017 and 2027 is $130.5 billion, peaking at $16.2 billion in 2025. Between 2017 and 2027, total operations related to natural gas is $110.0 billion, followed by $20.5 billion in crude oil.

Figure 2.6: British Columbia Operations and Capital Investment (million $CAD)

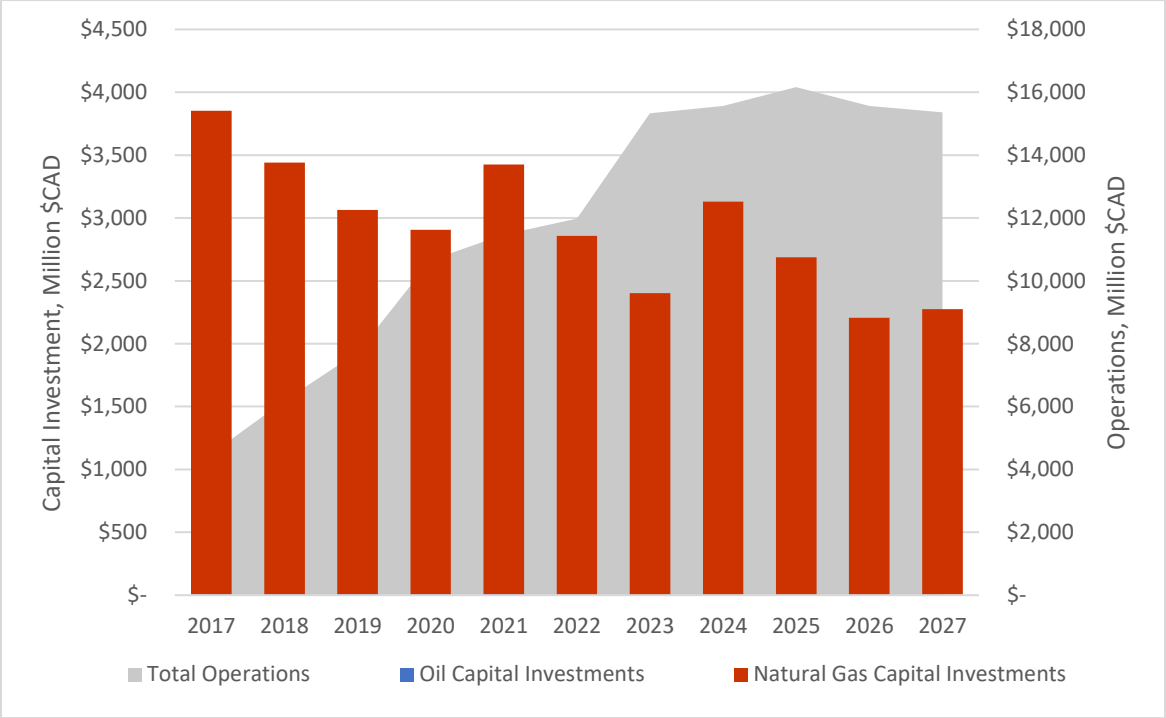


Figure 2.7 illustrates operations and capital investments in Saskatchewan. In the case of Saskatchewan, crude oil and natural gas are included. Over the study period (2017-2027), crude oil and natural gas capital investments in Saskatchewan total $19.6 billion and $39 million, respectively. The clear majority of capital investments in Saskatchewan are in the crude oil sector, particularly in the Bakken Formation. Crude oil capital investments peak at $1.9 billion in 2017, declining gradually until 2026, where capital investments increase to $1.7 billion. Capital investments in natural gas peak at only $6 million annually between 2024 and 2027. Total operation investment in Saskatchewan between 2017 and 2027 is $136.7 billion, peaking at $16.5 billion in 2027. Between 2017 and 2027, total operations related to crude oil is $135.8 billion, followed by only $887 million in natural gas.

Figure 2.7: Saskatchewan Operations and Capital Investment (million $CAD)

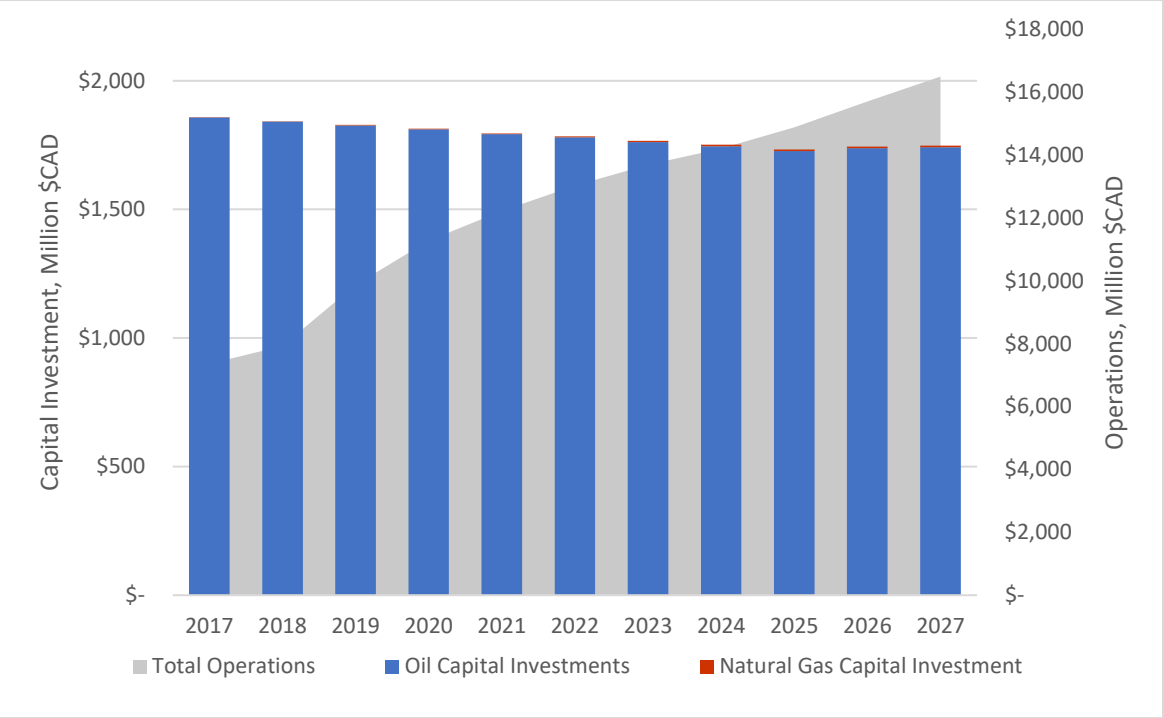


Figure 2.8 illustrates operations and capital investments in Newfoundland & Labrador. In the case of Newfoundland & Labrador, only crude oil is included, with the province not producing any natural gas. Associated natural gas is assumed to be reinjected to maintain reservoir pressure and hence it's sold on a market. Over the study period (2017-2027), crude oil capital investments in Newfoundland & Labrador total $7.7 billion. Crude oil capital investments peak at $1.1 billion in 2019, declining to $54 million in 2027. Total operation investment in Newfoundland & Labrador between 2017 and 2027 is $96.2 billion, peaking at $11.8 billion in 2027.

Figure 2.8: Newfoundland and Labrador Operations and Capital Investment (million $CAD)

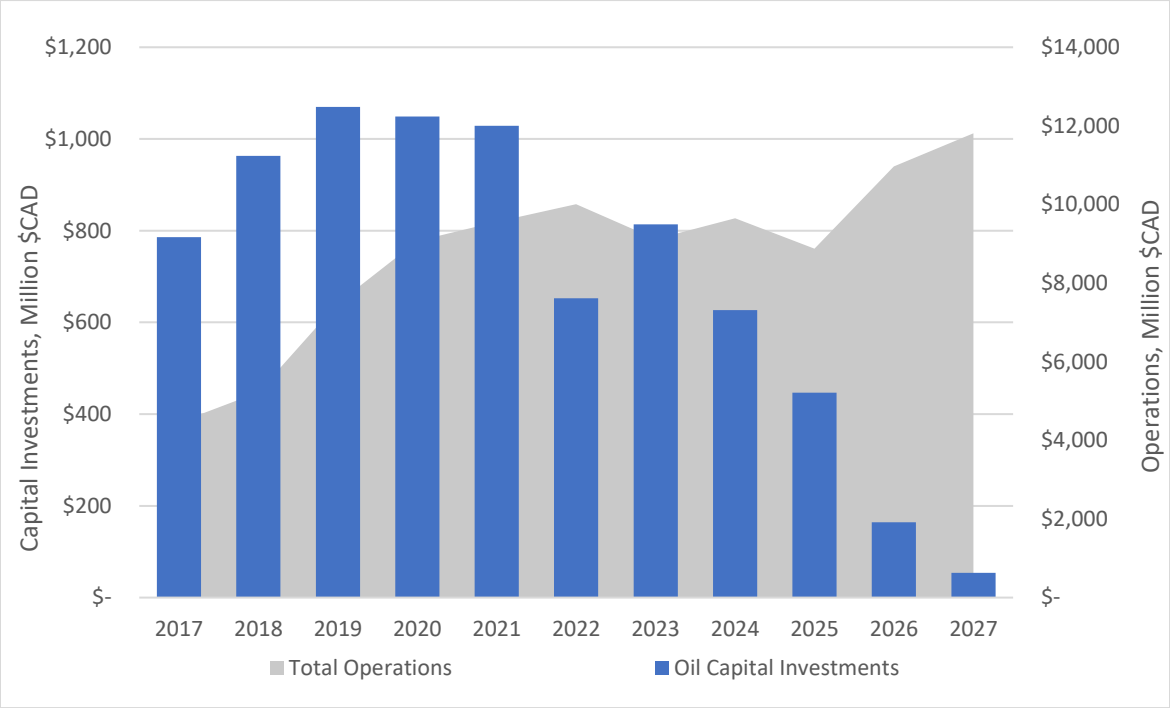
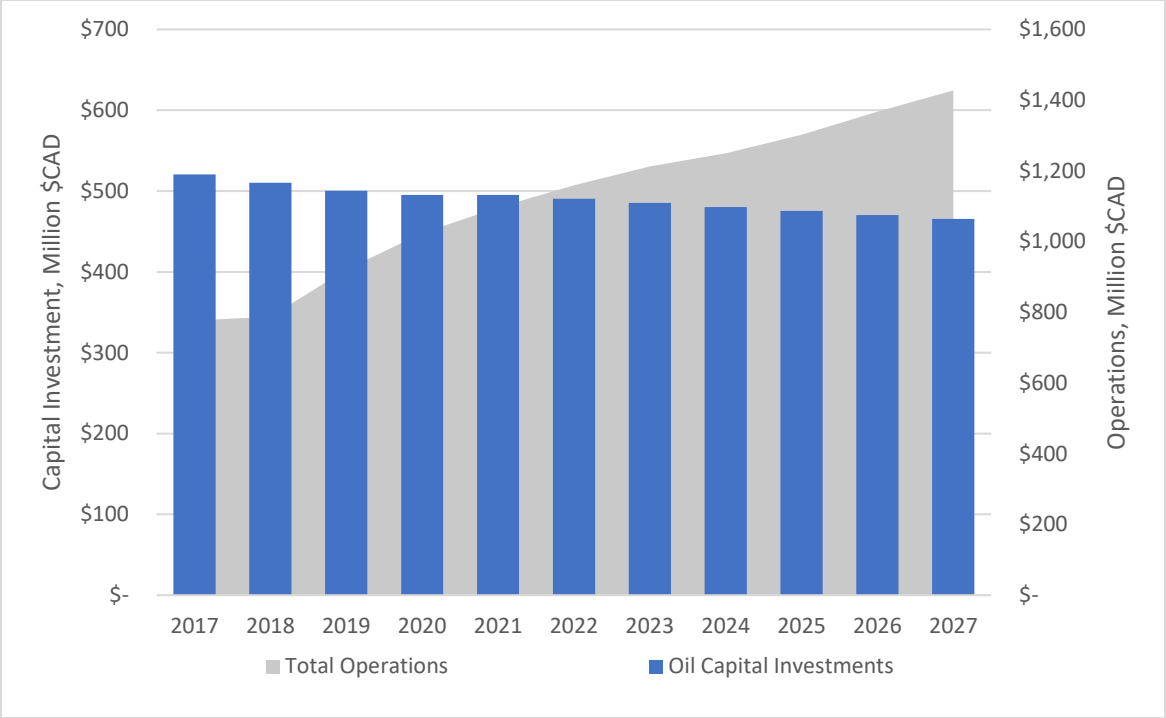


Figure 2.9 illustrates operations and capital investments in Manitoba. In the case of Manitoba, only crude oil is included, with the province not producing any natural gas. Over the study period (2017-2027), crude oil capital investments in Manitoba total $5.4 billion. Crude oil capital investments peak at $520 million in 2017, declining to $465 million in 2027. Total operation investment in Manitoba between 2017 and 2027 is $12.3 billion, peaking at $1.4 billion in 2027.

Figure 2.9: Manitoba Operations and Capital Investment (million $CAD)



Chapter 3: Canadian Impacts

This chapter examines economic impacts associated with development of Canadian crude oil and natural gas, including existing and future drilling activity within Western Canadian provinces and offshore Newfoundland. The forecast period is from 2017 to 2027, and the analysis includes conventional crude oil and natural gas, shale gas,[1] tight oil and oil sands.

Crude Oil and Natural Gas

To determine the economic impacts of Canadian natural gas and crude oil, this study uses the production forecasts for conventional crude oil (excluding oil sands) and natural gas from CERI Study 159: "Canadian Crude Oil and Natural Gas Production and Supply Costs Outlook (2016-2036)". Study 159 examined Canada's conventional crude oil and natural gas industries, including production forecasts and supply costs. It included shale gas, tight gas, coalbed methane, as well as tight and offshore oil production in Canada.

Both Canadian natural gas and oil producers have faced challenges with the price declines in both commodities as well as the 'shale revolution' that has occurred in the United States. The declines in commodity prices have not only negatively affected the Canadian oil and gas industry and related service sectors, but also the economic growth in Canada as well. While analysts debate to what degree Canada's economic growth has been affected, there is little doubt that the crude oil and natural gas industries are central to Canada's energy industry and are significant contributors to Canada's economy. Statistics Canada reports that Canada's oil and gas sector[2] contributes 8 percent to the country's GDP.[3]

In terms of natural gas, the effects are staggering, transforming the US from a net importer to a net exporter. With Canada being the main natural gas exporter to the US, it is no surprise that there are negative consequences for Canadian gas producers.

Being a global market, the decline in oil prices is more complex than its natural gas counterpart. The North American natural gas market is, for the most part, a continental market, though Liquefied Natural Gas (LNG) is changing that fact. However, like shale gas, advances in horizontal drilling and multi-stage hydraulic fracturing have been a game-changer for the crude oil market, opening up previously uneconomic and unfeasible areas for production, particularly in the United States.

While high oil prices over the last decade stimulated new sources of global oil supply, North American production has grown the fastest. This heightened global production, in turn,

[1] Economic impacts of shale gas do not include natural gas liquids. Pentanes plus and condensate are included in the crude oil production. Other liquids like ethane, propane and butane are not included.
[2] Here the oil and gas sector refers a sum of 3 NAICS industries: "Oil and gas extraction", "Support activities for mining and oil and gas extraction", "Oil and gas engineering construction".
[3] Statistics Canada, Gross domestic product (GDP) at basic process, by North American Industry Classification System (NAICS), provinces and territories, CANSIM table 379-0028, accessed June 2017.

contributed substantially to the lower world prices that materialized in mid-2014. In 2008, the production of shale oil was almost non-existent. Today, the sector produces about 4 million barrels per day and, before the recent drop in prices, was on track to increase its output to almost 4.8 million barrels per day in 2020.

Chapter 2 presented the natural gas production forecast, which included natural gas production for the provinces of British Columbia, Alberta and Saskatchewan that will be used for the economic impacts evaluation. CERI Study 159 examined gas production from the "Other" category that includes production out of Ontario, New Brunswick, Nova Scotia, the Yukon and Northwest Territories, but these are not included in this report.

Most natural gas production will continue to come from British Columbia and Alberta. Both provinces will see declining natural gas production from 2017 through 2018 while the market adjusts to the reduction in drilling that has happened in the current low price environment. Both provinces will also see an uptick in production leading to the LNG projects, the first of which CERI predicts will come online in 2022.[4] Once production has risen to accommodate the increase in demand that the LNG projects will cause, production remains stable with marginal increases through the remainder of the study period. In 2027, production of natural gas will be slightly above 20 Bcfpd.

As with natural gas, this report examines conventional crude oil production out of each province individually. Production is evaluated for British Columbia, Alberta, Saskatchewan, Manitoba and Newfoundland. Production levels are not expected to reach the highs seen in 2014 prior to the decline in oil price. Total production will remain flat through the remainder of the study period, with slight growth in Western Canada being offset by the declines seen in offshore Newfoundland. The growth in crude oil production will be dominated by Saskatchewan as it is expected the province will be focusing on drilling their tight oil formation. In 2027, total conventional crude oil production is just above 1.5 MMbpd.

Economic Impacts of Natural Gas Development

This section presents the economic impacts of natural gas development, including both existing and future drilling activity within the provinces of British Columbia, Alberta and Saskatchewan over the period of 2017 to 2027. The analysis covers conventional and shale gas, but not offshore natural gas production.

The production forecast as well as capital investment and operations revenues were presented in Chapter 2. Capital investment for drilling new wells in British Columbia, Alberta and Saskatchewan will total CAD$70.6 billion (2017-2027) or average CAD$6.4 billion per year. Revenues from natural gas sales will total CAD$300 billion or average CAD$27.2 billion per year.

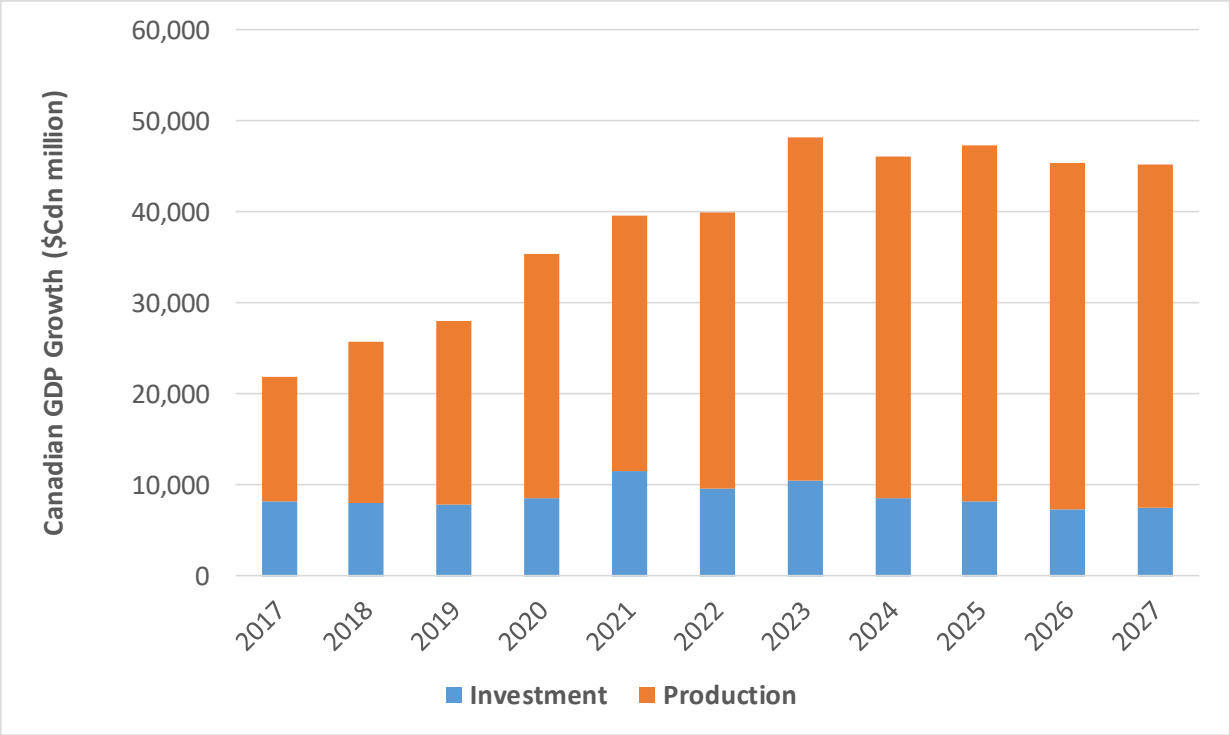
[4] At the time of estimating natural gas production forecast, the Petronas LNG project was assumed to be going online by 2022. The project was recently cancelled, however the gas forecast here does not reflect that.

Table 3.1 presents the total impacts associated with both investment and operation of natural gas projects in British Columbia, Alberta, and Saskatchewan for the period 2017 to 2027. Total Canadian GDP impact is estimated to be CAD$422.5 billion (2016 Canadian dollars), with 55 percent of impacts felt in Alberta, 37 percent in British Columbia, and the rest across other provinces and territories (Table 3.1). Ontario's share of GDP impact is 5 percent. Annual GDP growth will average approximately CAD$38.4 billion, starting at CAD$21.9 billion in 2017, increasing to CAD$45.2 billion in 2027 (Figure 3.1).

Table 3.1: Total GDP and Employment Impacts of Natural Gas Development (2017-2027)

Investment and Operations	$CAD Million	Thousand Person Years
2017-2027	GDP	Employment
Alberta	230,996	514
British Columbia	155,046	413
Manitoba	1,657	9
New Brunswick	551	3
Newfoundland/Labrador	341	1
Nova Scotia	507	3
Nunavut	32	0
Northwest Territories	108	0
Ontario	23,137	118
Prince Edward Island	42	0
Quebec	6,883	37
Saskatchewan	3,115	10
Yukon Territory	122	1
Governments Abroad	0	0
Total Canada	**422,537**	**1,109**

Figure 3.1: Annual GDP Impacts of Natural Gas Development (2017-2027)



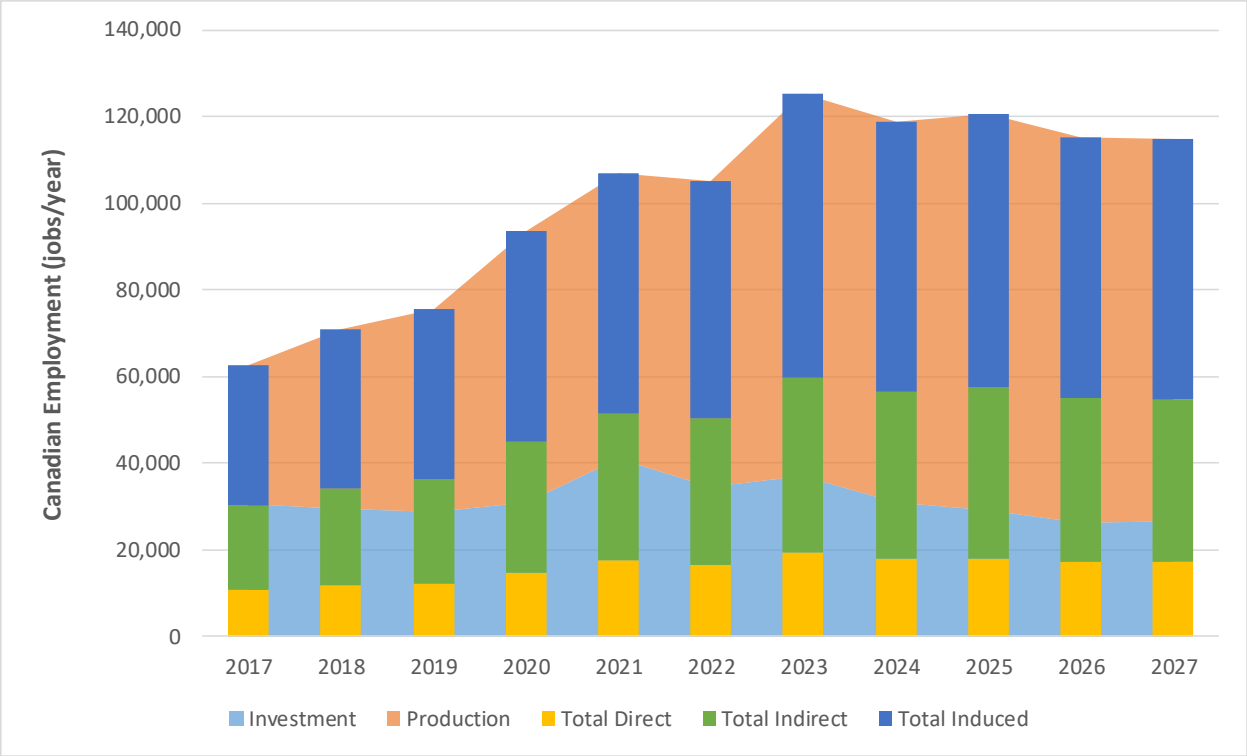
Total employment (direct, indirect, induced) will amount to 1,109 thousand person years, translating to growth from 62,477 jobs in 2017 to 114,878 jobs in 2027 (Figure 3.2). Direct employment grows from 10,767 jobs in 2017 to 17,112 jobs by 2027, with a peak of 19,417 jobs in 2023.

Indirect job effects account for the potential of jobs created in many industries across Canada that service the gas industry including manufacturing in Ontario, pipeline mills in Saskatchewan and Alberta, and electronic components in British Columbia, Ontario and Quebec, to name a few.

The indirect and induced number of jobs will almost double at the end of the forecast period. Indirect jobs increase from 19,422 jobs in 2017 to 37,556 jobs in 2027, and over the same period, induced jobs grow from 32,288 to 60,210 jobs.

Most jobs will be created and preserved during the production or operations phase (orange area in Figure 3.2) of gas projects, totalling 764,398 jobs over the 2017-2027 period; while construction or investment jobs (light blue area in Figure 3.2) add to 344,808 jobs over the same period. The employment impact in this study only shows what the potential labour impact could be – the analysis does not cover the dynamics of the labour market, such as labour supply and demand, labour availability and/or labour shortages.

Figure 3.2: Employment Impacts of Natural Gas Development (2017-2027)



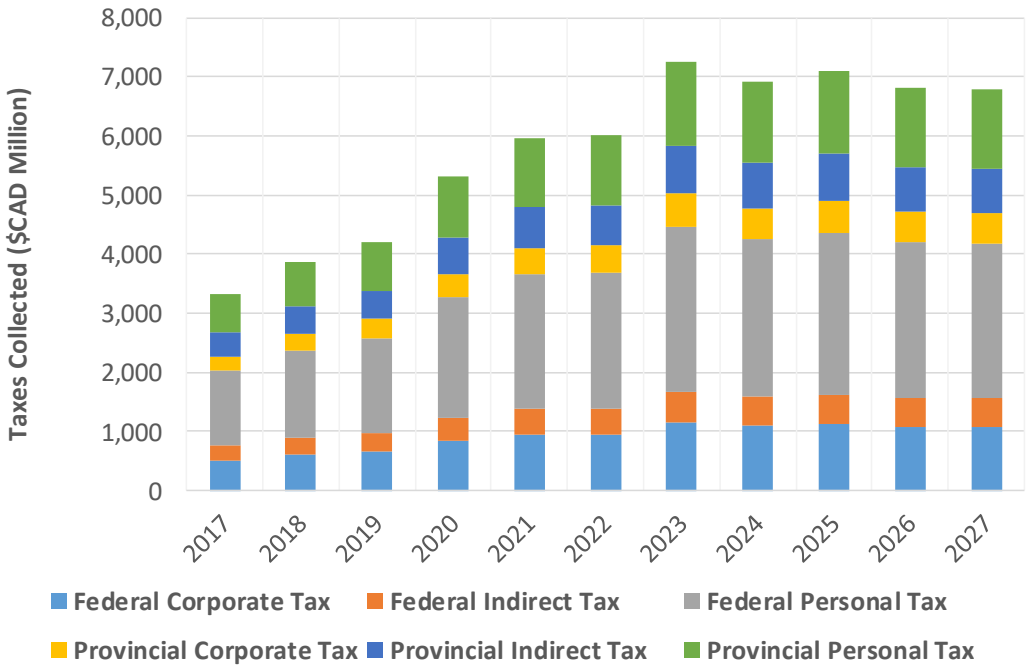
Taxes on income are considered direct taxes, while taxes on expenditures (GST, PST, HST, etc.) and all taxes deductible by corporations for income tax purposes (such as property taxes) are considered indirect taxes. The tax impact on a corporation includes taxes generated by economic activity within a province payable to federal, provincial and municipal governments.

Total tax revenues generated from natural gas development in Canada to the Federal government will amount to CAD$39.1 billion; to the provincial governments – in the order of CAD$24.5 billion over the 2017-2027 period (Table 3.2). On average, annual federal tax revenues will be CAD$3.5 billion; at the provincial level – CAD$2.2 billion per year. The provinces of British Columbia and Alberta will generate the highest shares of both federal and provincial tax revenues. Income taxes on wages constitute a larger proportion of total tax revenues than corporate taxes, both at the federal and provincial levels (Figure 3.3). Tax revenues do not include royalty revenues.

Table 3.2: Total Tax Receipts from Natural Gas Development (2017-2027)

Investment and Operations 2017-2027	Federal $CAD Million	Provincial $CAD Million
Alberta	21,949	12,965
British Columbia	13,748	8,358
Manitoba	139	142
New Brunswick	45	44
Newfoundland/Labrador	21	23
Nova Scotia	46	44
Nunavut	2	1
Northwest Territories	8	5
Ontario	2,277	1,891
Prince Edward Island	4	4
Quebec	647	775
Saskatchewan	219	205
Yukon Territory	8	4
Total Canada	**39,114**	**24,461**

Figure 3.3: Annual Tax Receipts from Natural Gas Development (2017-2027)



Economic Impacts of Conventional Crude Oil Development

This section presents the economic impacts of conventional crude oil development (oil sands are presented separately in the next section), including both existing and future drilling activity within the provinces of British Columbia, Alberta, Saskatchewan, Manitoba and offshore Newfoundland over the period 2017 to 2027. The analysis covers conventional crude, tight oil, and offshore.

The production forecast as well as capital investment and operations revenues were presented in Chapter 2. Capital investment for drilling new wells in Western Canada and offshore Newfoundland will total CAD$62 billion (2017-2027) or average CAD$5.6 billion per year. Revenues from crude oil sales will total almost CAD$482 billion or average CAD$43.8 billion per year.

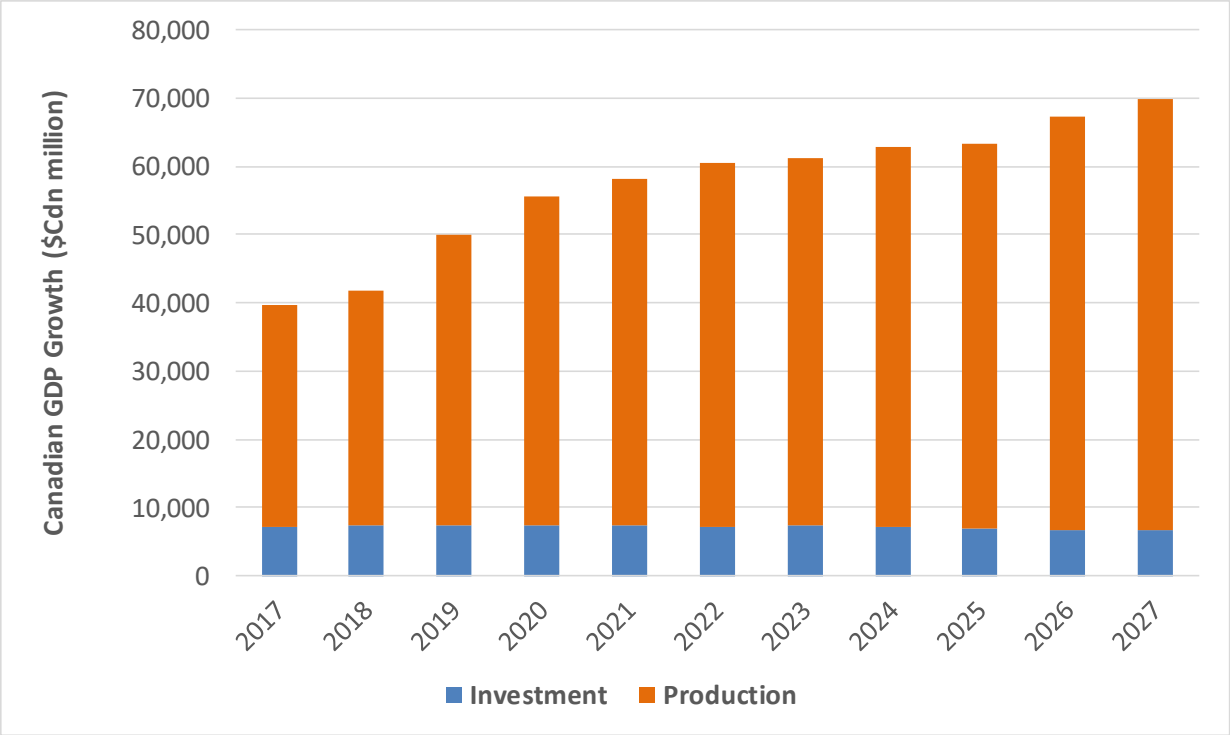
Table 3.3 presents the total impacts associated with both investment and operation of crude oil (excluding oil sands) projects in British Columbia, Alberta, Saskatchewan, Manitoba and Newfoundland for the period 2017 to 2027. Total Canadian GDP impact is estimated to be CAD$630.3 billion (2016 Canadian dollars), with 46 percent of impacts felt in Alberta, 23 percent in Saskatchewan, 16 percent in Newfoundland, and the rest across other provinces and territories (Table 3.3). Annual GDP growth will average approximately CAD$57.3 billion, starting at CAD$39.8 billion in 2017, increasing to almost CAD$70 billion in 2027 (Figure 3.4).

Table 3.3: Total GDP and Employment Impacts of Crude Oil Development (2017-2027)

Investment and Operations	$CAD Million	Thousand Person Years
2017-2027	GDP	Employment
Alberta	290,107	630
British Columbia	32,672	111
Manitoba	18,892	46
New Brunswick	1,291	7
Newfoundland/Labrador	100,557	138
Nova Scotia	1,274	8
Nunavut	43	0
Northwest Territories	120	0
Ontario	30,763	158
Prince Edward Island	108	1
Quebec	9,104	49
Saskatchewan	145,330	230
Yukon Territory	69	0
Governments Abroad	0	0
Total Canada	**630,330**	**1,379**

It is interesting to note that while Ontario has very little crude oil production, it plays a significant role in supporting the provinces that do, experiencing almost the same GDP impact as British Columbia.

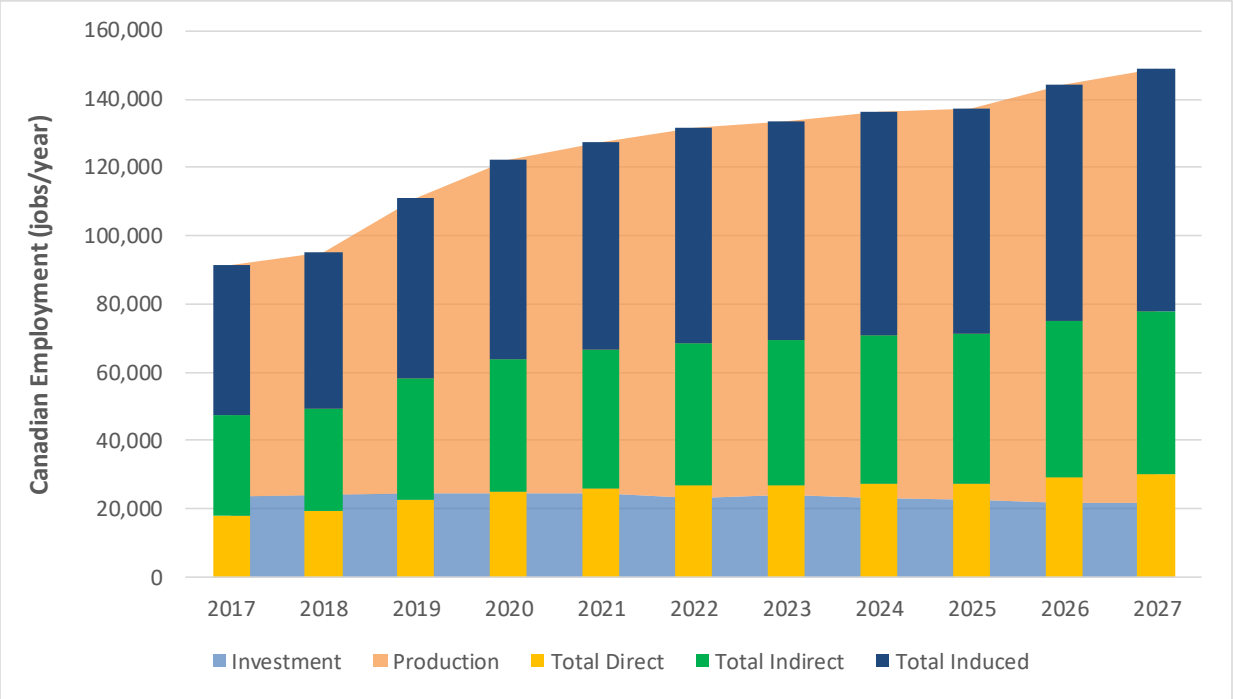
Figure 3.4: Annual GDP Impacts of Crude Oil Development (2017-2027)



Total employment (direct, indirect, induced) will amount to 1,379 thousand person years, translating to growth from 91,392 jobs in 2017 to 149,000 jobs in 2027 (Figure 3.5). Direct employment (i.e., employment in the upstream crude oil industry) grows from 18,178 jobs in 2017 to 30,100 jobs by 2027. The indirect and induced number of jobs will also increase in the forecast period. Indirect jobs go up from 29,198 in 2017 to 47,746 in 2027, and over the same period induced jobs grow from 44,017 to 71,154.

Most jobs will be created and preserved during the production or operations phase (orange area in Figure 3.5) of gas projects, totalling 1,120,533 jobs over the 2017-2027 period; while construction or investment jobs (light blue area in Figure 3.5) total 258,158 over the same period.

Figure 3.5: Employment Impacts of Crude Oil Development (2017-2027)

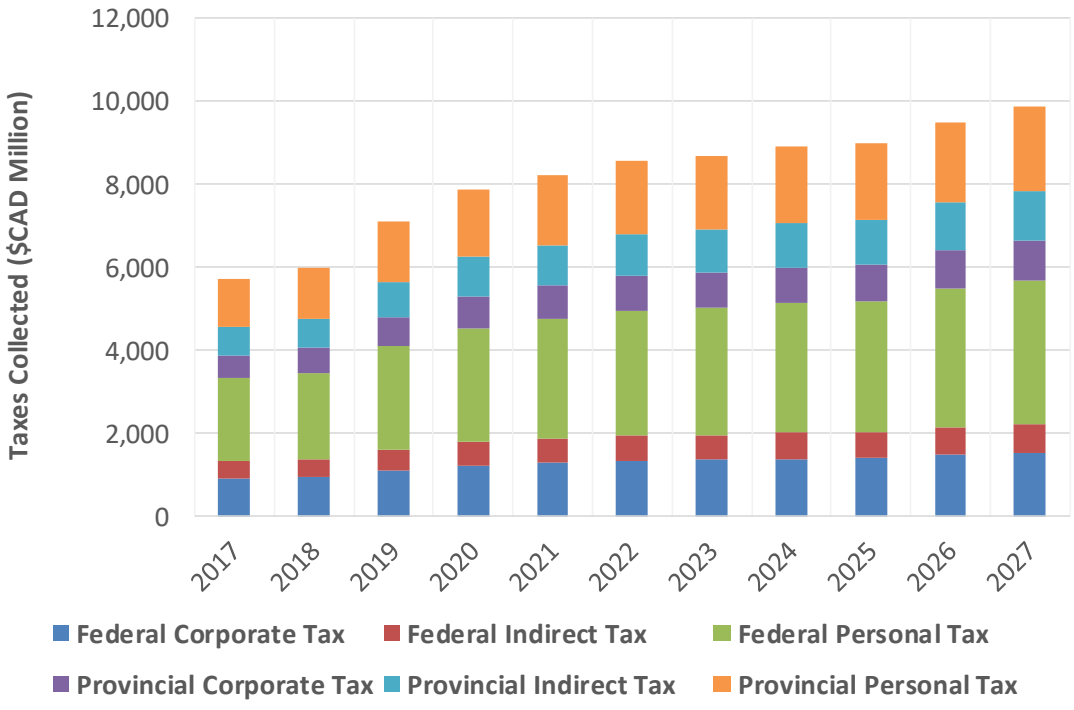


Total tax revenues to the Federal government will amount to CAD$51.7 billion; to the provincial governments – in the order of CAD$37.8 billion over the 2017-2027 period (Table 3.4). On average, annual federal tax revenues will be CAD$4.7 billion, and at the provincial level – CAD$3.4 billion per year. The provinces of Alberta and Saskatchewan will generate the highest shares of both federal and provincial tax revenues. Income taxes on wages constitute a larger proportion of total tax revenues than corporate taxes, both at the federal and provincial levels (Figure 3.6).

Table 3.4: Total Tax Receipts from Crude Oil Development (2017-2027)

Investment and Operations 2017-2027	Federal $CAD Million	Provincial $CAD Million
Alberta	27,528	16,241
British Columbia	2,941	1,853
Manitoba	1,476	1,365
New Brunswick	106	103
Newfoundland/Labrador	5,581	5,553
Nova Scotia	115	112
Nunavut	3	1
Northwest Territories	9	6
Ontario	3,037	2,531
Prince Edward Island	9	11
Quebec	858	1,028
Saskatchewan	10,003	9,037
Yukon Territory	5	3
Total Canada	**51,670**	**37,845**

Figure 3.6: Annual Tax Receipts from Crude Oil Development (2017-2027)



Oil Sands

To determine economic impacts of Canadian oil sands development, this study uses the production forecast for bitumen and synthetic crude oil from CERI Study 163: "Canadian Oil Sands Supply Costs and Development Projects (2016-2036)". Oil sands production projections are based on the summation of all announced projects, with a variety of assumptions pertaining to the project schedule and delays, technology and state of development. The methodology and assumptions developed by CERI to establish future forecasts are described in CERI Study 163. This study used the Reference Case Scenario from the previously mentioned study.

Economic Impacts of Oil Sands Development

This section presents the economic impacts of Canadian oil sands development, including both existing and future drilling activity within the active oil sands areas of the province of Alberta over the period 2017 to 2027. The analysis covers production of bitumen and synthetic crude oil.

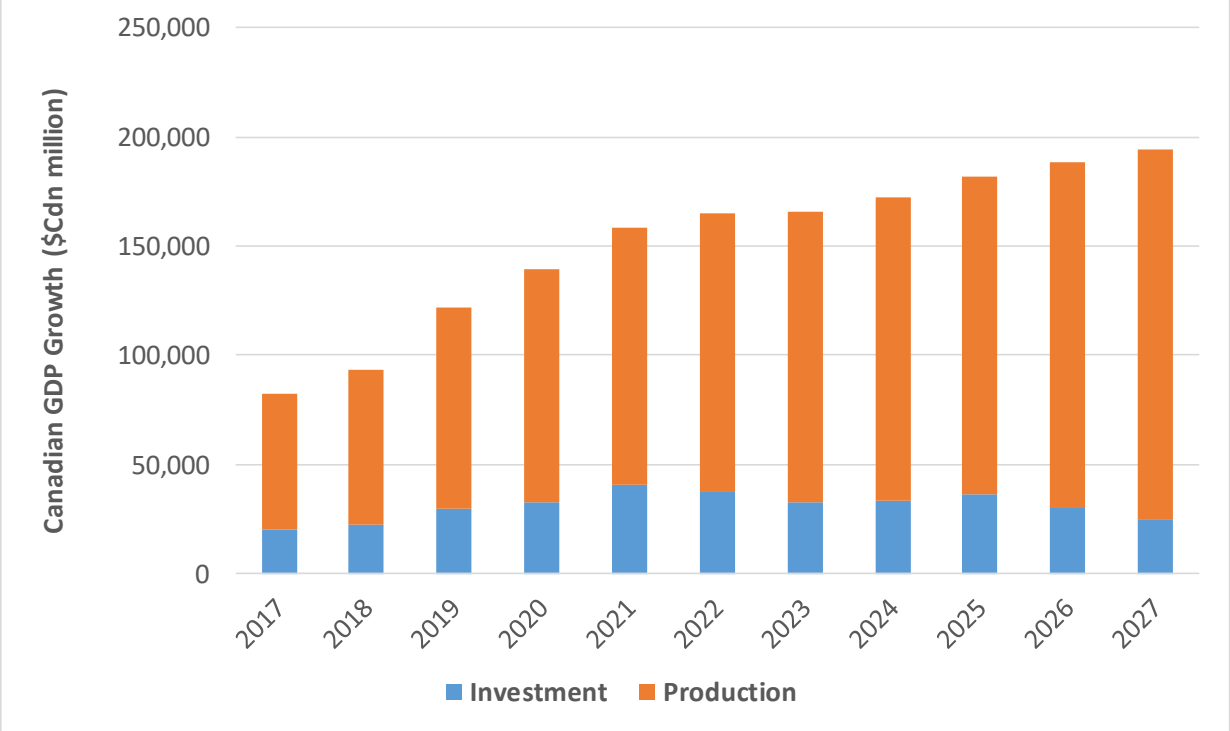
The bitumen production, capital investment, and operating revenues forecasts were presented in Chapter 2. Capital investment for drilling new wells will total CAD$247.5 billion (2017-2027) or average CAD$22.5 billion per year. Revenues from crude oil sales will total almost CAD$1,054 billion or average CAD$95.8 billion per year.

Table 3.5 presents the total impacts associated with both investment and operation of projects in the Alberta oil sands and direct staging and assembling facilities in Edmonton, Leduc and other Alberta communities for the period 2017 to 2027. Total Canadian GDP impact is estimated to be CAD$1,662.6 billion (or 1.7 trillion), with 88 percent of impacts felt in Alberta, followed by 6 percent in Ontario, and the rest across other provinces and territories (Table 3.5). Annual GDP growth will average approximately CAD$151 billion, starting at CAD$82.6 billion in 2017, and increasing to almost CAD$194 billion in 2027 (Figure 3.7).

Table 3.5: Total GDP and Employment Impacts of Oil Sands Development (2017-2027)

Investment and Operations	$CAD Million	Thousand Person Years
2017-2027	GDP	Employment
Alberta	1,460,821	3,029
British Columbia	48,083	273
Manitoba	7,110	40
New Brunswick	2,618	15
Newfoundland/Labrador	1,754	5
Nova Scotia	2,231	13
Nunavut	161	1
Northwest Territories	441	1
Ontario	98,744	505
Prince Edward Island	182	1
Quebec	28,710	153
Saskatchewan	11,548	46
Yukon Territory	225	1
Governments Abroad	0	0
Total Canada	**1,662,629**	**4,084**

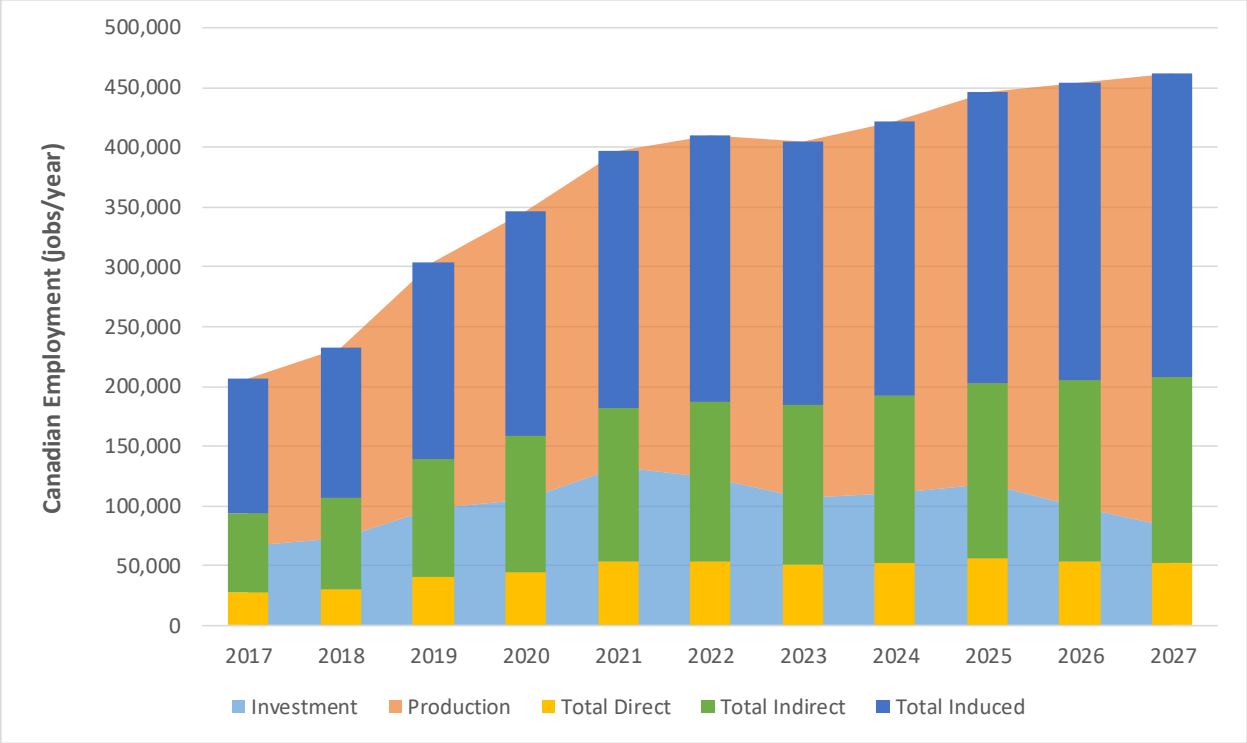
Figure 3.7: Annual GDP Impacts of Oil Sands Development (2017-2027)



Total employment (direct, indirect, induced) will amount to 4,084 thousand person years, translating to growth from 206,298 jobs in 2017 to 461,305 jobs in 2027 (Figure 3.8). Direct employment (i.e., created or preserved construction or operation jobs in the oil sands projects, manufacturing jobs in the oil sands staging areas (Edmonton, Leduc, etc.) and drilling related jobs in the cold bitumen production area) grows from 27,261 jobs in 2017 to 52,935 jobs by 2027. The indirect and induced number of jobs will more than double in the forecast period. Indirect jobs increase from 67,174 in 2017 to 154,597 in 2027, and over the same period induced jobs grow from 111,863 to 253,773.

Most jobs will be created and preserved during the production or operations phase (orange area in Figure 3.5) of gas projects, totalling 2,967,838 jobs during 2017-2027 period; while construction or investment jobs (light blue area in Figure 3.5) total 1,116,297 over the same period.

Figure 3.8: Employment Impacts of Oil Sands Development (2017-2027)

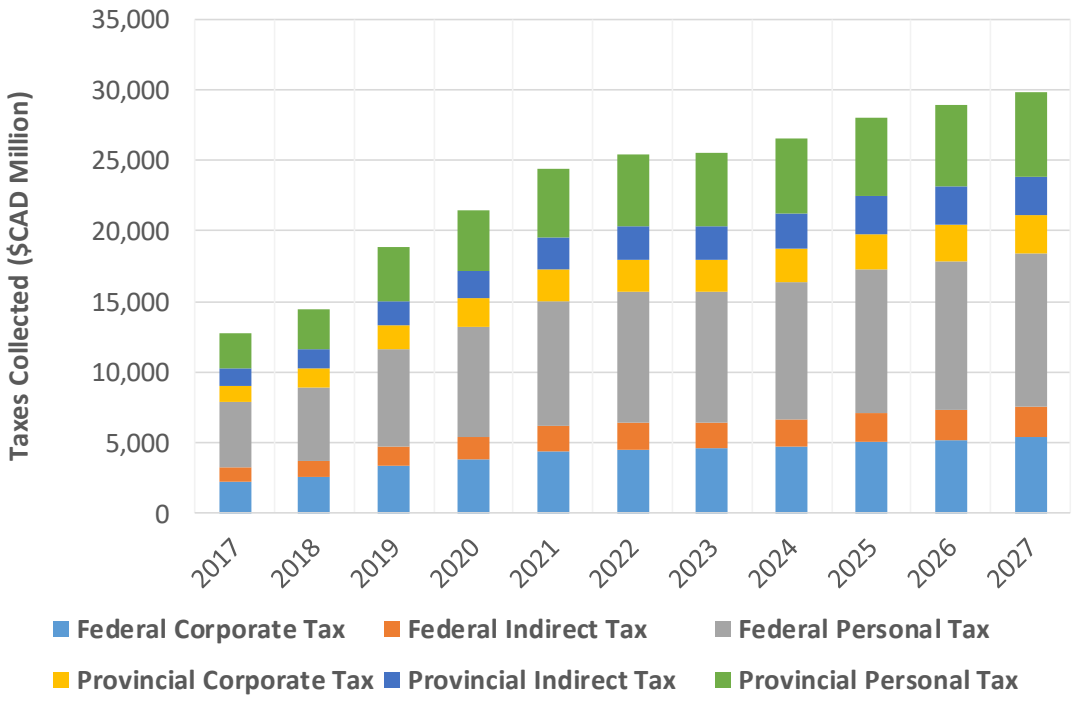


Total tax revenues generated from oil sands development to the Federal government will amount to CAD$157.8 billion; to the provincial governments – in the order of CAD$98.5 billion over the 2017-2027 period (Table 3.6). On average, annual federal tax revenues will be CAD$14.3 billion; at the provincial level – CAD$9 billion per year. Given that oil sands projects are in Alberta, the province will generate the highest shares of both federal and provincial tax revenues. Income taxes on wages constitute a larger proportion of total tax revenues than corporate taxes, both at the federal and provincial levels (Figure 3.9).

Table 3.6: Total Tax Receipts from Oil Sands Development (2017-2027)

Investment and Operations 2017-2027	Federal $CAD Million	Provincial $CAD Million
Alberta	138,800	81,985
British Columbia	4,503	3,096
Manitoba	599	615
New Brunswick	215	210
Newfoundland/Labrador	105	114
Nova Scotia	200	193
Nunavut	10	4
Northwest Territories	35	23
Ontario	9,751	8,131
Prince Edward Island	15	18
Quebec	2,723	3,291
Saskatchewan	819	777
Yukon Territory	17	9
Total Canada	**157,792**	**98,468**

Figure 3.9: Annual Tax Receipts from Oil Sands Development (2017-2027)



Chapter 4: US Impacts

Investments and operations of Canadian oil and gas projects make important contributions to the United States economy. The US benefits from not only importing oil and gas from Canada, but also from supplying goods and services used by the Canadian oil and gas industry.

In fact, prior to the 2014 oil price collapse, the Canadian oil and gas production sector imported CAD$6.5 billion worth of products and services from the US in 2013. Supply of those products and services spur economic activity and create or preserve jobs in respective US states. This chapter presents those economic impacts accruing in the US states because of Canadian oil and gas development. The first part will present the economic impacts of the upstream Canadian oil and gas supply chain of goods and services purchased in the US. The second part presents the economic impacts associated with Canadian oil and gas exports to the US.

Economic Impacts of Canadian Oil and Gas Supply

Economic impacts for the Canadian oil and gas industry supply chain were evaluated using the IMPLAN® model for all the US states. This section presents the economic impacts on the US economy as a result of purchases of goods and services from the US firms and businesses by Canadian upstream oil and gas companies, the oil and gas services sector and the engineering and construction sector. For more detailed results, see Appendix B.

US Economic Impacts of the Canadian Oil and Gas Industry

There are significant economic impacts associated with the Canadian oil and gas sector's development, not just in Canada but in the US as well. Through highly integrated economies of two countries, the impacts generated by purchases of goods (like machinery, equipment, valves, etc.) and services (legal, environmental, engineering, etc.) by Canadian companies in the US reverberate throughout the US economy.

This section presents the economic impacts accruing in the US associated with the Canadian conventional oil and gas sector's development. Similarly, to the oil sands, conventional oil and gas firms purchase goods and services in the US in order to develop their projects, and hence contribute to the US economy in generating a positive gross state product growth and creating or sustaining US employment.

For the forecast period of 2017-2027, it is estimated that the total of all US gross state products[1] will amount to almost US$29.6 billion or CAD$38 billion (using current exchange rate of CAD$0.78 per US$1). The total employment impact is measured in creating or preserving 260.5 thousand full-time equivalent jobs in the 11-year period (Table 4.1).

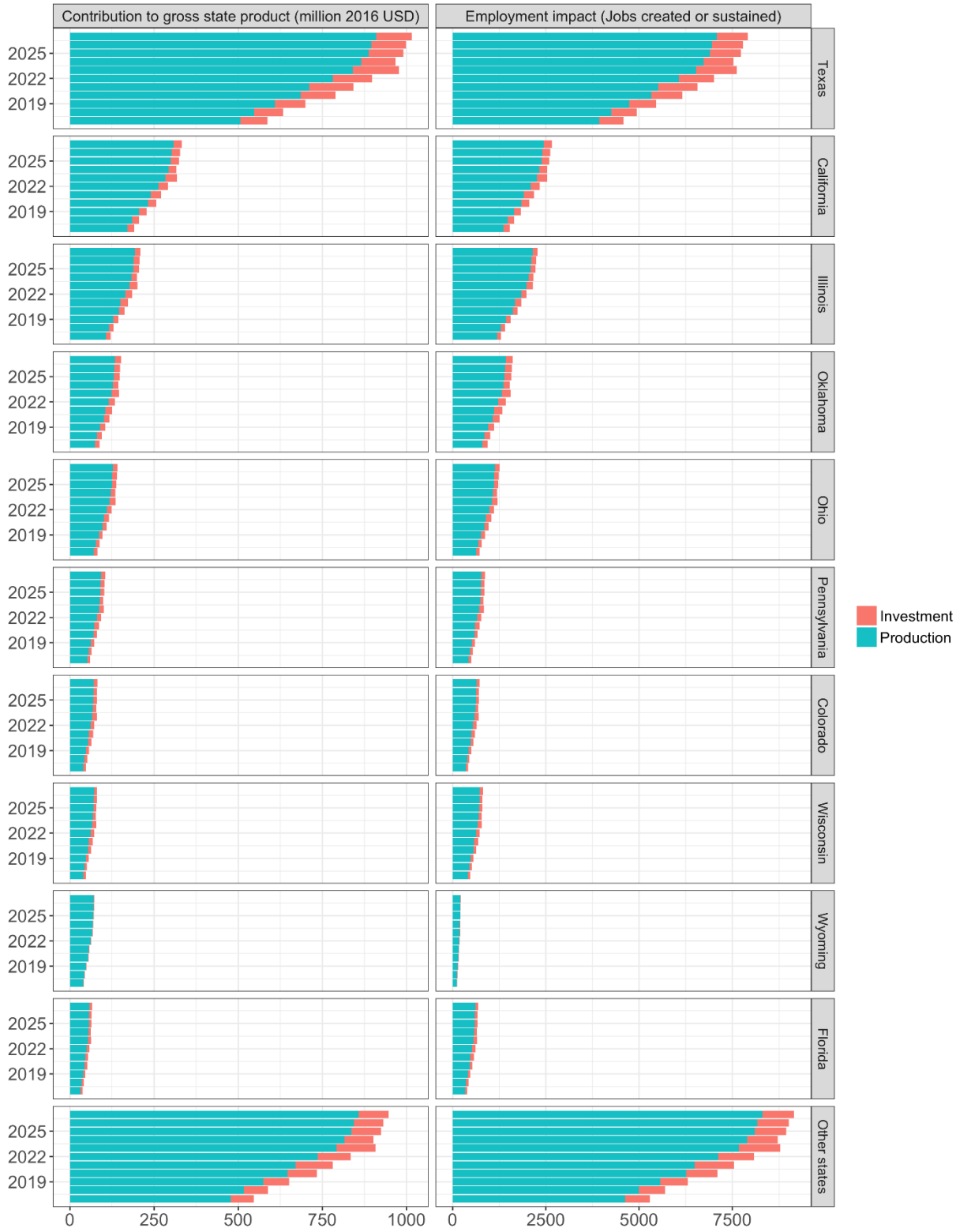
[1] In the US, the definition of gross state product (GSP) is similar to provincial gross domestic product (GDP) in Canada.

Table 4.1: Conventional Oil and Gas Economic Impacts in the US by State and by Type of Impact (2017-2027)

State	Employment Impact (# of Jobs created or sustained)				Contribution to gross state product (million 2016 USD)			
	Direct Effect	Indirect Effect	Induced Effect	Total Effect	Direct Effect	Indirect Effect	Induced Effect	Total Effect
Texas	21,935	25,819	25,525	73,279	$ 3,883	$ 3,403	$ 2,112	$ 9,398
California	7,973	8,843	7,702	24,517	$ 1,286	$ 1,053	$ 726	$ 3,065
Illinois	10,385	4,614	5,880	20,880	$ 876	$ 535	$ 522	$ 1,933
Oklahoma	5,865	4,967	4,102	14,934	$ 594	$ 508	$ 303	$ 1,405
Ohio	3,408	4,215	3,973	11,596	$ 534	$ 455	$ 316	$ 1,304
Pennsylvania	2,806	2,449	2,812	8,066	$ 418	$ 312	$ 236	$ 967
Colorado	2,198	2,152	2,346	6,696	$ 328	$ 242	$ 195	$ 764
Wisconsin	3,199	2,096	2,290	7,585	$ 374	$ 197	$ 178	$ 749
Wyoming	700	762	491	1,954	$ 545	$ 79	$ 37	$ 661
Florida	1,806	2,367	2,173	6,346	$ 207	$ 232	$ 168	$ 608
Arizona	1,423	2,335	1,920	5,678	$ 250	$ 157	$ 151	$ 558
Indiana	1,533	1,433	1,353	4,319	$ 324	$ 122	$ 102	$ 548
Minnesota	1,613	1,205	1,441	4,259	$ 262	$ 126	$ 122	$ 510
Utah	1,961	1,993	1,681	5,635	$ 190	$ 188	$ 125	$ 503
Montana	1,870	1,587	1,341	4,799	$ 253	$ 138	$ 85	$ 476
Michigan	4,269	1,762	2,123	8,154	$ 124	$ 168	$ 161	$ 453
Oregon	1,219	1,473	1,199	3,890	$ 164	$ 144	$ 88	$ 397
Iowa	1,192	1,104	958	3,254	$ 174	$ 107	$ 70	$ 352
Georgia	1,111	993	1,024	3,128	$ 166	$ 103	$ 81	$ 351
Virginia	925	701	617	2,242	$ 198	$ 79	$ 52	$ 329
New York	1,035	754	686	2,475	$ 146	$ 104	$ 70	$ 320
Kansas	1,328	1,252	992	3,571	$ 120	$ 120	$ 73	$ 313
Washington	1,301	1,047	824	3,172	$ 114	$ 122	$ 74	$ 311
New Jersey	723	841	816	2,380	$ 115	$ 110	$ 79	$ 304
North Carolina	765	751	693	2,209	$ 142	$ 67	$ 54	$ 262
Missouri	661	606	851	2,118	$ 135	$ 53	$ 65	$ 253
Louisiana	909	773	727	2,408	$ 125	$ 74	$ 53	$ 252
Mississipi	931	952	670	2,553	$ 122	$ 84	$ 45	$ 252
Alabama	682	867	614	2,164	$ 112	$ 86	$ 45	$ 243
North Dakota	295	507	260	1,061	$ 119	$ 59	$ 20	$ 198
Tennessee	603	550	495	1,648	$ 80	$ 53	$ 39	$ 172
Nevada	740	617	454	1,811	$ 77	$ 56	$ 38	$ 171
Kentucky	630	489	432	1,551	$ 83	$ 47	$ 31	$ 161
Connecticut	518	285	351	1,154	$ 76	$ 41	$ 35	$ 151
Nebraska	519	471	350	1,340	$ 69	$ 48	$ 27	$ 144
South Carolina	597	387	437	1,421	$ 75	$ 32	$ 31	$ 138
Idaho	742	560	430	1,732	$ 69	$ 41	$ 27	$ 138
Arkansas	459	452	352	1,264	$ 67	$ 44	$ 26	$ 136
Massachusetts	352	270	369	990	$ 63	$ 32	$ 34	$ 129
New Hampshire	308	183	246	737	$ 32	$ 18	$ 20	$ 69
Maryland	181	144	137	461	$ 23	$ 16	$ 12	$ 51
New Mexico	193	165	102	460	$ 19	$ 15	$ 7	$ 41
West Virginia	86	63	45	194	$ 11	$ 5	$ 3	$ 20
South Dakota	61	44	63	168	$ 11	$ 4	$ 5	$ 19
Delaware	24	10	13	47	$ 4	$ 1	$ 1	$ 6
Maine	56	23	20	99	$ 2	$ 2	$ 1	$ 6
Rhode Island	26	13	18	56	$ 3	$ 1	$ 2	$ 6
Alaska	12	4	4	20	$ 1	$ 1	$ 0	$ 2
Vermont	5	3	3	11	$ 0	$ 0	$ 0	$ 1
Total	**92,132**	**85,952**	**82,406**	**260,490**	**$ 13,166**	**$ 9,685**	**$ 6,749**	**$ 29,600**

The top ten states that benefit the most from Canadian conventional oil and gas development are, in descending order, Texas, California, Illinois, Oklahoma, Ohio, Pennsylvania, Colorado, Wisconsin, Wyoming, and Florida (Figure 4.2). Together the top ten states make up 70 percent of the total GSP impact and 68 percent of total employment impact. Again, Texas is the largest beneficiary in terms of GSP and employment; GSP is estimated to grow from US$600 million in 2017 to just over US$1 billion in 2027, totalling almost US$9.4 billion over the 11-year forecast or 32 percent of total GSP impact. Growing employment in Texas is estimated to change from almost 5,000 jobs in 2017 to just over 7,500 jobs in 2027. The disaggregated results show that California is the largest beneficiary in the isolated case of British Columbia natural gas production (see Appendix B for more results).

Figure 4.1: Conventional Oil and Gas Economic Impacts in the US by Top States (2017-2027)



US Economic Impacts of Canadian Oil Sands

Similarly, there are significant economic impacts associated with the Canadian oil sands sector's development, not just in Canada but in the US as well. For the forecast period of 2017-2027, it is estimated that the total of all US gross state products[2] will amount to almost US$16 billion or CAD$20.5 billion (using current exchange rate of CAD$0.78 per US$1). The total employment impact is measured in creating or sustaining just over 145 thousand full-time equivalent jobs in the 11-year period (Table 4.2).

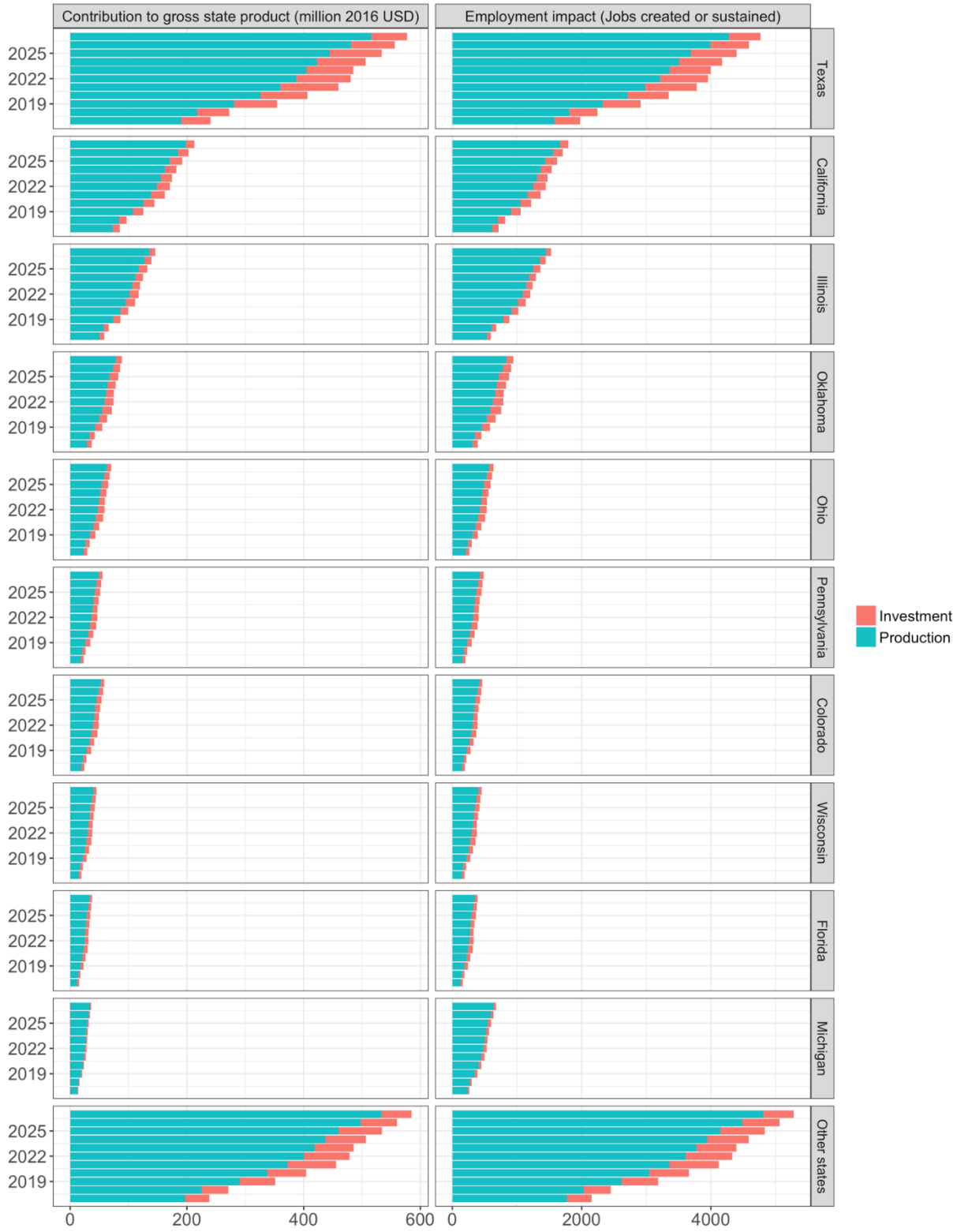
The top ten states that benefit the most from Canadian oil sands development are, in descending order, Texas, California, Illinois, Oklahoma, Ohio, Pennsylvania, Colorado, Wisconsin, Florida, and Michigan (Figure 4.2). Together the top ten states make up 73.5 percent of the total GSP impact and 72.2 percent of total employment impact. Texas is, by far, the largest beneficiary in terms of GSP and employment; GSP is estimated to grow by US$250 million in 2017 to approximately US$600 million in 2027, totalling almost US$5 billion over the 11-year forecast or 30.5 percent of total GSP impact. Growing employment in Texas that is created or sustained will more than double from 2,000 jobs in 2017 to just under 5,000 jobs in 2027.

[2] In the US, the definition of gross state product (GSP) is similar to provincial gross domestic product in Canada.

Table 4.2: Oil Sands Economic Impacts in the US by State and by Type of Impact (2017-2027)

State	Employment Impact (# of Jobs created or sustained)				Contribution to gross state product (million 2016 USD)			
	Direct Effect	Indirect Effect	Induced Effect	Total Effect	Direct Effect	Indirect Effect	Induced Effect	Total Effect
Texas	13,038	13,613	13,484	40,135	$ 2,081	$ 1,676	$ 1,116	$ 4,872
California	4,996	5,195	4,573	14,764	$ 711	$ 606	$ 431	$ 1,749
Illinois	5,900	2,848	3,644	12,392	$ 541	$ 336	$ 323	$ 1,200
Oklahoma	3,155	2,680	2,164	7,998	$ 322	$ 270	$ 160	$ 751
Ohio	1,810	1,760	1,820	5,390	$ 263	$ 188	$ 145	$ 595
Colorado	1,225	1,288	1,400	3,913	$ 231	$ 146	$ 116	$ 493
Pennsylvania	1,490	1,229	1,397	4,116	$ 208	$ 145	$ 117	$ 471
Wisconsin	1,589	1,070	1,162	3,821	$ 193	$ 101	$ 90	$ 385
Wyoming	364	392	252	1,008	$ 274	$ 41	$ 19	$ 334
Florida	1,002	1,196	1,117	3,314	$ 113	$ 117	$ 87	$ 317
Indiana	986	852	797	2,635	$ 155	$ 78	$ 60	$ 293
Michigan	2,577	1,394	1,479	5,451	$ 39	$ 137	$ 112	$ 288
Arizona	943	971	923	2,837	$ 123	$ 82	$ 72	$ 278
Montana	1,031	895	757	2,682	$ 140	$ 78	$ 48	$ 266
Utah	1,037	1,014	887	2,938	$ 106	$ 93	$ 66	$ 265
Minnesota	821	632	732	2,185	$ 115	$ 68	$ 62	$ 245
Oregon	689	810	647	2,146	$ 90	$ 79	$ 48	$ 216
Washington	806	679	527	2,011	$ 77	$ 79	$ 48	$ 203
Iowa	668	593	522	1,783	$ 97	$ 57	$ 38	$ 193
Georgia	586	477	498	1,562	$ 79	$ 49	$ 40	$ 167
Kentucky	660	459	594	1,713	$ 79	$ 42	$ 43	$ 164
New York	574	375	350	1,300	$ 73	$ 51	$ 36	$ 159
North Carolina	463	438	413	1,315	$ 84	$ 42	$ 32	$ 158
New Jersey	386	398	403	1,186	$ 58	$ 52	$ 39	$ 150
Louisiana	543	424	422	1,390	$ 74	$ 39	$ 31	$ 145
Kansas	676	604	462	1,742	$ 49	$ 58	$ 34	$ 141
Alabama	390	433	326	1,149	$ 61	$ 42	$ 24	$ 127
North Dakota	182	275	149	605	$ 84	$ 31	$ 11	$ 127
Connecticut	410	261	299	971	$ 57	$ 37	$ 30	$ 125
Missouri	384	373	381	1,139	$ 52	$ 35	$ 29	$ 117
Mississipi	443	440	313	1,196	$ 57	$ 39	$ 21	$ 117
Nevada	505	342	280	1,127	$ 48	$ 34	$ 24	$ 106
Tennessee	376	322	306	1,004	$ 50	$ 32	$ 24	$ 105
Virginia	363	230	220	813	$ 56	$ 25	$ 18	$ 100
South Carolina	418	278	304	1,000	$ 54	$ 23	$ 22	$ 98
Nebraska	353	315	236	904	$ 46	$ 32	$ 18	$ 96
Idaho	441	348	265	1,055	$ 42	$ 26	$ 17	$ 84
Massachusetts	240	167	217	624	$ 40	$ 21	$ 20	$ 81
Arkansas	280	251	196	726	$ 37	$ 24	$ 14	$ 76
Maryland	156	130	119	404	$ 19	$ 15	$ 11	$ 45
New Mexico	133	103	67	303	$ 14	$ 9	$ 5	$ 28
New Hampshire	115	70	94	278	$ 13	$ 7	$ 8	$ 27
West Virginia	41	27	21	88	$ 8	$ 2	$ 1	$ 12
Delaware	32	13	20	65	$ 5	$ 2	$ 2	$ 9
South Dakota	34	23	25	82	$ 4	$ 2	$ 2	$ 8
Maine	24	10	9	43	$ 1	$ 1	$ 1	$ 3
Rhode Island	11	5	7	23	$ 1	$ 1	$ 1	$ 2
Vermont	6	3	4	13	$ 0	$ 0	$ 0	$ 1
Alaska	4	2	2	8	$ 0	$ 0	$ 0	$ 1
Total	**53,356**	**46,707**	**45,283**	**145,347**	**$ 7,126**	**$ 5,151**	**$ 3,715**	**$ 15,992**

Figure 4.2: Oil Sands Economic Impacts in the US (2017-2027)



Economic Impacts of Canadian Oil and Gas Exports to the US

The economic impacts on the US economy as a result of the Canadian oil and gas sector's purchases of goods and services from US firms are significant based on the results from the previous section. This part of the chapter will delve into another aspect of the US-Canada trade – the economic impacts of Canadian exports of oil and gas on the downstream sectors of the US economy.

The US economic impacts of Canadian exports of crude oil and natural gas are estimated based on the assumption that the structure of the Canadian and US economies, as well as their interrelationship, remains static. In other words, the share of oil and gas exports to the US will not grow significantly in the future (there are no assumptions in the modeling that the downstream sector, like crude oil refineries or gas processing/distribution will be expanded or contracted), therefore the impacts will be influenced by the base trade pattern, calculated as an average of historical data for a time period of 2011-2016.

However, there are several factors that could influence the assumption of static structure of two economies. First, Canada is exploring potential exports to global markets by means of east and west coast tide water terminals, which could mean less volumes will be directed to the US. Secondly, US administration could ramp up its oil (and gas) exports to global markets, which would have a significant impact on North American energy flows. Third, a potential US tax reform that would impact the value of US exports and imports will carry consequences not only for US businesses but for Canadian exports to the US as well.

Another caveat that should be considered in interpreting the economic impacts of Canadian exports to the US is the substitution effect. In other words, the US downstream sector can partially replace the Canadian imports with either a) domestic production of crude oil and natural gas, which had already started to happen with the US increasing production from their shale gas and tight oil reserves; and/or b) other foreign sources. In this case, then, it is said with caution that Canadian oil and gas exports created or preserved economic impacts in the US downstream sector are solely responsible for creation or preservation of the US jobs in those sectors. The opposite of a contraction of Canadian exports to the US is an event where significant new volumes of oil and gas enter the US market in the future and displace other US imports, for example Venezuelan crude. In this case, upstream developments would not only create new jobs through additional demand for US goods and services, but they would also preserve jobs currently supported by US crude imports from other countries arriving by sea.

This type of estimation of the US economic impacts of Canadian oil and gas exports does not employ the traditional I/O methodology because there is no introduction to the economy of a particular set of expenditures or 'shocks' in evaluating impacts of exports to the US. Instead, the analysis involves utilizing an analytical approach that first determines the Canadian share of the total US downstream crude oil and natural gas flows based on historic trade pattern of the commodities; and second, applies these shares to the US downstream (refineries in the case of crude oil and natural gas distribution in the case of natural gas) activity measured in value-add

gross state product and employment to determine the Canadian contribution of the US downstream sectors.

Crude oil is not a final-use product, it needs further processing in the downstream refineries; hence the refining sector is used as a final consumer of crude oil. When it comes to natural gas, it is more complicated, because natural gas can either be used as a final product (heating, cooling) or as an intermediate product (power generation). Therefore, to simplify the analysis in determining how Canadian natural gas exports are used and distributed in the US, the natural gas distribution (NAICS Code 221210) sector is used as a final consumer of gas. The sector is comprised of:

- Establishments primarily engaged in operating gas distribution systems (e.g., mains, meters);
- Establishments known as gas marketers that buy gas from the well and sell it to a distribution system;
- Establishments known as gas brokers or agents that arrange the sale of gas over gas distribution systems operated by others; and
- Establishments primarily engaged in transmitting and distributing gas to final consumers.

The Canadian export data was obtained from the trade data published by Industry Canada, the oil and gas inputs in the US refinery and natural gas distribution sectors were sourced from the US EIA. The economic contributions of the two US downstream sectors for the most recent year available came from the data tables in the IMPLAN® model.

Economic Impacts of Natural Gas Exports

Based on Industry Canada's five-year (2011-2016) average of Canadian natural gas exports to the US, ten states were identified where a portion or most of natural gas distribution activity is attributable to Canadian natural gas imports (Table 4.3). The trade information from Industry Canada differs from the EIA data in gas volumes and which US states receive Canadian gas. The EIA shows natural gas imports at the entry point in the US, whereas Industry Canada shows it by the final recipient. The top three recipients of Canadian natural gas are Washington, New York and Illinois. Vermont is solely dependent on Canadian natural gas. Gas from western Canada is transported along the TCPL and arrives at the Vermont Gas System at Highgate. The Vermont system does not connect with any other pipelines. Washington has no production and relies heavily on gas from Canada as well.

Table 4.3: Canadian Natural Gas Exports by State

State	CAD Exports - 5-yr avg	CAD Exports - 5-yr avg	CAD import fraction
	Mmcf per year	Mmcfpd	%
Washington	1,021,217	2,798	88.0%
New York	660,590	1,810	26.8%
Illinois	546,420	1,497	15.0%
Iowa	173,703	476	7.9%
Minnesota	170,014	466	8.6%
Michigan	166,222	455	8.2%
Massachusetts	110,525	303	0.9%
Montana	18,830	52	2.3%
Vermont	15,717	43	100.0%
Tennessee	9,918	27	0.5%

Source: Industry Canada, EIA

According to the latest data from IMPLAN®, the historic 2015 value-added GSP and employment in the natural gas distribution sector varies significantly state by state. The sector in New York and Illinois is larger than in the rest of the importing states. GSP and employment impacts in New York are US$3.7 billion and 26,356 jobs, respectively (Table 4.4).

The US economic impacts attributable to Canadian gas exports are presented in Table 4.4. The GSP impact is largest in New York (US$985 million), closely followed by Washington (US$619 million). Employment impacts attributable to Canada's gas exports follow a similar pattern as GSP. The number of jobs is highest in New York (7,050 jobs) followed by Illinois (3,501 jobs).

Table 4.4: US Economic Impacts of Canadian Natural Gas Exports

State	Total								Attributable to Imports from Canada							
	Employment				Gross State Product				Employment				Gross State Product			
	Direct Effect	Indirect Effect	Induced Effect	Total Effect	Direct Effect	Indirect Effect	Induced Effect	Total Effect	Direct Effect	Indirect Effect	Induced Effect	Total Effect	Direct Effect	Indirect Effect	Induced Effect	Total Effect
	# Jobs				Mln 2016 USD				# Jobs				Mln 2016 USD			
Washington	1,214	1,405	1,360	3,979	$ 451	$ 129	$ 123	$ 703	1,068	1,236	1,197	**3,501**	$ 397	$ 114	$ 108	**$ 619**
New York	7,784	9,594	8,978	26,356	$ 1,902	$ 867	$ 915	$ 3,683	2,082	2,567	2,402	**7,050**	$ 509	$ 232	$ 245	**$ 985**
Illinois	4,611	6,731	6,308	17,650	$ 1,026	$ 622	$ 560	$ 2,208	690	1,008	945	**2,643**	$ 154	$ 93	$ 84	**$ 331**
Iowa	829	1,282	818	2,929	$ 147	$ 86	$ 60	$ 292	65	101	65	**231**	$ 12	$ 7	$ 5	**$ 23**
Minnesota	1,745	2,357	2,362	6,464	$ 331	$ 225	$ 201	$ 757	151	204	204	**558**	$ 29	$ 19	$ 17	**$ 65**
Michigan	2,679	5,299	4,658	12,636	$ 578	$ 356	$ 354	$ 1,288	219	434	381	**1,035**	$ 47	$ 29	$ 29	**$ 105**
Massachusetts	2,728	3,539	4,012	10,278	$ 651	$ 336	$ 372	$ 1,359	24	32	36	**92**	$ 6	$ 3	$ 3	**$ 12**
Montana	405	668	563	1,636	$ 72	$ 59	$ 36	$ 167	9	15	13	**38**	$ 2	$ 1	$ 1	**$ 4**
Vermont	143	287	144	574	$ 26	$ 11	$ 10	$ 48	143	287	144	**574**	$ 26	$ 11	$ 10	**$ 48**
Tennessee	593	1,194	790	2,578	$ 140	$ 66	$ 62	$ 268	3	6	4	**13**	$ 1	$ 0	$ 0	**$ 1**

Source: Industry Canada, EIA. Note: The indirect impact includes the transportation to a distribution hub.

Economic Impacts of Crude Oil Exports

Based on the five-year (2011-2016) average of Canadian crude exports to US refineries, and the total US crude oil refinery input, we determined the Canadian import share for each PADD

region.[3] The largest market share for the Canadian exports is by far the PADD 2 (US Midwest) region, at 55 percent, receiving 1.8 MMbpd on average. PADD 4 is next at 44 percent, followed by PADD 1, PADD 5, and PADD 3.

According to the latest data from IMPLAN®, the historic 2015 value-added GSP and employment in the refining sector differs from PADD to PADD region. PADD 3 (US Gulf Coast) is home to the largest refining capacity in the US and the world, therefore, it is not surprising that it also has the highest GSP and employment impacts among all the PADD regions' refining sectors. PADD 3 refineries capture US$129.6 billion of annual gross state product and generate 521,517 jobs (Table 4.5). However, Canadian imports make up a small amount of total crude input into PADD 3 refineries, and hence the economic impacts that are attributable to Canadian exports to PADD 3 are a small share of total PADD 3 impacts: annual GSP impact is US$3.6 billion (CAD$4.6 billion) and employment is 14,310 jobs.

Interestingly enough, while PADD 2 total economic impacts are less than PADD 3 impacts (GSP – US$41.6 billion, employment – 158,376 jobs), the region imports by far the most Canadian exports directed to the US. The economic impacts that are attributable to Canadian exports to PADD 2, therefore, are larger than in PADD 3. Annual GSP and employment impacts measure at about half of total PADD 2 impacts; annual GSP attributable to Canadian exports is US$22.9 billion (CAD$29.3 billion) and employment impact is 87,148 jobs.

The economic impacts that are attributable to the Canadian exports in other PADD regions are illustrated in Table 4.5 and in Figure 4.3.

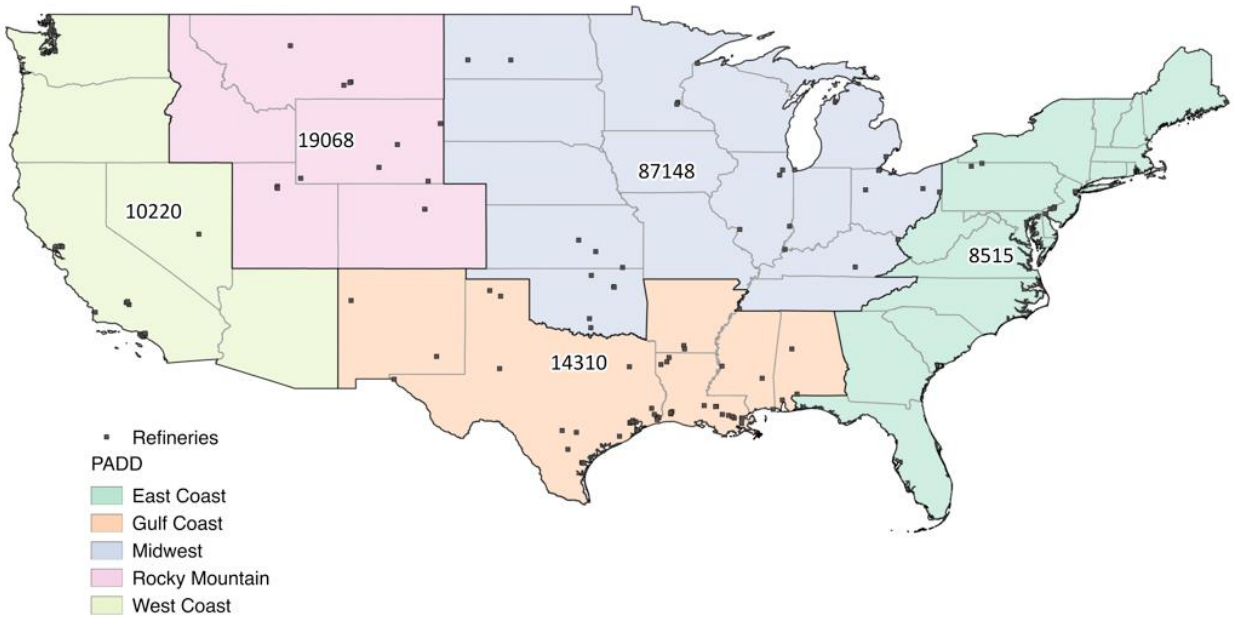
Table 4.5: US Economic Impacts of Canadian Crude Oil Exports

					Total		Attributable to Imports from Canada	
PADD	ImpactType	CAD Exports - 5-yr avg	CAD Exports - 5-yr avg	CAD import fraction	Employment	GSP	Employment	GSP
		Mb per year	Mbpd	%	# Jobs/year	Mln 2016 USD	# Jobs/year	Mln 2016 USD
PADD1	Direct Effect	10,667	184	22.4%	3,832	$ 4,638.95	860	$ 1,040.76
PADD1	Indirect Effect	10,667	184	22.4%	17,544	$ 2,747.26	3,936	$ 616.36
PADD1	Induced Effect	10,667	184	22.4%	16,578	$ 1,444.06	3,719	$ 323.98
PADD1	**Total Effect**	**10,667**	**184**	**22.4%**	**37,955**	**$ 8,830.26**	**8,515**	**$ 1,981.10**
PADD2	Direct Effect	105,431	1,817	55.0%	12,748	$ 29,933.92	7,015	$ 16,471.53
PADD2	Indirect Effect	105,431	1,817	55.0%	89,589	$ 7,251.77	49,298	$ 3,990.38
PADD2	Induced Effect	105,431	1,817	55.0%	56,038	$ 4,410.64	30,836	$ 2,427.01
PADD2	**Total Effect**	**105,431**	**1,817**	**55.0%**	**158,376**	**$ 41,596.32**	**87,148**	**$ 22,888.92**
PADD3	Direct Effect	10,340	178	2.7%	32,337	$ 62,383.20	887	$ 1,711.71
PADD3	Indirect Effect	10,340	178	2.7%	235,508	$ 46,761.26	6,462	$ 1,283.06
PADD3	Induced Effect	10,340	178	2.7%	253,672	$ 20,459.06	6,960	$ 561.37
PADD3	**Total Effect**	**10,340**	**178**	**2.7%**	**521,517**	**$ 129,603.53**	**14,310**	**$ 3,556.14**
PADD4	Direct Effect	17,586	303	43.5%	4,151	$ 5,133.97	1,807	$ 2,235.18
PADD4	Indirect Effect	17,586	303	43.5%	22,620	$ 3,493.80	9,848	$ 1,521.10
PADD4	Induced Effect	17,586	303	43.5%	17,026	$ 1,262.99	7,412	$ 549.87
PADD4	**Total Effect**	**17,586**	**303**	**43.5%**	**43,797**	**$ 9,890.77**	**19,068**	**$ 4,306.14**
PADD5	Direct Effect	11,720	202	8.8%	12,079	$ 19,024.09	1,058	$ 1,665.88
PADD5	Indirect Effect	11,720	202	8.8%	55,868	$ 8,192.73	4,892	$ 717.41
PADD5	Induced Effect	11,720	202	8.8%	48,760	$ 4,579.01	4,270	$ 400.97
PADD5	**Total Effect**	**11,720**	**202**	**8.8%**	**116,706**	**$ 31,795.84**	**10,220**	**$ 2,784.26**

Source: US EIA, Statistics Canada. Note: The indirect impact includes the transportation to a refinery.

[3] Crude oil input/demand to refineries by state is not available from the US EIA due to confidentiality.

Figure 4.3: US Employment Impacts of Canadian Crude Oil Exports



Chapter 5: Conclusions

This study examined the economic impacts of the Canadian oil and natural gas industry on both Canadian and the US economies, down to the provincial and state levels. This study is timely, particularly as the first round of NAFTA renegotiations will be held in Washington on August 16-20, 2017.[1]

Both countries form an integrated North American system, linked together by physical and economic infrastructure. While Canada is currently a net exporter of both commodities, natural gas and oil flow in both directions, as do other commodities critical to produce oil and gas in Canada. It is the latter that is often overlooked. The US benefits from not only importing and refining petroleum products from western Canada, but also from supplying products used by the Canadian oil and gas industry. Components, from trucks, gauges and valves are produced in central Canada or imported from the US. Products such as condensate, an ultra-light oil to help dilute bitumen from the oil sands, is an important commodity in Alberta that is imported from the US.

Summary of the Canadian Economic Impacts

The Canadian oil and gas industry is a significant contributor to the provincial and national economies in Canada. For the foreseeable future, natural gas and crude oil will be important elements in many economic sectors in Canadian and North American economies.

The recent 2014 decline in crude prices and persistently low natural gas prices have not only impacted the energy sector, but overall Canadian and provincial economies. CERI estimated that the low crude oil prices carry a net negative effect on the Canadian GDP growth. As a rule of thumb, for every Canadian dollar increase in WTI price, the Canadian GDP would gain almost CAD$1.7 billion, on average.[2]

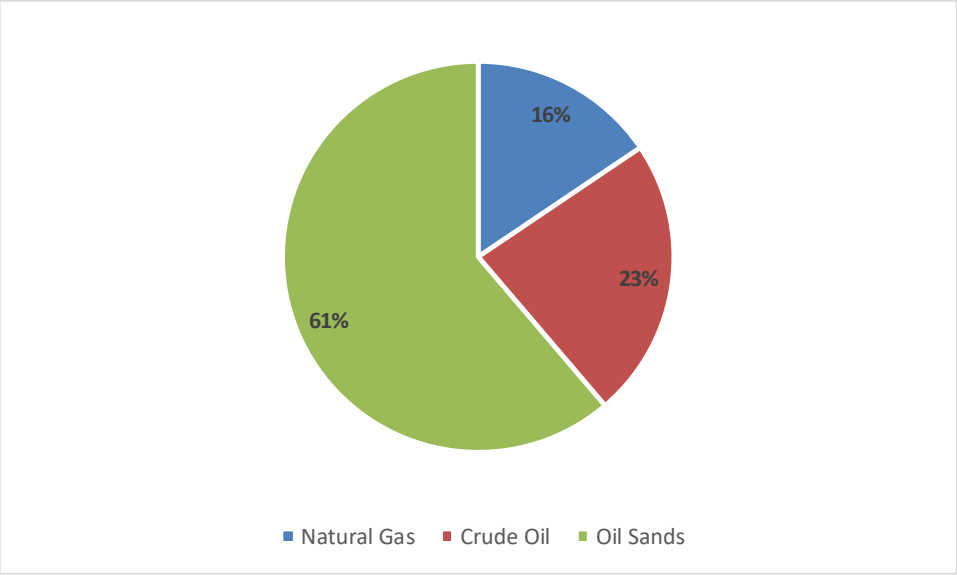
This section will summarize the Canadian economic impacts from the three upstream sectors that produce natural gas, crude oil and oil sands.

Among the commodities that were evaluated, the economic impacts from the oil sands development are greater than impacts from natural gas and conventional crude. This is in line with the fact that the oil sands sector's investment and operations have higher monetary value based on higher production levels. Total GDP impact from investment and operations throughout the forecast period of 2017-2027 for oil sands is almost CAD$1.7 trillion or 61 percent of total GDP impact, in comparison to GDP impact from crude oil – CAD$630 billion, or natural gas – CAD$422.5 billion (Figure 5.1).

[1] The Globe and Mail. "What the U.S. wants from NAFTA talks". https://www.theglobeandmail.com///news/politics/what-the-us-wants-from-naftatalks/article35714358/?cmpid=rss1/?567

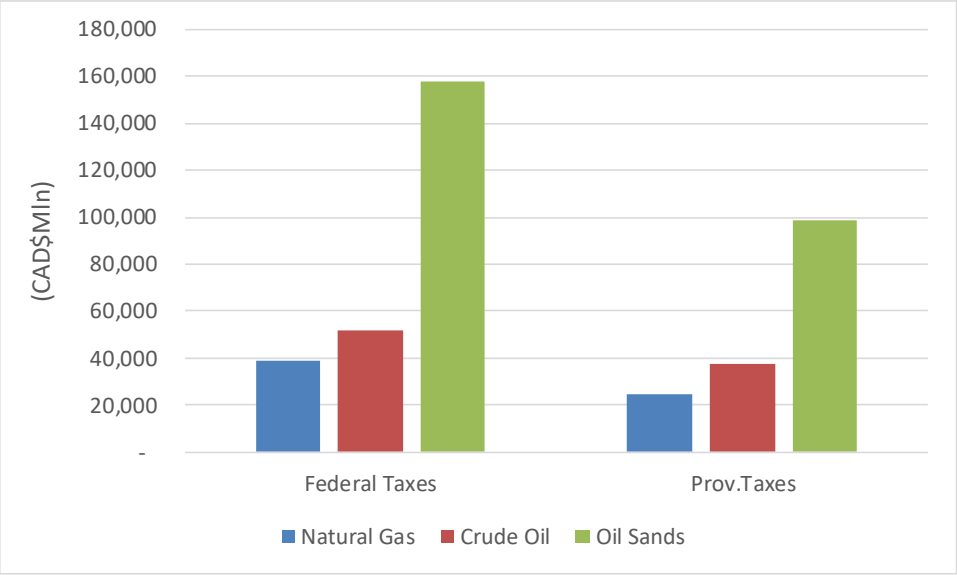
[2] CERI Study 156. "Low Crude Oil Prices and Their Impact on the Canadian Economy". February 2016.

Figure 5.1: Total GDP Impacts by Commodity (2017-2027)



Similarly, with government tax revenues, those collected and received from the oil sands projects are higher in magnitude. Federal taxes from oil sands projects are three times higher than those collected from conventional crude projects (Figure 5.2). Provincial tax revenues follow a parallel pattern – oil sands related provincial taxes are higher than those for gas and conventional crude put together.

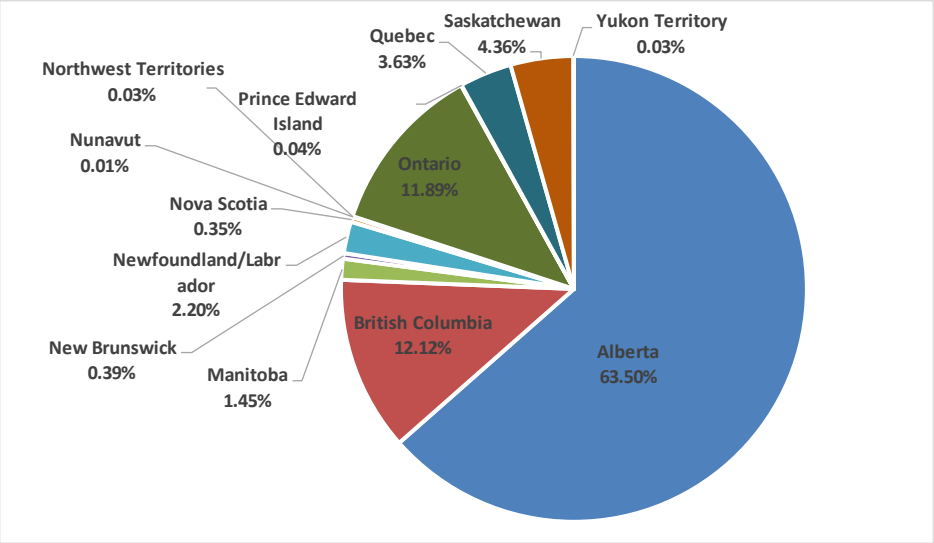
Figure 5.2: Total Tax Revenues by Commodity (2017-2027)



Total employment impacts from all Canadian oil and gas development will materialize in every province and territory. The largest labour impact will be felt in Alberta. However, companies that are suppliers of goods and services, such as machinery, manufacturing, trade, legal, environmental, financial services, often located outside of Alberta, will also benefit. While

Alberta's share of total employment is 64 percent, British Columbia and Ontario will also see employment impacts (each province's share at 12 percent).

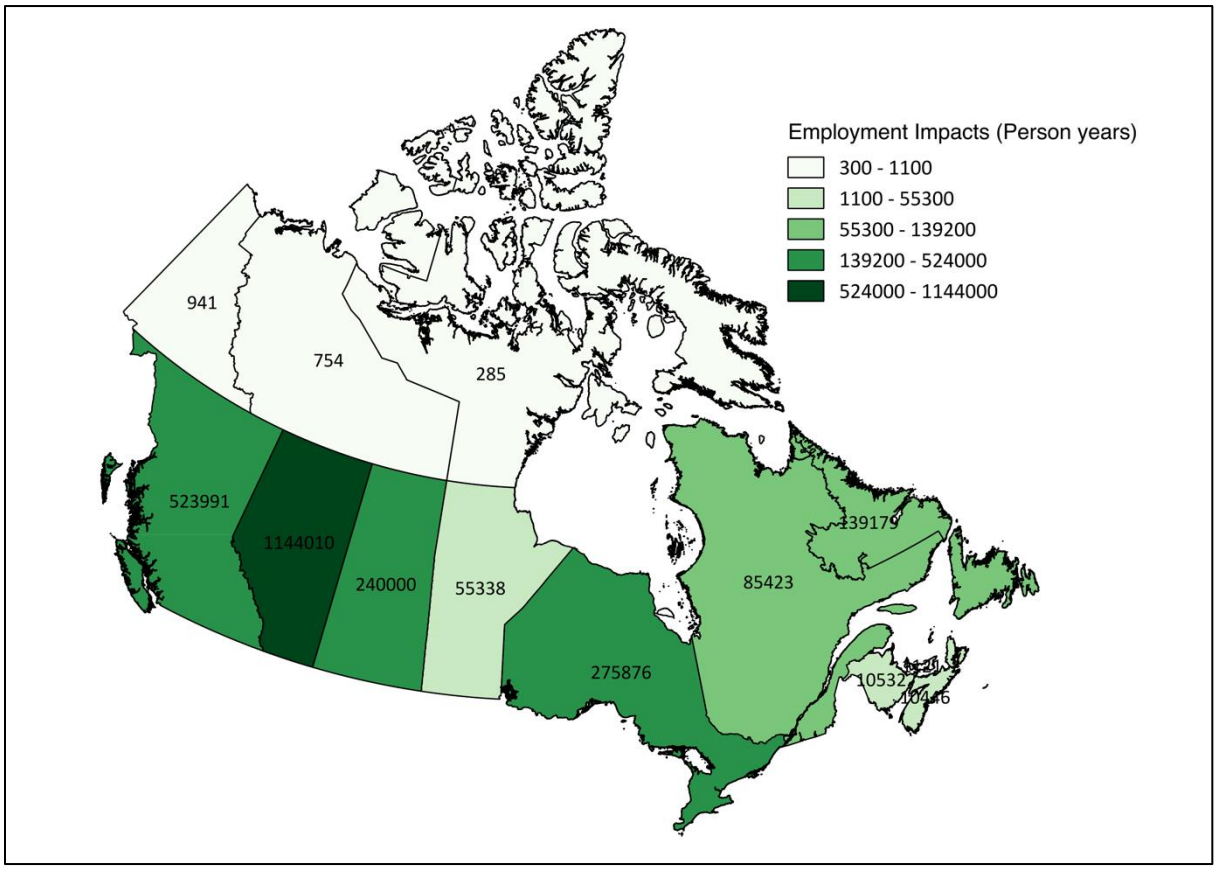
Figure 5.3: Total Employment by Province (2017-2027)



Overall, the employment impacts for conventional oil and gas (Figure 5.4) and oil sands (Figure 5.5) are spread out across the provinces. This is expected because while many oil and gas companies are committed to supporting local businesses and workers by purchasing goods and services from local suppliers and hiring local residents in the areas of oil and gas development, in some cases, it is either in the best interest of the company or their only option to seek goods and services from outside of the province where development is happening. Certain specialized goods and services must come from outside a specific province and even outside Canada. This out of province spending implies an increased spill-over effect or economic leakages from a base province (like British Columbia with shale gas production) to other provinces and even other countries.

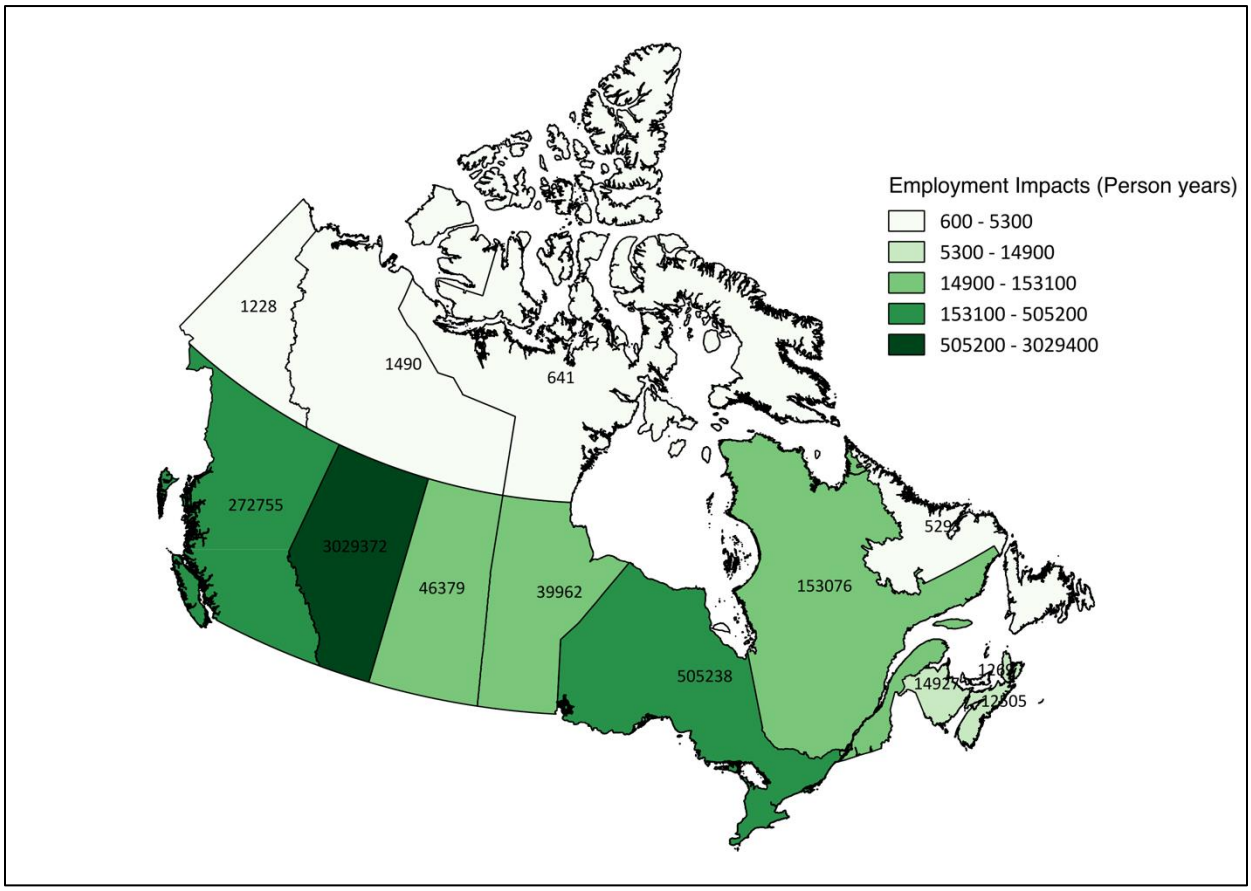
As Figure 5.4 illustrates, the largest employment impact from conventional oil and gas activity in the provinces of British Columbia, Alberta, Saskatchewan, Manitoba, and Newfoundland will be felt in Alberta, followed by British Columbia, Ontario and Saskatchewan; all other provinces and territories will also be impacted.

Figure 5.4: Canadian Employment Impacts of Conventional Oil and Gas Development



The total employment impact from the oil sands sector's activity will be predominant in the province of Alberta. Similarly, to the labour impacts from conventional oil and gas, all other provinces and territories are impacted. The second largest beneficiary in terms of incremental employment is Ontario, followed by British Columbia.

Figure 5.5: Canadian Employment Impacts of Oil Sands Development



Summary of the US Economic Impacts

As previously mentioned, any out-of-Canada spending by the Canadian oil and gas sector implies a spill-over effect, where economic impacts accrue outside of Canada but they can be attributed to the development of Canadian oil and gas resources. This report deals with the economic impacts of Canadian purchases of goods and services in the US only. Any spending done outside of Canada or US is not covered here.

Besides the economic impacts of the spill-over effect in the US, there are impacts that are associated with Canadian exports of oil and gas to the US. As stated in Chapter 4, these should be treated with careful consideration for the reasons outlined earlier.

This section summarizes the US job impacts resulting from the upstream development of Canadian oil and gas.

Figure 5.6: US Employment Impacts of Canadian Oil and Gas Development

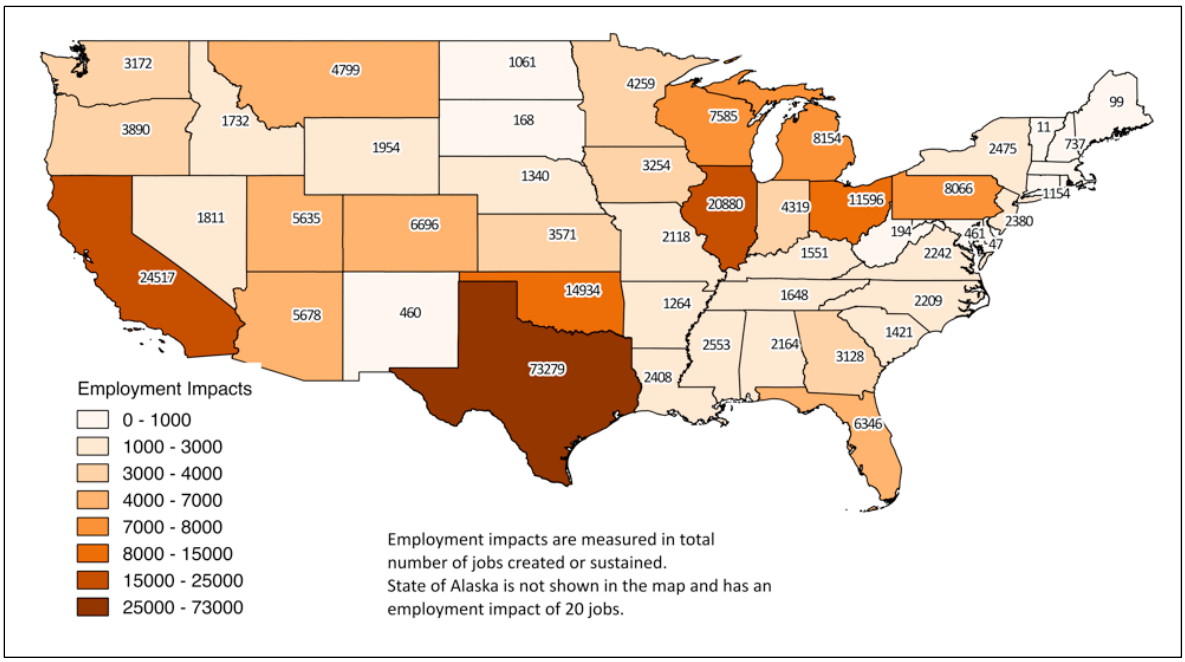
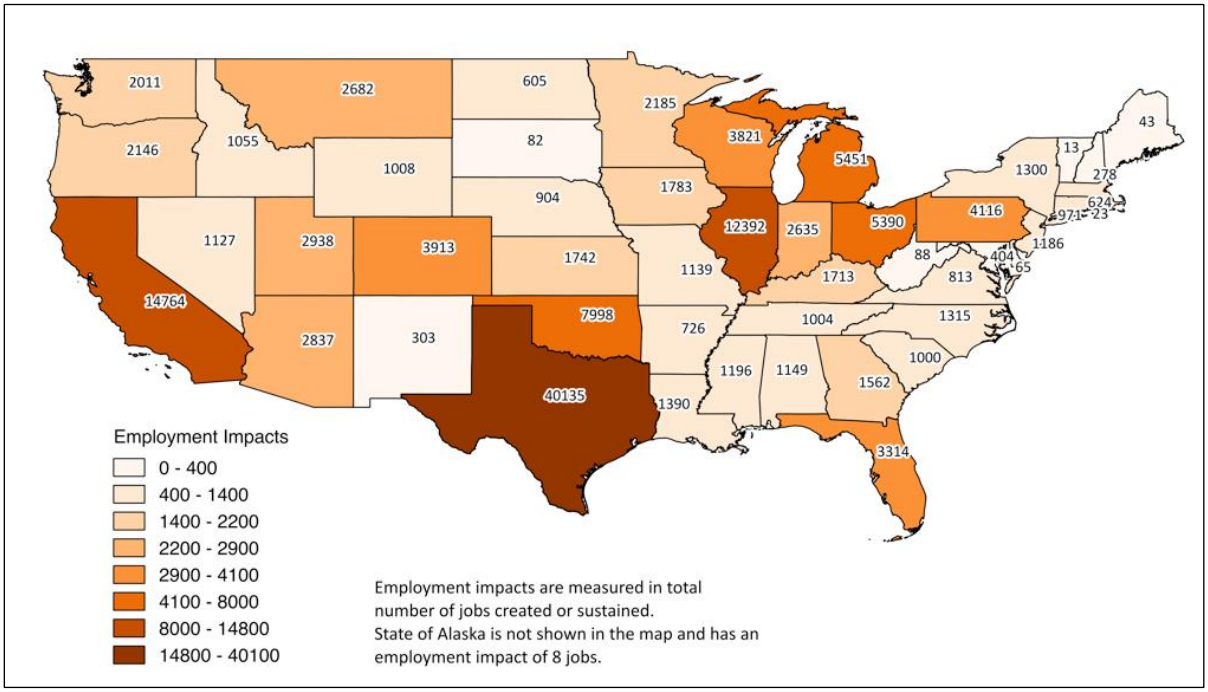


Figure 5.7: US Employment Impacts of Canadian Oil Sands Development



Summary of Economic Impacts

In summary, total economic impacts from investment and operations of Canadian oil and gas projects contribute to economic growth and employment in both countries. The capital investment of CAD$380 billion and operational revenues of CAD$1.8 trillion from Canadian oil and gas projects over the 11-year period will generate CAD$2.7 trillion in Canadian GDP and 6,572 thousand person-years in Canada, and US$45.6 billion in US GSP and 406 thousand jobs in the US (Table 5.1).

Table 5.1: Summary of Economic Impacts and Investments (2017-2027)

Total Capital Investment	*Mln 2016 CAD$*	**$380,133**
Total Operations	*Mln 2016 CAD$*	**$1,832,568**
Canada		
GDP	*Mln 2016 CAD$*	**$2,715,497**
Employment	*Person-years*	**6,572,030**
US		
GSP	*Mln 2016 US$*	**$45,592**
Employment	*# of Jobs*	**405,833**

For every direct job created in the Canadian oil and gas sector, 2 indirect and 3 induced jobs in other sectors are created in Canada on average. For every Canadian million dollars invested and generated in the Canadian oil and gas sector, Canadian GDP impact is CAD$1.2 million.

For every direct job created or sustained in the US, one indirect and one induced jobs are created or preserved in the US. For every US million dollars spent by the Canadian oil and gas and related service sectors in the US, US$0.6 million (CAD$0.8 million) is generated in US GSP.

Appendix A: Input-Output Models

This appendix discusses the multi-stage process to build CERI's Canada Multi-Regional Input-Output Model (the CMRIO 4.0 model). It also covers the US IMPLAN® model. The former is divided into two parts: the development of the CMRIO 4.0 and the economic sectors covered in the CMRIO 4.0. The latter discusses the US IMPLAN® Model.

CERI CMRIO 4.0

The following illustrates how the CMRIO 4.0 was developed, and how one can trace direct, indirect, and induced effects of the Canadian energy sector on the Canadian economy. The model provides insights at the provincial and national levels for Canada. The base year for the I/O tables is 2011, as this is the latest symmetric tables provided by Statistics Canada.

Compilation of the national CMRIO 4.0 includes the following:

1) Statistics Canada provides S level Symmetrical I/O tables (SIOTs) and Final Demand tables for 13 provinces and territories plus Government Abroad. Therefore, there are 14 regional tables for Canada plus one national table. Provincial data are only available at the S level due to confidentiality of more disaggregated data for some sectors in various provinces. The I/O tables used are at producer's prices (Basic Prices), meaning that CERI did not construct symmetrical tables from the Use and Make tables, as the compiled tables were available. As previously mentioned, the base year for the I/O tables is 2011.[1]

2) SIOTs are balanced. Hence, the use of inputs in the economy is equal to the production of outputs.

3) In order to highlight the energy sectors in the Canadian provincial SIOTs, CERI disaggregated the "Mining and Oil and Gas Extraction'' industry into five subsectors: Conventional Oil, Oil Sands, Natural Gas and NGLs, Coal, and Other Mining. In the same fashion, the manufacturing sector is divided into three subsectors: Refinery, Petrochemical, and Other Manufacturing.

4) It is important to note that the construction sector in this version is already split into the following five sub-sectors by Statistics Canada: Residential Construction, Non-residential Building Construction, Engineering Construction, Repair Construction and Other Activities of the Construction Industry.

5) CERI combines the SIOTs (13 provincial tables, and one for Government Abroad) to compile one national I/O matrix. The national matrix is then inverted to generate direct, indirect, and induced effect multipliers.

[1]Use tables show the inputs to industry production and commodity composition of final demand. Make tables show the commodities that are produced by each industry.

The following is a brief discussion of the modeling.

Based on a standard I/O model notation, and considering total gross outputs vector (**X**) and final demand vector (**FD**), the following relationship in I/O context holds as:

$$AX+FD = X \rightarrow (I-A)X=FD \rightarrow X= (I-A)^{-1}FD \rightarrow X= L.FD \qquad \text{(Equation 1)}$$

Where:
A = the matrix of input coefficients (n×n),
I = identity matrix (n×n), and
L = the Leontief inverse matrix (n×n).

This is the core formula of the Leontief quantity model. This relationship estimates direct and indirect impacts for a single economy (i.e., no trade flow). CERI can expand this model to include induced effects by endogenizing the most important component of local final demand, namely private consumption. This captures the economic impact of increased consumption due to earned wages from new jobs.

After endogenizing the private consumption expenditure, CERI arrives at the following relationship:

$$X = (I-Aind)^{-1}FD^* \qquad \text{(Equation 2)}$$

CERI endogenizes the household's private consumption expenditures and earnings by adding one column and one row to every province which then creates a new matrix of input coefficients as labeled **Aind**. This relationship estimates direct and indirect impacts.

CERI can extend the model to involve other economies (regions) by incorporating the interregional trade flow matrix **C**(n×n). After several steps of calculation, we arrive at the final interregional formula:

$$X = (I-C.Aind)^{-1}C.FD^* \qquad \text{(Equation 3)}$$

In the above equation, to have a finite solution, **(I-C.Aind**) must be a non-singular matrix.[2] As is the case for standard I/O models, the impact of an industry, such as the oil sands industry, is calculated by modeling the relationship between total gross outputs and final demand as follows:

$$\Delta X = (I-C.Aind)^{-1}C.\Delta FD^* \qquad \text{(Equation 4)}$$

Where:
ΔX – Changes (or increases) in total gross outputs of all provinces and territories, at the sectoral level, due to construction and operation of projects (i.e., oil sands). Dimension is either n=485 or 500. Thus, this vector is a 485x1 or 500×1 vector.

[2]For further information on Interregional I/O analysis please see (Howard et al. 2009; Hertwich and Peters 2010; Miller and Blair 2009; Oosterhaven, Stelder, and Inomata 2008; Sim, Secretario, and Suan 2007).

I – is a 485x485 or 500×500 identity matrix, unity for diagonal elements and zero for off-diagonal elements.
A – is a 485×485 block diagonal matrix of technical coefficients at the sectoral level for Canada. It is composed of 14 blocks of 33×33 matrix corresponding to each province (or territory) input technical coefficient matrix.[3] An element of such a matrix is derived by dividing the value of a commodity used in a sector by the total output of that sector. The element represents requirements of a commodity in a sector in order to produce one unit of output from that sector.
Aind – is a 500×500 block diagonal matrix of technical coefficients at the sectoral level for Canada. It is composed of 14 blocks of 34×34 matrix corresponding to each province (or territory) input technical coefficient matrix.[4] An element of such a matrix is derived by dividing the value of a commodity or household expenditure and earnings used in a sector by the total output of that sector or household expenditure. The element represents requirements of a commodity in a sector in order to produce one unit of output from that sector.
C – is a 485x485 or 500×500 transposed matrix of multi-regional trade coefficients. It includes import and export shares of a sector's total output in a province or territory. Each element on the row of this matrix measures the share of export to a particular sector in a province from a given sector in another province or territory.
ΔFD* – is a 485x1 or 500×1 vector of changes (or increases) in the exogenous part of final demand at the sectoral level. Outputs from Canada resulted from any change in the final demand components in any province or territory, including commodities directly demanded (or purchased) for the construction and development of any sector.

The calculation of total impact is based on the multiplication of direct impact and the inverted matrix. Based on the direct impact on a sector, Equation 4 above is used to estimate all the direct, indirect, and induced effects on all sectors in all provinces, particularly in terms of changes in consumption, imports, exports, production, employment, and net taxes. The direct impact is referred to as **ΔFD*** in Equation 4. The change in final demand (**ΔFD***) consists of various types of investment expenditures, changes in inventories, and government expenditures. In the current model, the personal expenditures are not part of the final demand and have been endogenized to accommodate the induced impact.

Direct impacts are quantitative estimations of the main impact of the programs, in the form of an increase in final demand (increase in public spending, increase in consumption, increase in infrastructure investment, etc.). The assumption of increased demand includes a breakdown per sector, so that it can be translated into the following matrix notation:

Direct, indirect, and induced impacts:

$$\Delta X = (I - C.Aind)^{-1} C.\Delta FD^* \qquad \textbf{(Equation 5)}$$

[3]In other words, one can say all 14 Canadian tables (13 provinces and one Government abroad) technical coefficients matrices are stacked together in construction of a diagonal block matrix at the national level.
[4]ibid.

Direct and indirect impacts:

$$\Delta X = (I - C.A)^{-1} C.\Delta FD \qquad \text{(Equation 6)}$$

The difference between Equation 5 and 6 is referred to as the induced impact of any changes in final demand components.

Once the impact on output (change in total gross outputs) is calculated, the calculation of impacts on GDP, household income, employment, taxes, and so forth, are straightforward. In particular, as previously mentioned, the base year for the I/O tables used in this report is 2011. CERI utilizes the tax information derived from these tables and federal and provincial tax information from the Finances of the Nation, where these numbers reflect the tax structure of the Canadian economy in the year 2011 (Treff and Ort 2012). CERI acknowledges that there have been changes, and there would be imminent changes to the corporate income tax structure and the goods and services sales tax (GST) since 2011. Any changes to the tax regime will result in changes in estimated tax figures as business responds to the new incentives. Therefore, tax estimates should be interpreted on a 2011 basis.

These impacts are estimated at the industry level using the ratio of each (GDP, employment, etc.) to total gross outputs. Using the technical Multi-Regional I/O table, CERI can perform the usual I/O analysis at the provincial and national levels.

Industries in the CMRIO 4.0

This section illustrates the various classification of industries in the CMRIO 4.0. Table A.1 also provides a brief description of the 34 sectors or commodities.

Table A.1. Sectors/Commodities in the CERI Canada Multi-Regional I/O Model

Serial No.	Sector or Commodity	Examples of Activities Under the Sector or Commodity
1	Crop and Animal Production	Farming of wheat, corn, rice, soybean, tobacco, cotton, hay, vegetables and fruits; greenhouse, nursery, and floriculture production; cattle ranching and farming; dairy, egg and meat production; animal aquaculture
2	Forestry and Logging	Timber tract operations; forestry products: logs, bolts, poles and other wood in the rough; pulpwood; custom forestry; forest nurseries and gathering of forest products; logging
3	Fishing, Hunting and Trapping	Fish and seafood: fresh, chilled, or frozen; animal aquaculture products: fresh, chilled or frozen; hunting and trapping products

Serial No.	Sector or Commodity	Examples of Activities Under the Sector or Commodity
4	Support Activities for Agriculture and Forestry	Support activities for crop, animal and forestry productions; services incidental to agriculture and forestry including crop and animal production, e.g., veterinary fees, tree pruning, and surgery services, animal (pet) training, grooming, and boarding services
5	Conventional Oil[5]	Conventional oil, all activities e.g., extraction and services incidental to conventional oil
6	Oil Sands	Oil sands, all activities e.g., extraction and services incidental to oil sands
7	Natural Gas and NGL	Natural gas, NGL, all activities e.g., extraction and services incidental to natural gas and NGL
8	Coal	Coal mining, activities and services incidental to coal mining
9	Other Mining	Mining and beneficiating of metal ores; iron, uranium, aluminum, gold and silver ores; copper, nickel, lead, and zinc ore. Mining; non-metallic mineral mining and quarrying; sand, gravel, clay, ceramic and refractory, limestone, granite mineral mining and quarrying; potash, soda, borate and phosphate mining; all related support activities
10	Utilities	Electric power generation, transmission, and distribution; natural gas distribution; water and sewage
11	Residential Construction	Residential building construction
12	Non-residential Building Construction	Industrial, commercial and institutional buildings
13	Engineering Construction	Engineering construction includes transportation, oil and gas, electric power, communication and other engineering construction
14	Repair Construction	Repairing and renovating construction
15	Other Activities of the Construction Industry	Other activities of the construction industry

[5]Statistics Canada reports the oil, gas, coal, and other mining as one sector due to confidentiality issues. CERI uses an in-house developed approach to disaggregate this sector into five sectors: oil sands, conventional oil, natural gas + NGL, coal, and other mining.

Serial No.	Sector or Commodity	Examples of Activities Under the Sector or Commodity
16	Refinery	Petroleum and coal products; motor gasoline and other fuel oils; tar and pitch, LPG, asphalt, petrochemical feedstocks, coke; petroleum refineries
17	Petrochemical	Chemicals and polymers: resin, rubber, plastics, fibres and filaments; pesticides and fertilizers; etc.
18	Other Manufacturing	Food, beverage and tobacco; textile and apparel; leather and footwear; wood products; furniture and fixtures; pulp and paper; printing; pharmaceuticals and medicine; non-metallic mineral, lime, glass, clay and cement; primary metal, iron, aluminum and other metals; fabricated metal, machinery and equipment, electrical, electronic and transportation equipment, etc.
19	Wholesale Trade	Wholesaling services and margins
20	Retail Trade	Retailing services and margins
21	Transportation and Warehousing	Roads, railways; air, water and pipeline transportation services; postal service, couriers and messengers; warehousing and storage; information and communication; sightseeing and support activities
22	Information and Cultural Industries	Motion picture and sound recording; radio, TV broadcasting and telecommunications; publishing; information and data processing services
23	Finance, Insurance, Real Estate and Rental and Leasing	Insurance carriers; monetary authorities; banking and credit intermediaries; lessors of real estate; renting and leasing services
24	Owner-Occupied Dwellings	Owner-occupied dwellings
25	Professional, Scientific and Technical Services	Advertising and related services; legal, accounting and architectural; engineering and related services; computer system design
26	Administrative and Support, Waste Management and Remediation	Travel arrangements and reservation services; investigation and security services; services to buildings and dwellings; waste management services
27	Educational Services	Universities; elementary and secondary schools; community colleges and educational support services
28	Health Care and Social Assistance	Hospitals; offices of physicians and dentists; misc. ambulatory health care services; nursing and residential care facilities; medical laboratories; child and senior care services

Serial No.	Sector or Commodity	Examples of Activities Under the Sector or Commodity
29	Arts, Entertainment and Recreation	Performing arts; spectator sports and related industries; heritage institutions; gambling, amusement, and recreation industries
30	Accommodation and Food Services	Traveler accommodation, recreational vehicle (RV) parks and recreational camps; rooming and boarding houses; food services and drinking establishments
31	Other Services (Except Public Administration)	Repair and maintenance services; religious, grant-making, civic, and professional organizations; personal and laundry services; private households
32	Non-Profit Institutions Serving Households	Religious organizations; non-profit welfare organizations; non-profit sports and recreation clubs; non-profit education services and institutions
33	Government Sector	Hospitals and government nursing and residential care facilities; universities and government education services; other municipal government services; other provincial and territorial government services; other federal government services including defence
34	Household (Labour)	Household labour

US IMPLAN® Model

Whereas the trade flow between Canadian provinces and territories is provided by Statistics Canada, the trade flow pattern between the individual provinces and the US is available from Industry Canada. The data is used to create a trade flow matrix that depicts trading patterns between each Canadian province or territory and the US state. The trade flow table depicts import flows of goods and services purchased of each Canadian province with a US state. The data is gathered and compiled by CERI and used to run the IMPLAN® model.

IMPLAN® is an acronym for IMpact analysis for PLANning. The IMPLAN® System is a general input output model that is comprised of software and regional datasets. One of the most powerful aspects of IMPLAN® is that input-output models for specific regional economies can be created. Rather than extrapolating regional data from national averages, IMPLAN® measures economic impacts from data representing actual local economies. IMPLAN® datasets are available from the zip code level to the national level, and regional files can be combined to create precise geographic definitions when calculating impacts. This study uses state-level data in the IMPLAN® modeling.

The analysis results in a report that demonstrates the detailed effects of local changes on supporting industries and households. Reports can provide both detailed and summary information related to job creation, income, production, and taxes. IMPLAN® Version 3.0 can

even track the impacts of a local change on surrounding regional economies through a multi-regional analysis.

IMPLAN® data tracks all the available industry groups in every level of the regional data. This permits detailed impact breakdowns and helps ensure accuracy of inter-industry relationships. IMPLAN® traces local impacts by looking back through the supply chain. These backward linkages provide IMPLAN® with the information required to examine the iterations of local indirect and induced impacts until the initial spending is completely removed from the study area by leakage.

Just like the CERI Input-Output model, the IMPLAN® model estimates impacts assuming that the relationships of the current data year are maintained (i.e., relationships are static). The IMPLAN® datasets are a snapshot in time of a local economy.

IMPLAN® datasets are constructed annually by MIG Inc. Regional data is derived from many different sources, primarily federal agencies responsible for data collection. The primary sources for data derivation include:

- the US Bureau of Labour Statistics (BLS) Covered Employment and Wages (CEW) program,
- the US Bureau of Economic Analysis (BEA) Regional Economic Information System (REA) program,
- the US Bureau of Economic Analysis Benchmark I/O Accounts of the US,
- the BEA Output estimates,
- the BLS Consumer Expenditure Survey,
- the US Census Bureau County Business Patterns (CBP) program,
- the US Census Bureau Decennial Census and Population Surveys,
- the US Census Bureau Economic Censuses and Surveys, and
- the US Department of Agriculture Census.

When combined, these sources provide all the elements needed to assemble a complete US dataset. However, the actual assembly of these elements, into a cohesive and complete US IMPLAN® dataset formatted for the software, requires about five months. Since the BLS CEW data is not released until July of the following year (i.e.,2008 data was released in July of 2009), IMPLAN® datasets are also released one year after the current calendar year, typically in the month of December. A more thorough explanation of IMPLAN® data creation, and the federal data sources used to derive the different IMPLAN® data elements is available on the IMPLAN® webpage.

Appendix B: Detailed Results

This Appendix presents the US detailed results that are not shown in the main report. These results are associated with the US Economic Impacts of Canadian Oil and Gas Supply Chain section of Chapter 4.

The first section of Chapter 4 presented the economic impacts of the Canadian oil and gas industry supply chain that were evaluated using the IMPLAN® model for all the US states. This Appendix presents the economic impacts of individual province's oil and gas industry purchases of goods and services from US firms and businesses on all the US states.

The first part of the Appendix shows the results for all oil and gas producing provinces, introduced in Chapter 2, in table format for cumulative results over the 11-year period and graph format for year-by-year impacts. The second part of the Appendix presents the results of the US economic impacts of goods and services purchased from the US by the Canadian energy services sector.

US Economic Impacts of Canadian Provincial Oil and Gas Development

Table B.1: US Economic Impacts of Alberta Oil and Gas Development by Top 10 US States (2017-2027)

	GROSS STATE PRODUCT IMPACT	EMPLOYMENT IMPACT
	Million 2016 USD	# of jobs created or sustained
TEXAS	1,879.7	14,656
CALIFORNIA	613.0	4,903
ILLINOIS	386.6	4,176
OKLAHOMA	280.9	2,987
OHIO	260.8	2,319
PENNSYLVANIA	193.3	1,613
COLORADO	152.8	1,339
WISCONSIN	149.8	1,517
WYOMING	132.3	391
FLORIDA	121.5	1,269

Table B.2: US Economic Impacts of Alberta Oil Sands Development by Top 10 US States (2017-2027)

	GROSS STATE PRODUCT IMPACT	EMPLOYMENT IMPACT
	Million 2016 USD	# of jobs created or sustained
TEXAS	4,872.4	40,135
CALIFORNIA	1,748.8	14,764
ILLINOIS	1,200.3	12,392
OKLAHOMA	751.4	7,998
OHIO	595.2	5,390
COLORADO	493.2	3,913
PENNSYLVANIA	470.7	4,116
WISCONSIN	384.9	3,821
WYOMING	333.9	1,008
FLORIDA	316.5	3,314

Table B.3: US Economic Impacts of British Columbia Oil and Gas Development by Top 10 US States (2017-2027)

	GROSS STATE PRODUCT IMPACT	EMPLOYMENT IMPACT
	Million 2016 USD	# of jobs created or sustained
CALIFORNIA	418.6	3,259
WASHINGTON	330.4	2,895
OREGON	224.8	2,388
ILLINOIS	201.4	1,605
TEXAS	129.6	1,015
OHIO	89.0	727
PENNSYLVANIA	86.7	595
MINNESOTA	52.1	467
WISCONSIN	41.5	400
CONNECTICUT	40.6	328

Table B.4: US Economic Impacts of Saskatchewan Oil and Gas Development by Top 10 US States (2017-2027)

	GROSS STATE PRODUCT IMPACT	EMPLOYMENT IMPACT
	Million 2016 USD	# of jobs created or sustained
TEXAS	311.0	2,733
ILLINOIS	249.3	2,075
WISCONSIN	131.1	1,295
OHIO	100.5	1,003
MINNESOTA	96.0	845
PENNSYLVANIA	70.3	678
NORTH DAKOTA	40.6	210
OKLAHOMA	39.3	418
IOWA	36.7	346
INDIANA	33.2	276

Table B.5: US Economic Impacts of Manitoba Oil Development by Top 10 US States (2017-2027)

	GROSS STATE PRODUCT IMPACT	EMPLOYMENT IMPACT
	Million 2016 USD	# of jobs created or sustained
ILLINOIS	6.3	37
MINNESOTA	5.5	41
TEXAS	4.1	28
WISCONSIN	2.3	22
IOWA	1.6	13
ARKANSAS	1.6	11
OHIO	1.5	12
NEW JERSEY	1.4	10
INDIANA	1.3	11
MASSACHUSETTS	1.2	6

Table B.6: US Economic Impacts of Newfoundland and Labrador Oil Development by Top 10 US States (2017-2027)

	GROSS STATE PRODUCT IMPACT	EMPLOYMENT IMPACT
	Million 2016 USD	# of jobs created or sustained
TEXAS	59.9	499
MISSOURI	15.4	166
VIRGINIA	8.7	55
LOUISIANA	8.3	77
PENNSYLVANIA	6.1	60
GEORGIA	5.1	49
FLORIDA	3.8	37
WISCONSIN	3.7	32
WASHINGTON	3.5	39
CALIFORNIA	2.8	22

Figure B.1: US Economic Impacts of Alberta's Conventional Oil and Gas Development (2017-2027)

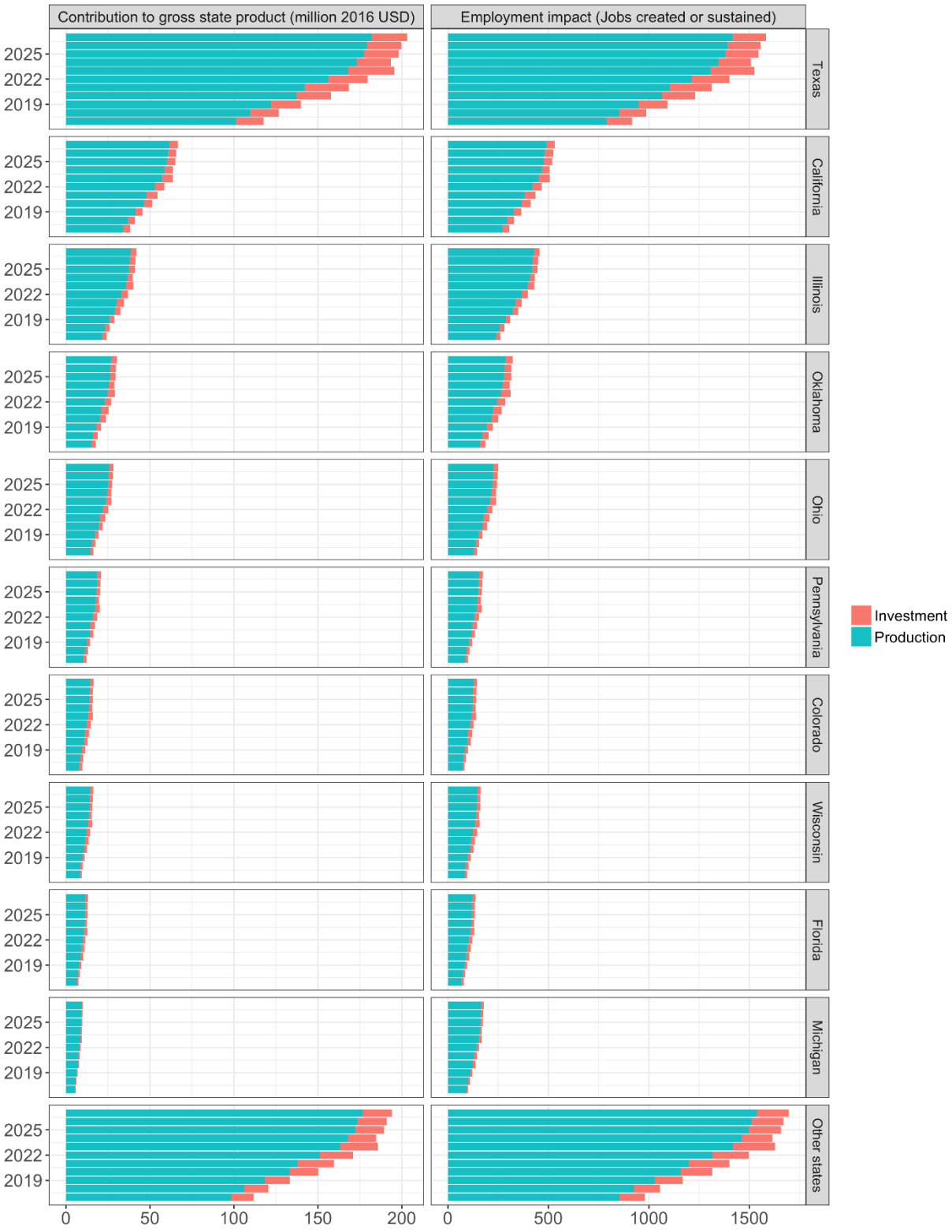


Figure B.2: US Economic Impacts of Alberta's Oil Sands Development (2017-2027)

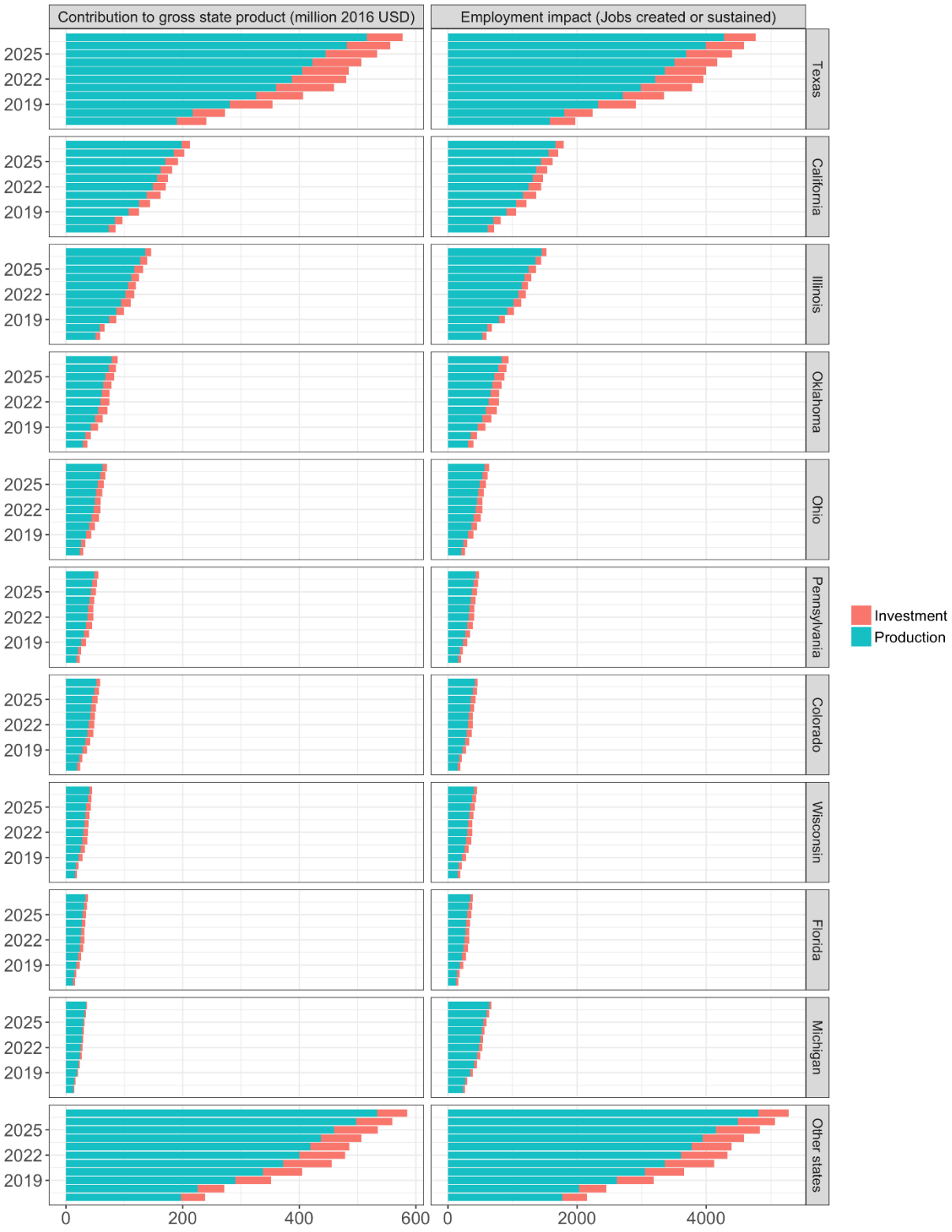


Figure B.3: US Economic Impacts of British Columbia's Oil and Gas Development (2017-2027)

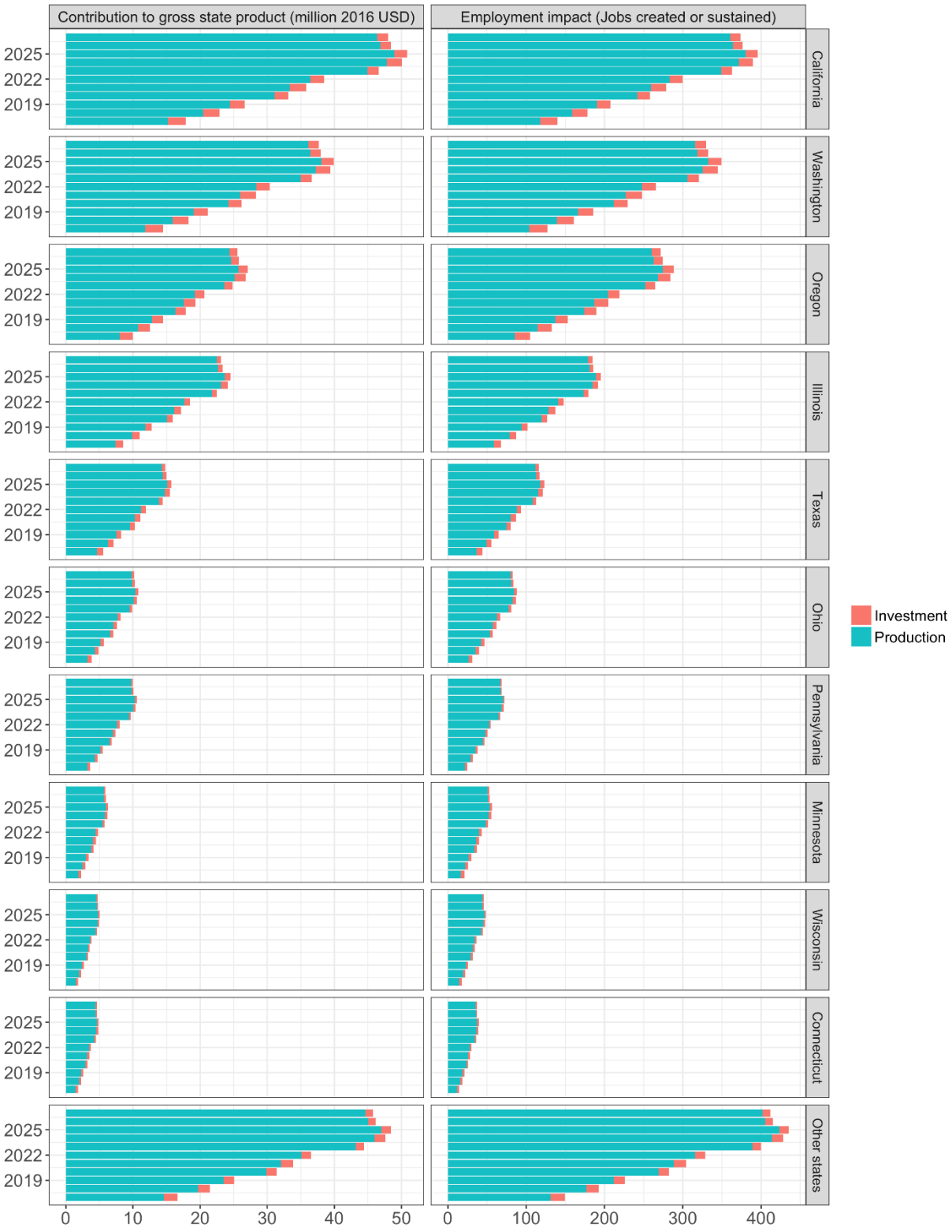


Figure B.4: US Economic Impacts of Saskatchewan's Oil and Gas Development (2017-2027)

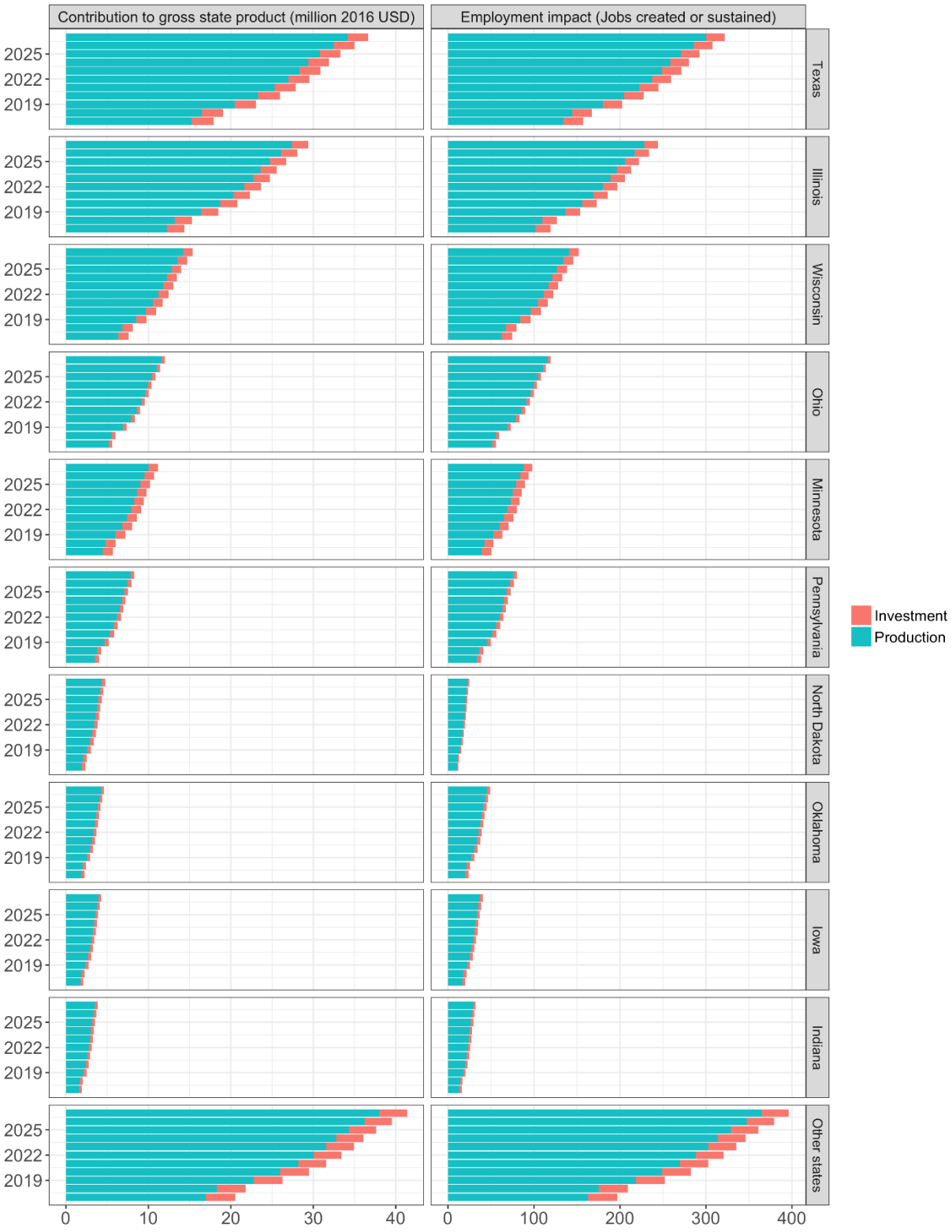


Figure B.5: US Economic Impacts of Manitoba's Oil Development (2017-2027)

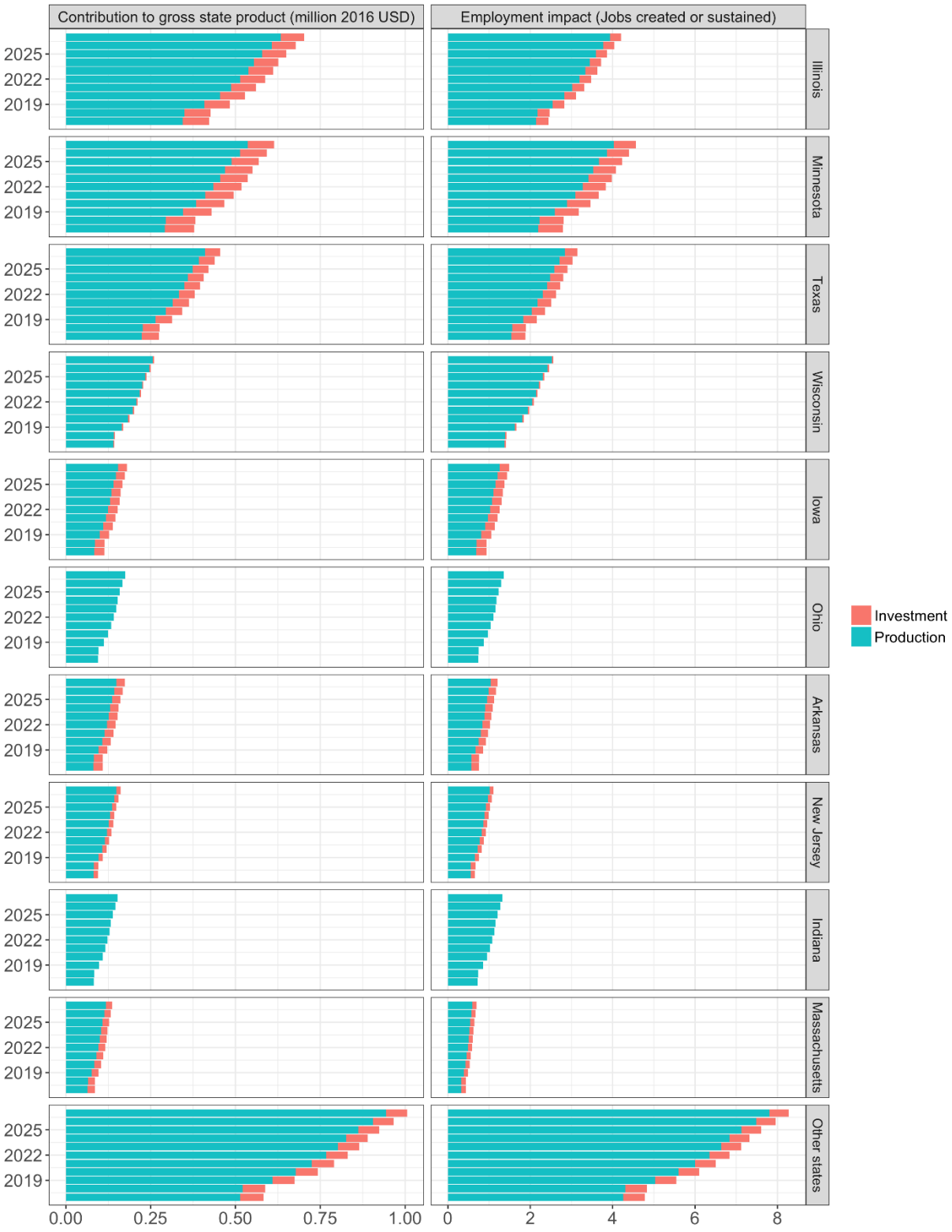
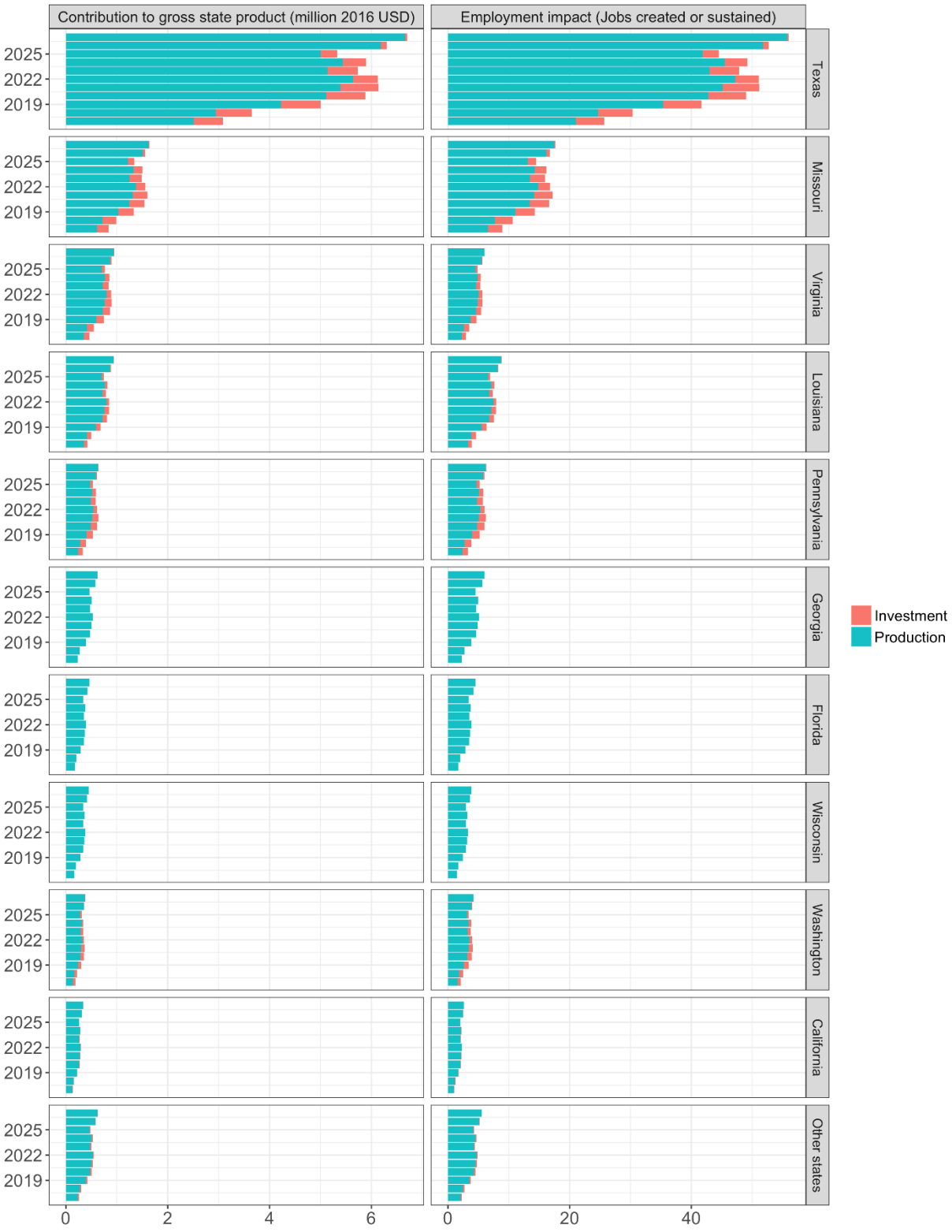


Figure B.6: US Economic Impacts of Newfoundland and Labrador's Oil Development (2017-2027)



US Economic Impacts of the Canadian Oil and Gas Services Sector

Figure B.7: US Economic Impacts of BC's Conventional Oil and Gas Services Sector (2017-2027)

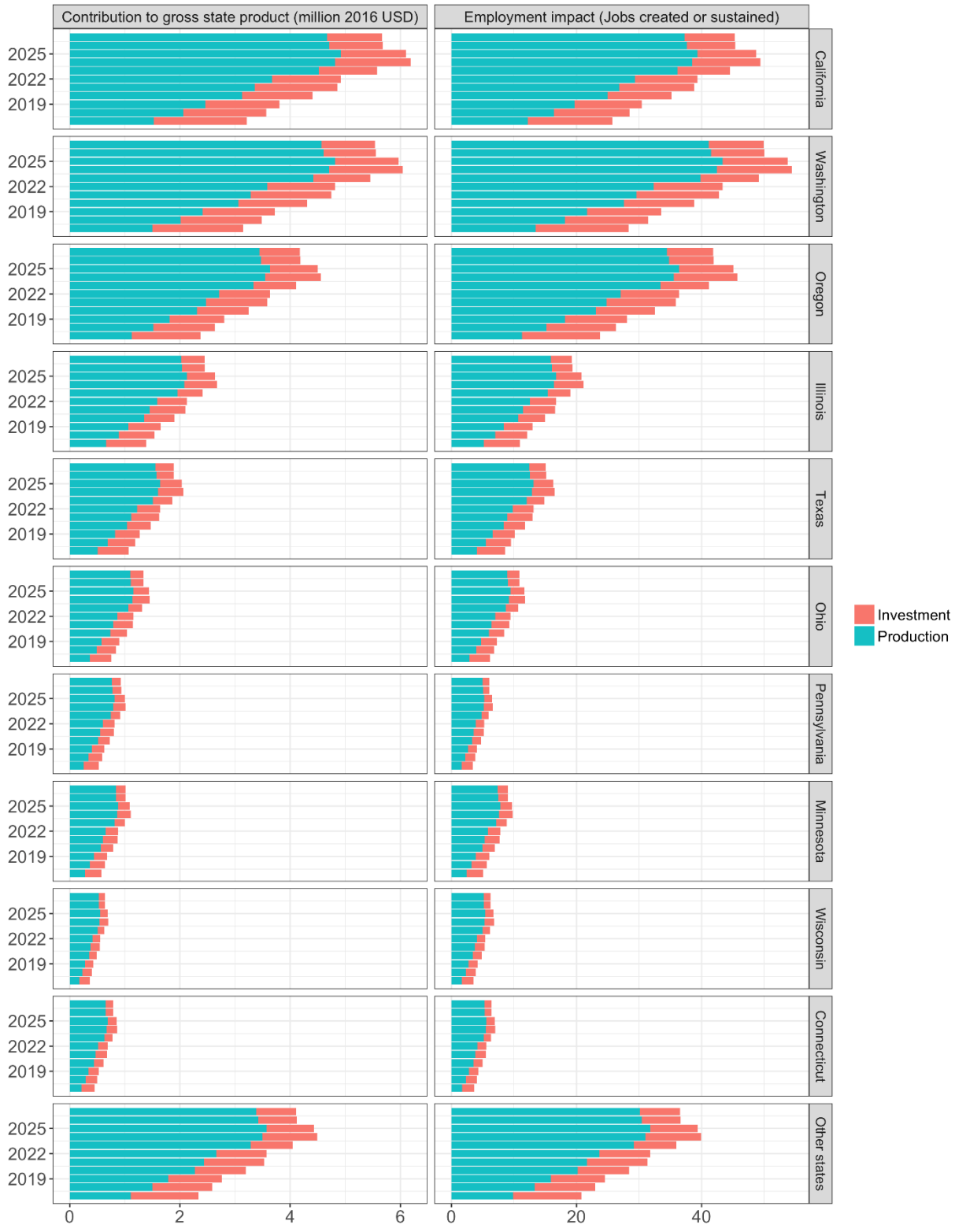


Figure B.8: US Economic Impacts of Alberta's Conventional Oil and Gas Services Sector (2017-2027)

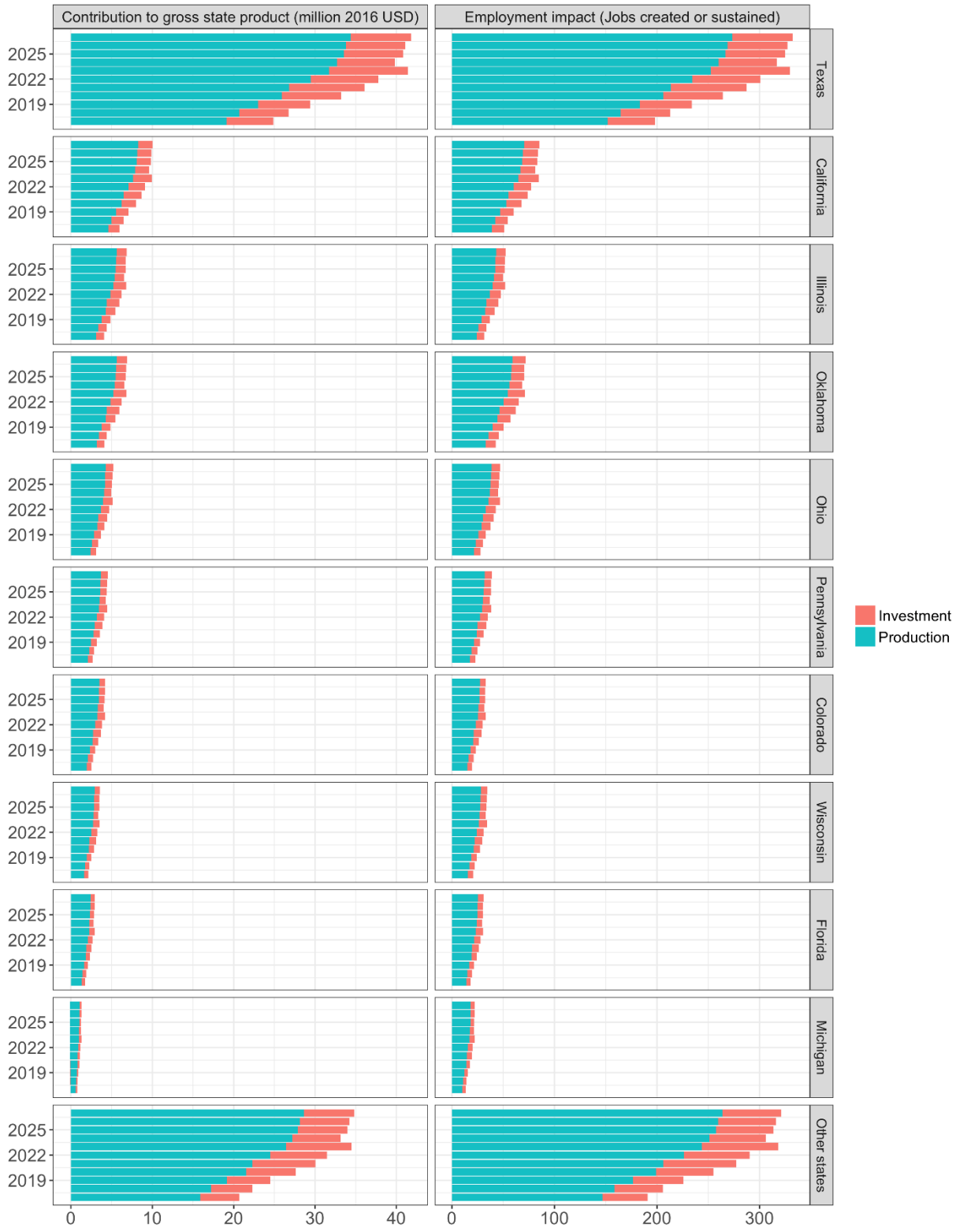


Figure B.9: US Economic Impacts of Alberta's Oil Sands Services Sector (2017-2027)

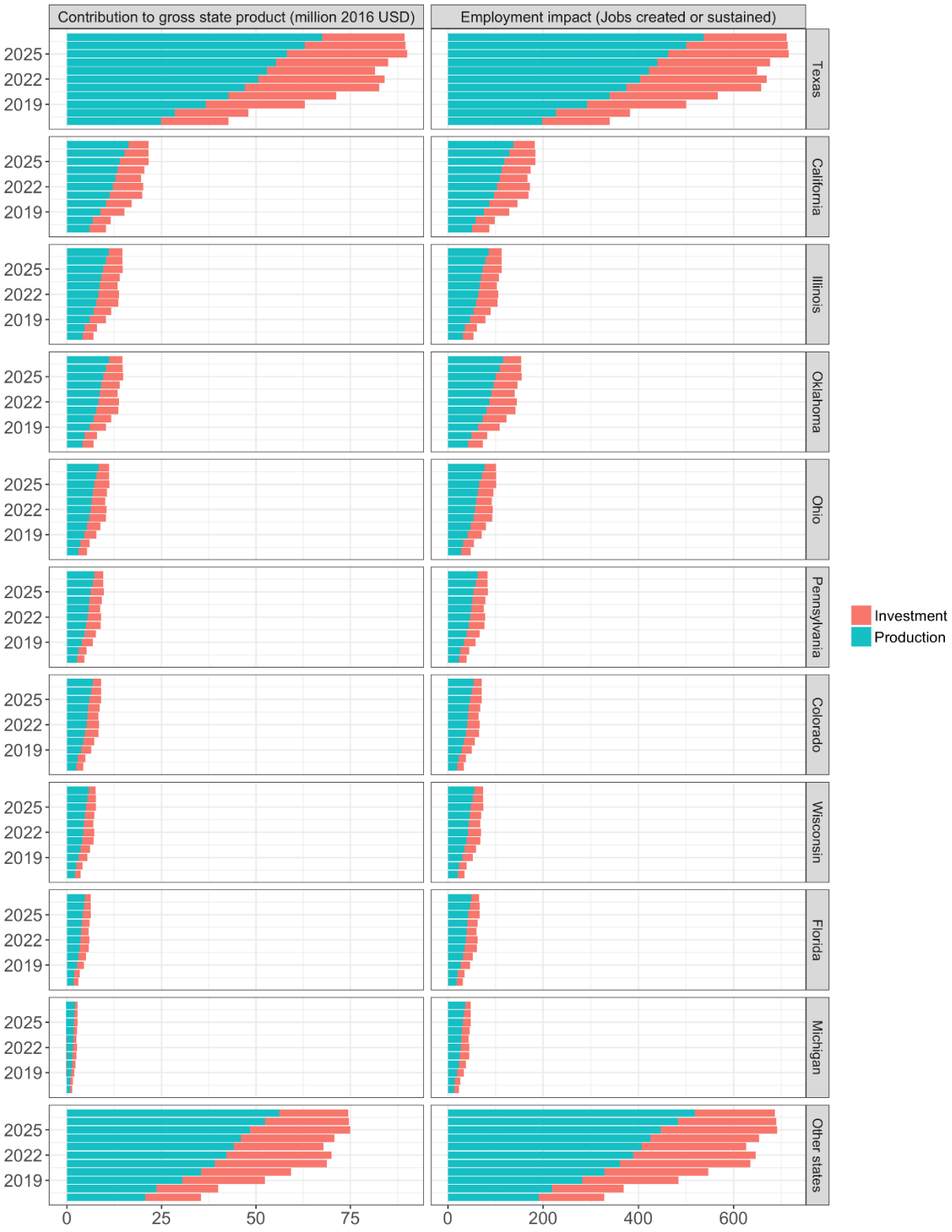


Figure B.10: US Economic Impacts of Saskatchewan's Oil and Gas Services Sector (2017-2027)

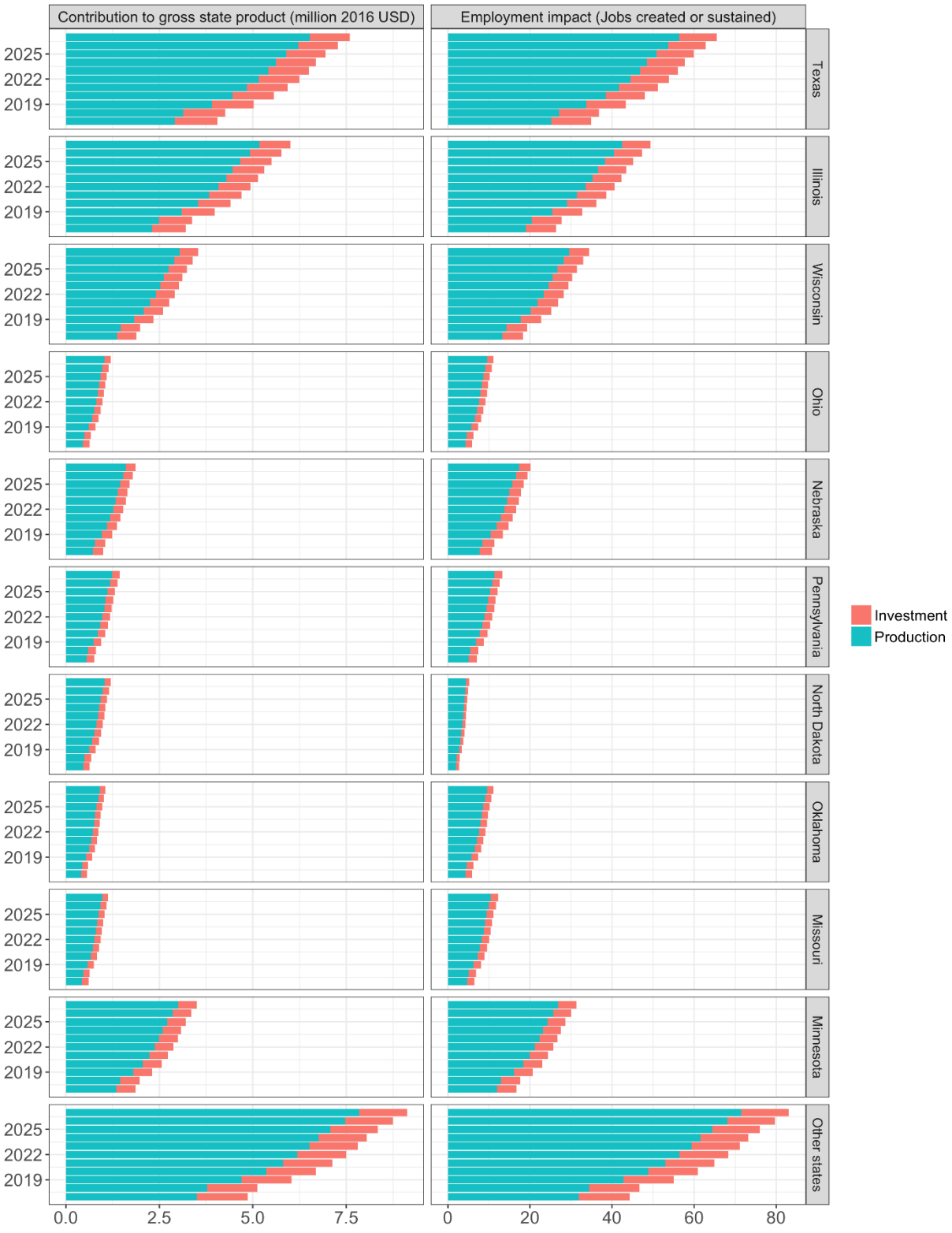


Figure B.11: US Economic Impacts of Manitoba's Oil and Gas Services Sector (2017-2027)

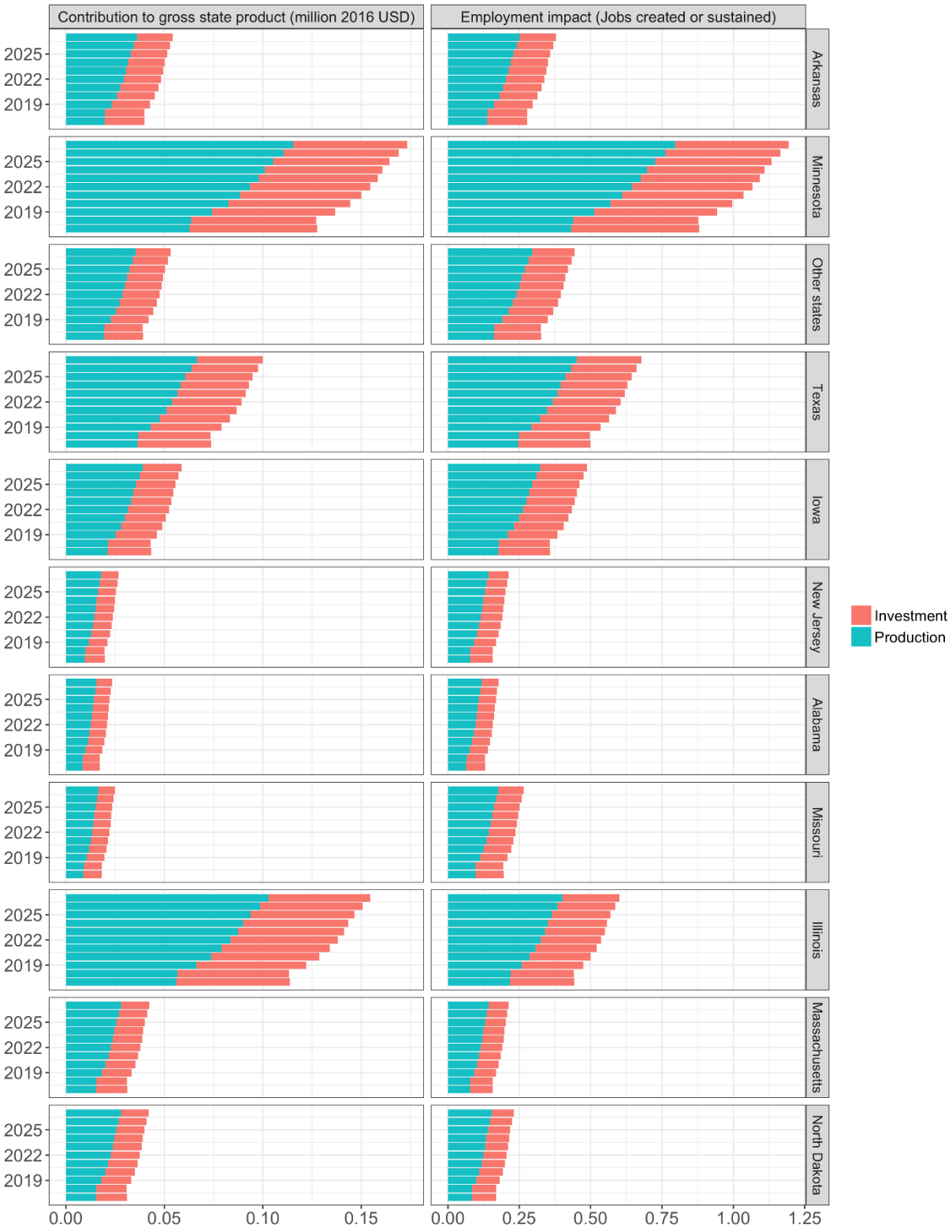


Figure B.12: US Economic Impacts of Newfoundland and Labrador's Oil and Gas Services Sector (2017-2027)