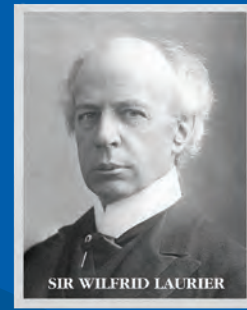
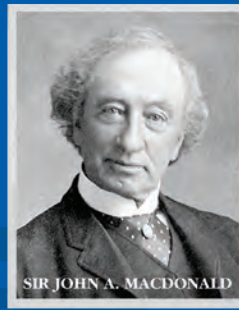




A national project: How oil sands investment and production benefit Canada's economy

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Executive Summary

Since 1998, investment and production of the country's oil sands deposits has been one of the forces driving Canada's economic growth. However, the impact of investing in an oil sands extraction project is different from actual oil production. This paper is the first to document how the impact of oil sands investment differs from that associated with production. It also breaks down the effect that oil sands investment and production have on the economies of both Alberta and the rest of Canada.

The study simulates two scenarios: \$10 billion of investment spending on a typical oil sands megaproject, and a \$10 billion expansion of oil sands production. The analysis compares the economic impact of investment with that of production, particularly how reliant each type of activity is on domestic suppliers in Alberta and the rest of the country, how much they import, how many jobs are created, and the average pay of these jobs.

Both investment and production in the oil sands are important to Canada's economy – and are expected to remain so. Oil sands production continues to grow as investment projects come on stream; it accounts for 70 percent of Canada's oil output, with most destined for the growing US market for oil from Canada. Meanwhile, investment in the oil sands remains substantial by its own historical standards and by comparison with sluggish business investment in most other sectors in recent years. Though substantially less than at its peak at the height of the oil boom in 2014, at \$8.3 billion in 2020 oil sands investment is still 4.5 percent of all business investment in Canada. This exceeds all investments made by the retail trade industry, construction, or all business services, and is four times more than auto manufacturing.

There is a growing market in the United States for Canadian crude oil. While total US imports of oil from all sources declined as its own shale oil production surged, imports of Canadian oil rose steadily to account for more than half of all US oil imports. Currently, Canada exports about 3.8 million barrels per day (bpd) to the US, and this is expected to rise to between 4.2 and 4.4 million bpd over the next few years.

This paper's analysis using the Statistics Canada input-output model indicates that boosting oil sands investment and production each by \$10 billion affects total GDP by about the same amount, but the results are much different for employment both within Alberta and across Canada.



Production is much more stable than capital spending, especially during downturns.

Oil sands investment leads to more jobs and labour income than does increased spending on oil production, but production is much more stable than capital spending, especially during downturns. Investment also has a slightly greater ripple effect on provinces outside of Alberta than does production. Provinces outside of Alberta garner 18.3 percent of the increase in GDP from investment and 13.5 percent from production. Because oil sands production uses much more capital and requires few workers in Alberta and capital goods tend to be made in provinces like Ontario and Quebec, the provinces outside of Alberta account for a larger share of the gains in employment, at 21.2 percent for investment and 33.9 percent from the expansion of oil sands production. Apart from Alberta, Central Canada, notably Ontario, benefits the most of any region from both oil sands investment and production.

Furthermore, the jobs added by oil sands growth – in either investment or production – pay well above the average. In Alberta, the very high pay for people directly involved in oil sands production lifts the average income from more output to \$96,043 compared with \$81,811 from investment.

The oil sands are a uniquely Canadian success story and an increasingly rare example of innovation in Canada. To protect the large investments already made in the oil sands against its demonization by its opponents, further innovation will be required to further lower operating costs and emissions. The track record of relentless innovation by the industry suggests such an outcome is eminently possible. It will then be important for the industry and governments in Canada to set the public record straight on what this industry has accomplished and its importance to Canada's economy. This paper contributes to a better understanding of the oil sands.

Sommaire

Depuis 1998, la production et l'investissement dans les sables bitumineux du pays sont un des moteurs de la croissance économique au Canada. Cependant, investir dans un projet d'extraction de sables bitumineux n'a pas le même impact que de produire effectivement du pétrole. Cette étude est la première à documenter la manière dont ces activités diffèrent sur le plan des retombées. Elle décompose également l'effet de l'investissement et de la production dans le secteur des sables bitumineux sur les économies de l'Alberta et du reste du Canada.

Deux scénarios sont envisagés dans le cadre de l'étude : l'ajout de dix milliards de dollars en dépenses d'investissement dans un mégaprojet typique de sables bitumineux, et un accroissement de la production, d'un montant de 10 milliards de dollars. L'analyse compare les retombées de l'investissement à celles de la production, en particulier l'interdépendance entre chacune de ces activités et les fournisseurs nationaux en Alberta et dans le reste du pays, la quantité d'importations, le nombre d'emplois créés et le salaire moyen lié à ces emplois.

Les investissements et la production dans les sables bitumineux sont tous les deux importants pour l'économie canadienne – et devraient le rester. La production dans ce secteur continue de croître au fur et à mesure que les projets d'investissement entrent en production; elle compte pour 70 pour cent de la production de pétrole du Canada, dont la majeure partie est destinée au marché croissant du pétrole canadien aux États-Unis. Parallèlement, les investissements dans les sables bitumineux demeurent considérables par rapport à leurs propres normes historiques et à la faiblesse de l'investissement des entreprises dans la plupart des autres secteurs ces dernières années. Bien qu'ils soient nettement inférieurs au sommet atteint au plus fort du boom pétrolier en 2014, les investissements dans les sables bitumineux, qui ont atteint 8,3 milliards de dollars en 2020, représentent encore 4,5 pour cent des investissements des entreprises au Canada. Ils dépassent l'ensemble des investissements réalisés dans l'industrie du commerce de détail, la construction ou les services aux entreprises, et représentent le quadruple de l'investissement dans l'automobile.

Le marché du pétrole brut canadien est en pleine expansion aux États-Unis. Alors que les importations américaines totales de pétrole, toutes sources confondues, ont diminué en raison de l'augmentation de la production de pétrole de schiste, les importations américaines de sources canadiennes augmentent régulièrement et représentent maintenant plus de la moitié de toutes les importations de pétrole des États-Unis. Actuellement, le Canada exporte environ 3,8 millions de barils par jour vers les États-Unis, et ce chiffre devrait atteindre entre 4,2 et 4,4 millions de bpj au cours des prochaines années.

L'analyse effectuée dans la présente étude, à l'aide du modèle d'entrées-sorties de Statistique Canada, indique qu'une relance de l'investissement ou de la production de 10 milliards de dollars, dans le secteur des sables bitumineux, a une incidence à peu près équivalente sur le PIB total, quoique les résultats de l'investissement ou de la production sur le plan de l'emploi sont très différents tant en Alberta qu'à travers le pays.



Si investir plutôt que d'augmenter la production dans les sables bitumineux crée plus d'emplois et de revenus salariaux.

Si investir plutôt que d'augmenter la production dans les sables bitumineux crée plus d'emplois et de revenus salariaux, en revanche, la production est une force stabilisante beaucoup plus importante que l'investissement, surtout en période de ralentissement. L'investissement a également un effet d'entraînement légèrement plus important que la production hors de l'Alberta. En effet, le reste du pays se partage l'équivalent de 18,3 pour cent de l'augmentation du PIB en conséquence de l'investissement, mais l'équivalent de 13,5 pour cent en conséquence de l'accroissement de la production. Puisque la production dans les sables bitumineux exige plus de capital et moins de main-d'œuvre en Alberta, et que les biens d'équipement ont tendance à être fabriqués dans des provinces comme l'Ontario et le Québec, les retombées sont encore plus importantes dans le reste du pays en matière d'emploi : soit 21,2 pour cent des gains pour l'investissement et 33,9 pour cent des gains pour l'accroissement de la production. Hors de l'Alberta, c'est le centre du Canada, notamment l'Ontario, qui bénéficie le plus des investissements et de la production dans les sables bitumineux.

En outre, les emplois créés par l'expansion des sables bitumineux – que ce soit du côté de l'investissement ou de la production – sont bien mieux rémunérés qu'en moyenne. En Alberta, les emplois bien rémunérés rattachés directement à la production de sables bitumineux font passer le revenu moyen à 96 043 \$ en conséquence de l'accroissement de la production, contre 81 811 \$ en conséquence des investissements.

Les sables bitumineux créent un modèle canadien de réussite unique et un exemple d'innovation de plus en plus rare. Pour protéger les importants investissements déjà réalisés de l'image diabolisée que leur donnent leurs opposants, il faudra continuer d'innover pour réduire davantage les coûts d'exploitation et les émissions. Or, l'industrie n'a jamais cessé d'innover, ce qui permet de croire qu'un tel résultat est éminemment possible. Il sera alors important pour l'industrie et les gouvernements au Canada de rétablir les faits relativement aux accomplissements de cette industrie et sur son importance pour l'économie du Canada. Ce document vise à mieux faire comprendre les sables bitumineux.

Introduction

Since 1998, investment and production of the country's oil sands deposits has been one of the forces driving Canada's economic growth. However, the impact of investing in an oil sands extraction project is different from actual oil production. This paper is the first to document how the impact of oil sands investment differs from that associated with production. The importance of this difference became evident in 2020, when investment in the oil sands fell sharply but relative stability of production and employment provided an important firewall against an unprecedented contraction in the economy. The paper also breaks down the effect that oil sands investment and production has on the economies of both Alberta and the rest of Canada.

The study uses Statistics Canada's input-output model derived from its supply and use tables to simulate two scenarios.¹ One is investment spending on a typical oil sands megaproject of \$10 billion. The second is an expansion of oil sands production by \$10 billion. Investment and production increase by the same amount to facilitate comparisons of their impact on GDP, employment, and labour income, both in Alberta and across the country. The analysis compares the economic impact of investment with the economic impact of production, particularly how reliant each type of activity is on domestic suppliers in Alberta and the rest of the country, how much they import, how many jobs are created, and the average pay of these jobs.

A \$10 billion outlay is comparable to oil sands projects such as phases of Canadian Natural Resource's Horizon,² the Fort Hills project developed by Suncor Energy, and Imperial Oil's Kearl project (Morgan 2018b). Invariably such large projects are spread out over several years. However, the input-output model requires simulating the results as if all the investment and production occur in one year.³ Assuming that all the investment occurs in one year facilitates the comparison with production (where a \$10 billion increase in one year is possible), which is the goal of this exercise. Furthermore, discounting future values with today's near zero interest rates makes little difference.

Given how several oil sands projects have been delayed or cancelled (Teck's Frontier project was the latest in 2020) due to a combination of regulatory

roadblocks and low prices, studying such projects may seem like a review of past accomplishments rather than of potential future benefits. While a better understanding of the role the oil sands played in the recent growth of Canada's economy is always instructive (especially when our growth led the G7 nations after the global recession in 2009), the expansion of the oil sands is still about the future as much as the past.

Both investment and production in the oil sands remain important to Canada's economy. Oil sands production continues to grow as investment projects come on stream, so the simulation showing how higher oil production affects the economy is still relevant to Canada today. Meanwhile, investment in the oil sands remains substantial by its own historical standards and by comparison with sluggish business investment in most other sectors in recent years; at \$8.3 billion in 2020, oil sands investments is 4.5 percent of all business fixed investment in Canada. This exceeds all investments made by the retail trade industry, construction, or all business services, and is four times more than auto manufacturing where every capital project receives government subsidies and blanket coverage from the media.



Both investment and production in the oil sands remain important to Canada's economy.

To fully appreciate the impact of the development of the oil sands on the Canadian economy, this study also summarizes how both the reality and the perception of the oil sands have evolved since their beginnings early in the 20th century. From this angle, the oilsands are not only a creator of wealth and jobs but a stellar example for others of how Canadian ownership and indigenous innovation can help boost Canada's economy. Unfortunately, negative public and media perceptions of the oil sands (telegraphed by their disparaging and completely inaccurate description as the 'tar sands'), encouraged by competitors overseas and customers in the United States who have benefited enormously from heavily discounted prices for bitumen from the oil sands,⁴ have largely precluded Canadians from looking at this industry as an example to emulate and not a pariah to defame.

A resurgence of oil sands investment and production is still a realistic scenario. The International Energy Agency has projected that the demand for oil will remain high for decades, so the probable downturn in future US shale oil production as deposits are exhausted will leave few alternatives to developing more oil sands deposits. Already we have seen the oil sands fill a supply

gap, replacing heavy oil previously sourced from Mexico and Venezuela when their supply dwindled due to falling reserves and a reluctance to invest amid political turmoil. Recurring cycles in its fortunes is a constant for the industry. Relentless innovation in lowering the costs and the environmental impact of the oil sands could make both investors and the public more supportive in the future of further development of the oil sands.

The results of this paper should not be interpreted as favouring investment over production or production in place of investment. The two are inextricably linked. Increasing oil sands production first requires large investments that make more extraction possible. Enhanced investments in the oil sands are made solely with the goal of boosting future production. What this study shows is that the two have different impacts on GDP, imports, and employment and labour income, both in Alberta and across the nation.

This paper begins with an overview of how the oil sands grew over time, highlighting the ongoing importance of innovation in their development. The oil sands are a unique resource, requiring new technologies largely developed by Canadian companies and scientists. The analysis then presents the differential impacts of oil sands investment and production on Canada's economy.

OIL SANDS ARE NOT TAR SANDS

A word on terminology: this study uses the term “oil sands,” which is what the industry has called this resource since the early 1950s when one of the first companies was named the Great Canadian Oil Sands (the predecessor to Suncor today) (Ebner 2007). Some writers misleadingly use the term “tar sands” when referring to the oil sands. Tar sands is technically incorrect because oil is the goal of oil sands extraction even if its texture sometimes resembles that of pine tar or coal tar. While the texture resembles tar, in fact there is no tar in the oil sands (most tar does not exist in nature but is man-made by extracting it from coal, wood, or petroleum). The tar-like texture of crude bitumen reflects how the oil is engulfed in a mixture of clay, sand, water, and bitumen, which has to be removed at considerable expense to extract the oil embedded inside. The viscosity of oil derived from oil sand varies depending on the method used for its extraction: naturally occurring bitumen in its raw state has a gummy viscosity ten times thicker than peanut butter, while the oil extracted by injecting steam flows like cream.

The reason people insist on using the term “tar sands,” even though it incorrectly implies the presence of tar, is primarily political. Calling something tar rather than oil devalues its image to a cheap product of limited use, mostly for road paving, whereas oil is one of the most versatile prod-

ucts in our economy, although most crude oil requires refining to make it into products of economic use. Most people would be surprised to learn that there is more oil embedded in the plastics and textiles of their vehicle than in the gas tank (Epstein 2014, 74).

Almost invariably, opponents of oil sands development refer to them as tar sands, especially in the environmental lobby industry. The term should be avoided as it is both technically wrong and politically charged. Statistics Canada, for example, would never use the word for both these reasons. Any serious analyst should follow suit. It is encouraging that *The Economist*, which has long used the term “tar sands,” in 2020 correctly referred to them as the oil sands. The French language conspicuously avoids any such controversy by calling the oil sands “les sables bitumineux” or bituminous sands. However, it is probably too late to adopt this convention in English.

The development of the oil sands

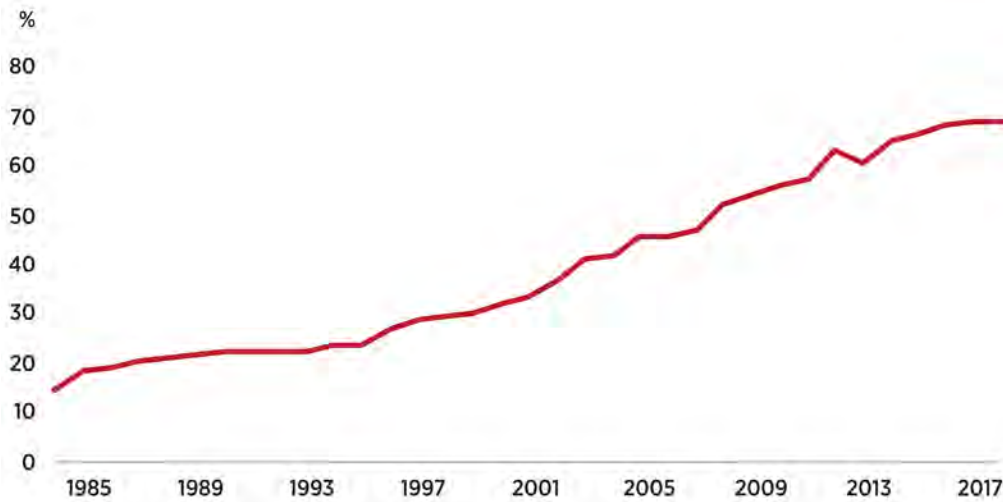
The first attempts at commercial development of the oil sands date back more than a century. The Abasand Oils refinery and separation plant south of Fort McMurray began to operate in 1941, partly reflecting the shortage of North American oil supplies during the Second World War. The Abasands venture was distinctive “in that it blended American expertise and Canadian capital and resources” instead of the typical formula of combining American capital with Canadian resources (Ferguson 1985, 94). However, its operations were plagued by technical problems and fires. Exploratory work increased after the war, and the Great Canadian Oil Sands Consortium was formed in 1953 (Ferguson 1985, 153).

Commercial production began in 1967. Syncrude was the second major oil sands venture, a project sponsored by a consortium of American and Canadian oil firms and governments in Canada in response to the 1973 surge in world oil prices (Ferguson 1985, 155). Prime Minister Jean Chrétien in his 2007 autobiography (when oil prices were setting records) claimed credit for helping in 1975 to finance “the initial development of the oil sands with grants, incentives, and subsidies.” Chrétien went on to quote former Alberta Premier Peter Lougheed: “If we have the oil sands today, we owe Jean Chrétien a big thank you” (Chrétien 2007, 387). Such grandiose claims prove the adage that victory has a thousand fathers, but defeat is an orphan. Despite a boost from these tax changes and the 1973-1974 energy crisis, growth in the oil sands remained modest in the 1970s and 1980s.

The development of the oil sands did not begin in earnest until the late 1990s, when a change in the tax treatment of investments and the development of

new technologies sparked a surge in growth despite the low oil prices prevailing at that time. More precisely, in 1996 the Alberta government changed the royalty charge so companies paid just 1 percent of revenues until they had recouped their capital costs (Poitras 2018, 37). The federal government also modified its tax policy to allow investments to be written off faster. At the same time, the technical process of extracting and transporting ore using bucket-wheels and conveyor belts was being phased out in favour of more efficient large shovels and trucks.

FIGURE 1: OIL SANDS' SHARE OF CANADIAN OIL PRODUCTION

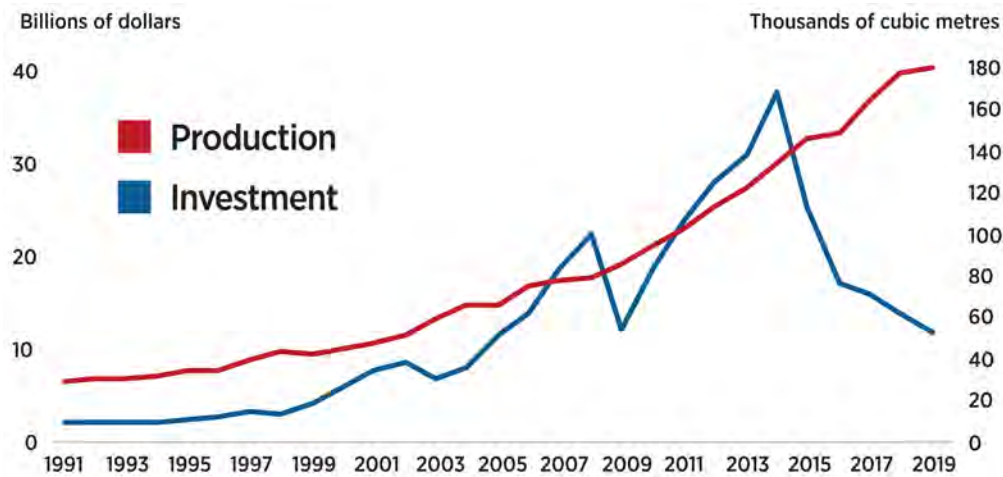


Source: Statistics Canada tables 25-10-0014-01, 25-10-0063-01.

The oil sands have accounted for a sharply rising share of Canada's oil production since the 1990s (Figure 1).⁶ This reflects both the rapid increase of investment in oil sands production and a levelling off of production from conventional oil wells. The oil sands accounted for about 15 percent of Canada's oil production in the early 1980s, rising to nearly 25 percent by the mid-1990s. However, the surge of investment after 1997 boosted the oil sands share of production to over 40 percent by 2004 (Figure 1). This was only the beginning of the oil sands' rise to dominance in the Canadian oil industry.

Crude oil prices began to climb starting in 2003, rising to a record of over US\$100 a barrel in 2008 for West Texas Intermediate. (The paper will talk about the disparity between prices for US crude and Canadian crude (Western Canada Select) a bit later on.) By 2009, oil sands production accounted for more than half of all of Canada's oil output. After a brief downturn due to the global financial crisis, world oil prices remained near \$100 a barrel until late 2014. By 2015 the oil sands represented 65 percent of Canada's oil output. Since then, prices have averaged about \$50 a barrel, although volatility also has increased. The ensuing drop in investment constrained the growth in the oil sands' share of domestic output to 70 percent in 2019.

FIGURE 2: OIL SANDS INVESTMENT AND PRODUCTION



Source: Statistics Canada tables 25-10-0014-01, 25-10-0063-01, 34-10-0036-01, 34-10-0016-01 and 25-10-0064-01 (for investment in 2016*).

Investment and production in the oil sands

While production shows a string of almost unbroken annual gains, investment has been more cyclical than production (Figure 2). However, despite lower investment in 1998, 2003, 2009, and 2015 when prices fell, the broad trend for investment was a marked acceleration up to 2015. Investment increased from about \$1 billion in 1996 to \$10 billion in 2005, but it took only three more years for investment to rise by another \$10 billion to reach \$20 billion in 2008. After a large drop during the Great Recession of 2009, investment soared to its all-time peak of \$35.7 billion in 2014. Since then, plunging oil prices followed by the 2020 pandemic saw investment retreat to \$8.3 billion.

While investment in the oil sands in 2020 pales in comparison to its level at the peak of the oil boom in 2014, \$8.3 billion remains a sizeable level of investment, the equivalent of 4.5 percent of all business fixed investment in Canada as of the third quarter of 2020. Oil sands investment in 2020 remains larger than any year before 2005, a period when the oil sands were regarded as developing rapidly, and almost equal to investment in 2009. Lower prices after 2015 have not stopped every new project in the oil sands. While most new investments consist of expanding existing operations,⁷ new greenfield projects were started by Canadian Natural Resources at its 40,000-barrel-a-day Kirby North project, while Imperial Oil's \$2.6 billion Aspen project in 2018 had a goal of 75,000 barrels a day, with the possibility of doubling its capacity at a later date.

Production has been more stable than investment, increasing every year from 1991 until 2020 with the exception of minor declines in 1999 and in 2005. Prices boomed in the late 1990s, the mid 2000s and after 2009, alternating with busts when oil prices plunged in 2002, 2009, and after 2015. Besides low prices, the industry also faced new carbon levies and higher

royalties and corporate income taxes in Alberta after the NDP government's election in 2015. Despite this volatility, the resilience of oil sands production is reflected in how the output in 2019 of 2.9 million barrels a day essentially matched the 3.1 million forecast by the Canadian Energy Research Institute in 2015 (Millington and Murillo, xii).

The more stable course of production compared with investment partly reflects that it takes years of investment to complete a project and start producing, while less investment only implies that future output will increase at a slower rate. For example, a drop in investment in 2003 was not reflected in output until 2005, while the very steep decline in investment during the global recession of 2009 was not apparent in production until it levelled off in 2012. IHS Markit projects that the plunge in oil prices due to the 2020 pandemic will not significantly lower production over the next 10 years, which it forecasts will increase by 1.1 million barrels per day (bpd) to 3.8 million by 2030. Half of this increase comes from existing projects and half from projects where capital has already been deployed and even some greenfield projects (Birn and Hwang 2020, 3)

“ Production has been more stable than investment, increasing every year from 1991 until 2020.

One reason oil sands production does not decline when prices fall is the high level of fixed costs. The leading producer Suncor estimates that nearly “80 percent of our costs in oil sands are fixed” (Williams 2015). High fixed costs mean little is saved by lowering output. As a result, one industry executive has observed that “Once you build a plant you’re going to produce as much as you can. You’re not going to shut down the plant and walk away. With a drilling rig, you can stop drilling and move to the States” (quoted in McMahon 2013). Raising production at a large oil sands plant lowers average costs. Canadian Natural Resources estimated that expanding production in 2015 lowered its operating expenses at its flagship Horizon mine by \$10 a barrel (Dawson 2015).

Conversely, reducing oil sands production could increase costs. For example, stopping production could trigger a requirement that billions of dollars be spent for reclamation of tailing ponds (Tuttle 2015). It could also damage oil reservoirs and hamper the resumption of production since closing mining projects has meant in the past “they lost their steam chamber” (Morgan 2016). Shutting in situ steam projects is even more problematic because

firms have no experience with stopping production for extended periods. One report cited concerns about stopping in situ production because of “substantial risks to the reservoir, well-bores, surface facilities and overall performance of the project” (Cattaneo 2016).

The time horizon for oil sands investments and production is much longer than the industry norm. Investments take years before generating more production, while plants will continue producing for decades. While this imposes long lags before production can react to price changes, it also makes oil sands production more resilient to industry downturns than conventional or shale operations. The more stable course of oil sands production than conventional drilling is reflected in much lower layoff rates; on average, from 1995 to 2016, the layoff rate in oil and gas extraction (which is dominated by the oil sands) was six percentage points lower than in drilling and exploration, with layoffs peaking during the 2015 price crash at a rate of 6 percent for extraction versus 18 percent in drilling and exploration (Chen and Morissette 2020, 3).

The long planning horizon for the oil sands also means that most are well capitalized, which also is an advantage during the inevitable downturns in a cyclical industry. For example, the price slump starting in 2015 triggered a wave of bankruptcies among shale producers, but mostly just consolidations and mergers in the oil sands. The greater stability of oil sands production and employment was evident during the sharp downturn of the oil industry during the 2020 pandemic. Employment in oil and gas extraction fell only 0.9 percent from 54,899 in February 2020 to 54,421 in December 2020, while employment in drilling and exploration plunged 17.0 percent from 72,649 to 60,671.⁸

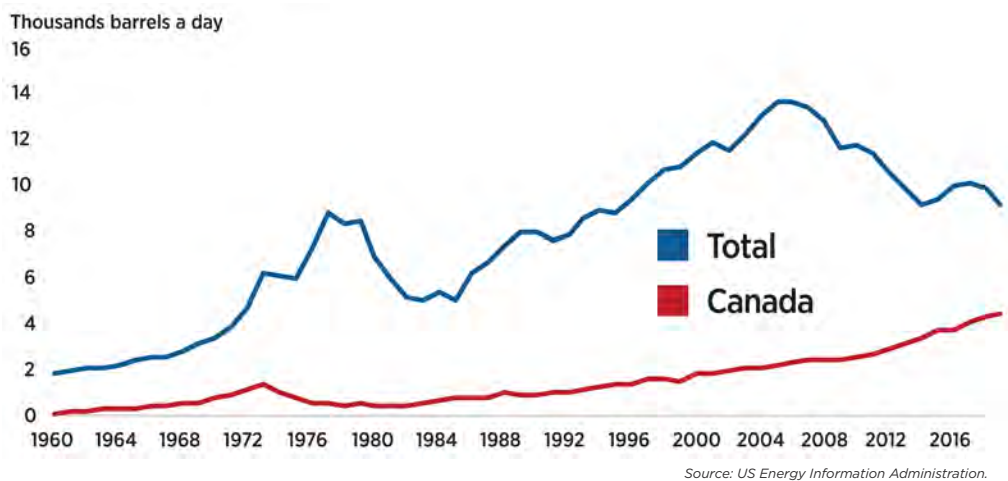
Canada's share of US imports is rising

There is a growing market in the United States for Canadian crude oil. While total US imports of oil from all sources declined as its own shale oil production surged, imports of Canadian oil rose steadily to account for more than half of all US oil imports (Figure 3). Currently, Canada exports about 3.8 million bpd to the US, and this is expected to rise to between 4.2 and 4.4 million bpd over the next few years. Even with the cancellation of the Keystone XL project, the new Line 3 and Trans Mountain pipelines will ensure enough capacity to increase exports to the US. Western Canada's oil production alone was 4.64 million bpd in 2020 and is scheduled to rise to 4.72 million bpd in 2021 and 5.17 in 2025 according to the Canadian Association of Petroleum Producers.⁹

Canada's rising oil exports to the United States demonstrates that a growing market exists for our oil. This is especially true for refineries on the Gulf Coast that are configured for heavy grades of oil from Mexico and Venezuela. As supplies from these countries have dwindled, the Gulf Coast refineries have increasingly turned to the heavy grades from the oil sands as a replacement (Statistics Canada 2017). In fact, getting Alberta's heavy oil to the Gulf Coast was the major motivation behind the original Keystone XL pipeline proposal.

Unfortunately, Canada's rising oil exports to the US also reflect that at the moment there is no alternative export destination for our oil. Since no large pipeline in Canada reaches tidewater, our oil cannot be exported to overseas markets. With all of Canada's oil exports locked into the US, mostly the Midwestern states, the US can – and does – pay lower prices for Canadian oil than the world price of oil without risking the loss of this supply. As Western Canada's oil production ramps up when long-planned oil sands projects come on line, this means increasing amounts of our crude can only be sold in the Midwestern US, usually at a substantial price discount. The discount means that the price for Western Canadian Select oil is less than the price for West Texas Intermediate, even after allowing for the greater amount of refining that bitumen requires compared with conventional oil.

FIGURE 3: US OIL IMPORTS



Innovation and the oil sands

Two types of oils sands projects: Mining and in situ

Just as there is a significant difference between conventional and oil sands operations, the oil sands themselves have two very distinct methods of extraction: mining and in situ (literally meaning “in place”). While the initial expansion of the oil sands was driven by mining operations, in situ production

now accounts for well over half of all oil sands output. Both the economic and the environmental impact of each is quite different.

Mining operations in the oil sands using shovels and trucks began in the late 1990s. The method basically consists of physically removing the sand and its embedded oil and trucking them to a facility where they are crushed and turned into slurry. Water and sand are extracted from the slurry. The water is recycled, while the sand and other solids are left in a tailing pond. Most mining projects upgrade the mined bitumen into light quality crude for sale to refineries, with cokers removing hydrocarbons and lowering the viscosity of the bitumen so it flows more easily through pipelines (except for Shell's Athabasca and Kearl Lake operations). Mining projects typically are much larger than in situ operations, with the largest operated by Suncor, Syncrude, Athabasca Oil Sands, Canadian Natural Resources, and Imperial Oil.



Mining operations in the oil sands using shovels and trucks began in the late 1990s.

The first attempt at the in situ application of steam into the oil sands was in 1924 (Ferguson 1985, 65). However, the first in situ project did not start to operate until 2001 using Steam-Assisted Gravity Drainage (SAGD). In this process, water is pumped from underground and then heated by natural gas-fueled steam generators. The steam is injected into the uppermost of two horizontally-drilled, slotted wells to heat the bitumen. After a period of weeks or months, the steam released through the slots heats the oil embedded in the sands and liquefies it. Gravity then draws the liquefied heavy oil mixed with water into the slots of the lower well and is carried to the surface. The heavy oil and water are then separated and the water is sent back to the steam generators for re-use (Dawson 2015). In situ processes use much less water than mining operations. However, if two wells are situated relatively closely to each other, their placement can have a major impact on productivity, though the results are often hard to predict.

The increased use of solvents has lowered costs to the point that the process is described as solvent-assisted SAGD (solvents include propane, pentane, and butane). Solvents also have the advantage of producing a less viscous product, reducing the need to blend bitumen with diluent to move it through pipelines. Another in situ process involves cyclic steam simulation (CSS), which injects steam from a wellbore into the reservoir. The largest in situ projects are operated by EnCana, CNR, ConocoPhillips, and Husky (Alberta Energy Regulator 2020).

In situ projects have several advantages. SAGD allows the recovery of deep-lying bitumen more than 250 feet below ground (strip mining is only economical for deposits less than 70 metres from the surface) (The Economist 2014). In situ fares better in the low-price environment prevailing since 2015 because these operations are smaller, more flexible, and usually have lower costs. In situ usually does not involve upgrading bitumen on-site to produce synthetic crude oil, which lowers the extraction cost (although synthetic crude is easier to transport). SAGD also has the advantage of not requiring federal government approval, a process that has slowed work on mining operations.

One drawback of in situ operations is that greenhouse gas (GHG) emissions are higher because natural gas is heated to produce steam. Some, including Canada's current environment minister, have proposed that switching from natural gas to nuclear power would reduce emissions (Wells 2020). The industry is pursuing the idea of using carbon dioxide as a resource rather than seeing it as waste; the "holy grail" is to produce methanol from captured GHG emissions and hydrogen (McKenzie-Brown 2014).

“ GHG emissions are not uniform across the oil sands, any more than conventional oil wells have the same environmental footprint.”

GHG emissions are not uniform across the oil sands, any more than conventional oil wells have the same environmental footprint (oil facilities in Nigeria, for example, have high emissions due to extensive flaring) (Alberta Oil Magazine 2015). The IEA's chief economist observed that statistically the contribution of the oil sands to global GHG emissions "is not peanuts, it is a small fraction of peanuts" (McCarthy 2012). A 2014 study for Congress found that Canada's oil sands crude emissions on average were only 17 percent higher than US crude when measured from "well to wheels" (Congressional Research Service 2014, 5). There are several methods of measuring emissions from oil: the first is the upstream emissions released from extraction through upgrading; the second is well-to-refinery-gate, which measures emissions from extraction, upgrading, transporting crude oil to the refinery, and then refining it; a third is well-to-tank, which adds in emissions from transporting the refined product to distribution centres (such as gas stations); and the fourth is well-to-wheels, which adds the emissions that occur when the customer combusts the final product (Sleep et. al. 2021, 8). New technologies have lowered upstream GHG emissions 14 to 19 percent. However, emissions

vary substantially from project to project, even when the same technological process is used (Sleep et. al. 2021, 4).

Innovation is as constant for the oil sands as negative media coverage

The proliferation of the new techniques described in the previous section, which have been developed in less than two decades, illustrates how innovation flourishes in the oil sands. Technological innovation has focused on extracting and then separating the sand that englobes the oil. Northern Production Co. made the first attempt at exploiting the oil sands.¹⁰ It imported a drilling rig in 1915 to get at the light oil it thought lay underneath the bitumen. Canada's almost complete reliance on imports of oil in the 1920s piqued government interest in the oil sands. However, the oil sands evolved from "a highly alluring resource in 1920, an interesting one by 1926, and irrelevant amidst the price collapse of the early 1930s" (Ferguson 1985, 35).

The Great Canadian Oil Sands (the predecessor to Suncor) began commercial production in 1967 using mining techniques (Gault 2014). Alternatives to mining began to appear as far back as 1956, when scientists floated the idea of using a controlled underground nuclear explosion to create the heat to separate the oil from the sand, reducing its viscosity enough so it could be extracted by conventional drilling methods (Sweeny 2010, 96). The SAGD process was partly developed with assistance from the Alberta Oil Sands Technology and Research Authority (AOSTRA), created in 1974 with \$100 million from Alberta's Heritage fund as an arms-length institution to develop new technologies for extracting the oil sands.

Most innovation in the oil sands today is directed at in situ technology. SAGD is increasingly being modified by the use of solvents that lower costs and GHG emissions. "Toe-to-Heel Air Injection" involves the underground combustion of a portion of the bitumen, which then melts the rest, enabling it to flow into a horizontal production well. This method reduces the carbon footprint and the need for upgrading. Radio waves may prove to be another way to heat the bitumen without using any natural gas or water. Microwaves are also being used to melt bitumen. Another technology being explored is flooding a thick copper cable with an electrical current to create an alternating magnetic field to melt bitumen (*The Economist* 2014). Canada's Oil Sands Innovation Alliance encourages and diffuses innovation; it fosters the sharing of innovative technologies and funds the development of new projects that improve technology or reduce the industry's environmental footprint.

The oil sands industry lost the public relations battle about its environmental impact long ago. As noted, underground SAGD has overtaken mining as the leading production process in the oil sands, and this has considerably reduced the environmental footprint of upstream processing. Nevertheless,

almost all media stories on the oil sands are accompanied by a photo of gigantic shovels loading bitumen into huge trucks, travelling across a landscape scarred by open pit mining, and skirting tailing ponds presumably full of toxic materials. *The Economist* spoke for many (at least in Europe) when it called the strip mining of the oil sands “One of the bleakest scenes of man-made destruction” (*The Economist* 2014). These apocalyptic photos have become “the coveted oil sands porn of the industry’s critics” (Gault 2014).

Media portrayals rarely present what an oil sands mine looks like after the land has been rehabilitated, something all companies must commit to and set aside funds for when they begin operations. Equally rare are photos of relatively pristine SAGD sites, where most of the mining work is conducted underground with no need for waste ponds. As one critic admitted, in situ plants “are squeaky clean with little to no above-ground toxins. By melting bitumen below ground (in situ) instead of mining the stuff in an open pit, they produce no tailings ponds” (Lovins and Cohen 2011, 115). The boreal footprint of the oil sands is less than 10 percent of the 11,000 square kilometres Quebec has flooded to build its massive hydro power facilities (McArthur and Macgregor 2013). Yet most Quebec politicians continue to denounce Alberta’s “dirty oil” while ignoring the environmental damage of its self-styled clean hydro.¹¹

The oil sands: A Canadian success story

The oil sands are a uniquely Canadian success story and an increasingly rare example of innovation in Canada. Canadians took the lead in developing the oil sands. As far back as 1920 the federal government organized a research committee to investigate the chemical composition of bitumen. The Great Canadian Oil Sands company led the development of these deposits in the 1950s and 1960s. BP sold its oil sands leases to Canadian Natural Resources (CNR) in 1999, choosing instead to focus on Russia, Angola, and the Gulf of Mexico. CNR turned those leases into its Horizon project.

The largest oil sands plants today are operated by Canadian companies including Suncor Energy, CNR, and Cenovus Energy (Cenovus was the oil company spun off from EnCana when it decided to separate its oil and gas operations in 2009). Canada’s participation in the oil sands extends to First Nations. A Métis community in Alberta owned the first Aboriginal oil sands company, One Earth Oil & Gas Inc., which developed the Gift Bluesky heavy oil project by building on work done by First Nations entrepreneurs on the oil services side of the industry (Cattaneo 2013).

The participation of foreign oil companies in the oil sands has fluctuated with oil prices. The Atlantic Richfield Company (ARCO), an American company, partnered with Syncrude in an oil sands venture, but abandoned the project in 1974 when prices suddenly dropped. In its place, the governments of Canada, Ontario, and Alberta took over the 30 percent share abandoned by ARCO (Alberta Oil Magazine 2011). This began a trend of multinationals rushing to invest in the oil sands when prices and profitability are high, but then abandoning them when low prices make their high fixed costs and poor environmental image too much to bear. Several large foreign companies have left, including BP, Statoil, Total, ConocoPhillips, Royal Dutch Shell, and Marathon Oil.

Complicating matters is that European oil companies (like Statoil and Total) saw their brand image enhanced and they possibly even gained some market share when the EU banned imports from the oil sands (the ban was largely symbolic given the difficulty of moving Canada's oil to tidewater ports in order to access overseas markets). As noted elsewhere, the oil sands generally have a positive image in Canada but a poor one overseas, partly because oil sands companies did not do enough to counter the salacious image established early on by environmentalists.

The oil sands are a uniquely Canadian success story and an increasingly rare example of innovation in Canada.

The hostility to the oil sands is most pronounced in Europe. Its oil companies bowed to pressure from environmentalists and withdrew their investments in the sector, the EU banned imports of oil extracted from oil sands, BP refused for years to recognize oil sands deposits as economically viable,¹² and leading media outlets like *The Economist* insisted on using the derogatory term “tar sands.” This hostility in Europe influenced the public debate in parts of the US and Quebec, a back channel overlooked by the communications strategy of the oil sands industry (if it ever had one).

One reason multinationals have not been leading players in the oil sands is that while their ability to deploy large amounts of capital is useful, and sometimes imperative for megaprojects costing billions of dollars, their technical expertise cannot be transferred to the oil sands. The unique technologies needed to extract the oil sands were developed in Alberta, including AOSTRA and universities in Alberta. SAGD was developed by AOSTRA in collaboration with Imperial Oil, with its first commercial application at Foster Creek in 2002

(Gault 2014). Almost immediately, the Houston-based *Oil & Gas Journal* revised its estimate of Canada's oil reserves upward, from 4.9 to 180 billion barrels (Gault 2014).

The input-output model

Statistics Canada's Input-Output supply and use tables provide a detailed accounting of how spending on the oil sands affects Canada's economy. It uses company tax records to document the exact trail of purchases that oil sands producers make from other businesses, the provinces where business is conducted, the incomes they pay to workers, and the taxes collected by governments. All the results are in current dollars, since the input-output tables are not adjusted for price changes.

I measured the impacts of oil sands investment and production on GDP and employment in terms of their direct, indirect, and induced effects. The direct impact reflects the increase in the oil sands operations themselves of more investment and production by measuring the initial requirements for an extra dollar's worth of output. The indirect effects measure inter-industry purchases made from suppliers (both domestic and foreign) to meet the increased demand of investment and output in the oil sands. These suppliers include those providing manufactured products needed in building capital goods, and those providing services including legal, financial, engineering, and even mundane services such as cleaning and security. The induced effect includes the consumer spending that results from the rise in incomes generated by both the direct and indirect increases just outlined.

By necessity, the model reflects the technology and purchasing patterns used when these tax records were collected. While it is possible that new technologies and rising pressures on profit margins would lead to slightly different results if new projects were undertaken today, past experience suggests that technology and buying patterns tend to evolve gradually. The characteristics of both investment and production in the oil sands are different for mining compared with in situ. Unfortunately, the Statistics Canada model cannot differentiate between the two, and even if it could, confidentiality requirements would likely forbid their publication. Therefore, the results in this paper reflect the blended results of the two methods.

I used the Input-Output model to simulate the impact of \$10 billion of investment in the oil sands, based on actual industry outlays in 2017. The bulk of this investment spending (\$7.892 billion) was directed to production facilities for oil and gas exploration and other engineering construction. Other major outlays in support of this investment include \$292 million for oil and gas exploration, \$154 million for research and development, \$54 million for trucks and trailers, and \$42 million for custom software.

Investment in 2017 was broadly representative of recent oil sands investments. For example, 82.2 percent of oil sands investments in 2017 were for construction and 17.8 percent for machinery and equipment. This is close to their averages of 77.4 percent for construction and 22.6 percent for machinery and equipment for the period 2017 to 2020.¹³ Oil sands investment has evolved over time. Between 2006 and 2010, for example, spending was more concentrated on machinery and equipment (at 37.5 percent), reflecting a greater reliance on mining (which uses excavators and trucks) than in situ projects. In recent years, investment has been directed more to in situ projects, which tend to have a smaller scale, lower costs, and use less labour. This shift is captured in the investment data for 2017, which shows that the use of machinery and equipment has fallen by more than half.

The simulation of a \$10 billion increase in oil sands production was more straightforward. The only specification needed in the model was to boost oil sands extraction by \$10 billion, and then follow what past patterns show would be required in terms of purchases from other industries here and abroad to meet that higher demand and the increase in consumer spending that would be induced by higher incomes.

The economic impact of oil sands investment and production differs substantially

Boosting oil sands investment and production each by \$10 billion affects total GDP by about the same amount, but the results are much different for employment both within Alberta and across Canada. The expansion of oil sands production results in a net increase in nominal GDP of \$10.042 billion, while raising investment by the same amount lifts overall GDP by \$10.059 billion. These gains would boost Canada's overall GDP by 0.5 percent, a substantial impact at a time of chronically slow growth.

Meanwhile, higher investment in the oil sands increases overall employment by 81,734, equal to 0.4 percent of total jobs in Canada, while the simulated hike to production leads to a gain of 38,237 jobs, the equivalent to 0.2 percent of employment.¹⁴ The smaller employment increase from higher oil sands production reflects the capital-intensity of these operations; once built, they require only modest amounts of labour to expand production. Put another way, these facilities have very high labour productivity. Raising output by \$10 billion only requires 4195 more workers directly employed in the oil sands plants themselves, and an additional 23,009 employees among firms that supply the oil sands. This implies an average output per employee of \$367,593 (or \$420,734 using full-time equivalents). The high level of labour productivity is reflected in high levels of wages and salaries in the industry.

However, the mirror image of the high labour productivity of the oil sands is their capital intensity, which lowers their overall Total Factor Productivity

TABLE 1: THE ECONOMIC IMPACT OF \$10 BILLION INCREASES IN OIL SANDS PRODUCTION AND INVESTMENT

	Production	Investment
GDP	\$ 10,042,341,000	\$ 10,058,667,000
Jobs	38,237	81,734
Labour income	\$ 3,217,003,000	\$ 6,349,226,000

(which accounts for inputs of both labour and capital). Put another way, the oil sands can be a higher cost method of extracting oil than conventional oil production (Alberta 2016, 5). However, the oil sands compare favourably with other capital-intensive extraction methods, such as off-shore drilling and the fracking of shale oil deposits.

A \$10 billion investment in the oil sands increases total spending by \$13.5 billion. This includes the direct effect of the \$10 billion investment in the oil sands and the indirect effects of supplying more inputs to make these investments and the induced effect from consumers having more wages and salaries to spend. Of this \$13.5 billion of spending, \$3.1 billion goes to imports from other countries (and therefore does not appear in GDP), especially for the specialized machinery and equipment needed to build an oil sands plant. Another \$2.1 billion goes to higher interprovincial imports, mostly from Ontario (\$1.0 billion), BC (\$0.4 billion) and Quebec (\$0.3 billion). Even Alberta sees its own exports rise by \$86 million, much of it energy to meet higher industrial demand in other provinces from the upturn in business.



Oil sands can be a higher cost method of extracting oil than conventional oil production.

Raising oil sands production by \$10 billion leads to a total increase in spending of \$11.8 billion. Of this, \$1.5 billion goes to imports, less than half the leakage that occurs if the same amount is spent on investment (which requires machinery and equipment that are not produced in Canada). Another \$1.5 billion goes to interprovincial trade, which almost matches the \$2.1 billion from investment. Again, the largest beneficiaries are Ontario (\$0.8 billion), BC (\$0.3 billion), and Quebec (\$0.2 billion).

TABLE 2: THE REGIONAL DISTRIBUTION OF HIGHER OIL SANDS PRODUCTION AND INVESTMENT ON GDP (\$ THOUSANDS)

	Production	Investment
Alberta	\$ 8,687,349	\$ 8,217,202
Ontario	\$ 722,620	\$ 932,277
British Columbia	\$ 276,684	\$ 389,932
Quebec	\$ 188,402	\$ 245,685
Prairies	\$ 123,908	\$ 213,713
Atlantic	\$ 39,904	\$ 55,329
Canada (total)	\$ 10,042,341	\$ 10,058,667

Alberta benefits the most

Alberta reaps the most benefits from both higher investment in and more production from the oil sands. Alberta's GDP increases by \$8.7 billion as a result of more production of oil and \$8.2 billion from more investment. These gains are equal to 2.6 percent and 2.5 percent, respectively, of Alberta's GDP in 2017. The direct impact from production is much higher than for investment (\$5.9 billion versus \$4.0 billion), but investment has a much larger impact on purchases of inputs from other industries in Alberta (\$2.5 billion versus \$2.0 billion) and spurs more consumer spending (\$0.7 billion versus \$0.3 billion). The much larger impact on induced consumer spending for investment reflects that investment generates many more jobs in Alberta (64,441 compared with 25,266 for production), although this advantage is partly offset by the higher wages and salaries paid for the jobs needed for higher production.

However, while investment generates substantially more jobs than production in Alberta, the jobs from production (which includes their indirect effect on suppliers and induced increases in consumer spending) pay more on average than investment-related jobs, at \$96,043 compared with \$81,811. This reflects that jobs directly related to oil sands production are extremely lucrative, paying on average about \$214,000 a year in 2017. As a result, the gap between the wages and salaries derived from more production (\$3.217 billion) over more investment (\$6.349 billion) is not as great as the employment gap would suggest. The difference in the pay for jobs generated by production versus investment is not significant in the other provinces since high-paying production jobs are confined to Alberta.

TABLE 3: THE REGIONAL DISTRIBUTION OF HIGHER OIL SANDS PRODUCTION AND INVESTMENT ON GDP (\$ THOUSANDS)

	Production	Investment
Alberta	25,266	64,441
Ontario	6,963	8,466
BC	2,380	3,767
Quebec	2,070	2,610
Atlantic	410	548
Canada	38,237	81,734

Alberta accounts for the lion’s share of imports drawn into the country by higher oil sands activity. This is particularly the case for investment, where imports (both for final use and for intermediate inputs used in the production of goods and services) total \$2.7 billion or 87.4 percent of all the \$3.1 billion of imports into Canada needed to supply all the activity generated by a \$10 billion investment.

Alberta’s high import intensity for investment reflects the specialized equipment needed to build an oil sands project: of the direct and indirect spending in Alberta, 33.1 percent goes to imports. This compares with an import content of 17.3 percent in the rest of the country. The consumer spending induced by the investment in the oil sands serves to lower the overall import content in Alberta to 31.8 percent while it raises the import share to 20.2 percent in the rest of the country.

By comparison, higher oil sands production requires fewer imports than oil sands investment. Under the scenario of a \$10 billion increase in production, imports into Canada rise by \$1.4 billion, less than half the \$3.1 billion of imports needed for the same amount of investment. Alberta again dominates this import demand, with 81.8 percent of imports destined for the province. However, the import intensity of oil sands production in Alberta is also much lower than for investment. The import content for production is 13.9 percent, less than half that of imports under the investment scenario (31.8 percent). The import propensity of the rest of Canada in the production scenario is 19.4 percent, comparable to the 20.2 percent for investment.

Large impacts in Canada beyond Alberta

While Alberta garners the most economic benefits from the development of the oil sands, of course, the benefits from both more investment and more

production are spread out across Canada. For investment, 18.5 percent of the GDP generated accrues to other provinces – worth \$1.920 billion in absolute terms. In the case of higher production, 13.8 percent of the increase in GDP, or \$1.415 billion, accrues to the rest of Canada.

For both higher oil sands production and investment, the geographic location of jobs is more evenly diffused across Canada than just outlined for GDP. For higher investment, 21.2 percent of the gains (or 17,293 jobs) occur outside of Alberta, while higher production by the oil sands results in 33.9 percent employment gains (or 12,971 jobs) outside of Alberta. For production, the outsized gains in the share of jobs in the rest of Canada reflects the fact that oil sands production is so capital intensive that it generates comparatively fewer jobs in Alberta than does investment.

Outside of Alberta, Ontario is the greatest beneficiary of both higher investment and higher production in the oil sands. Ontario reaps 9.3 percent of Canada's total increase in GDP from investment, worth \$932 million. This is equivalent to 0.1 percent of Ontario's GDP in 2017. For production, Ontario garners 7.2 percent of the benefits to Canada's GDP, equal to \$722 million or 0.1 percent of GDP in 2017. The larger impact of oil sands investment than production on Ontario's economy reflects both larger purchases from suppliers (\$520 million versus \$464 million) and larger increases in spending induced by income growth (\$413 million versus \$259 million).

Ontario captures about half of the increase in jobs outside of Alberta from both higher investment (8,466 jobs) and production (6,963) in the oil sands. One reason for the large impact of induced spending in Ontario noted in the previous paragraph is that the jobs created in Ontario from both investment and production in the oil sands are well paying, at \$65,738 annually on average for investment and \$63,522 for production. Both are the highest in Canada outside of Alberta.

British Columbia is the second largest beneficiary from the oil sands outside of Alberta. Its GDP rises by \$390 million from more investment in the oil sands and \$277 million from higher oil sands output. This represents 3.9 percent of Canada's increase in GDP from oil sands investment, and 2.8 percent from production. BC's share of jobs is slightly higher than its increase in GDP, at 4.6 percent for investment and 6.2 percent for production, because of the relatively fewer jobs the oil sands create in Alberta. Proportionately more of BC's benefits come from induced consumer spending under the investment scenario than with production.

Quebec is the third largest beneficiary of the oil sands in Canada outside of Alberta, reaping 2.4 percent of the increase in GDP due to more investment and 1.9 percent from enhanced production. In absolute terms, Quebec's GDP is lifted by \$246 million from investment and \$188 million from production.

Jobs in Quebec increase by 2070 in the scenario where oil sands production rises and by 2610 in the case of more investment.

Combined with Ontario, central Canada reaps 13.6 percent of the jobs and 11.7 percent of the GDP generated by oil sands investment. For oil sands production, central Canada's share of GDP is slightly less than for investment at 9.1 percent, but its share of jobs jumps to 23.6 percent. The larger share of jobs mostly reflects the fact that oil sands production generates relatively few jobs in the oil sands in Alberta itself. So while the share of jobs in central Canada is higher for oil sands production than for investment, in absolute terms oil sands investment generates more jobs in central Canada than oil sands production does, even if central Canada's share of jobs from production is higher than from investment.



Oil sands investment generates more jobs in central Canada than oil sands production.

For analytical purposes, Manitoba and Saskatchewan are combined into the Prairie region in Tables 1 and 2. The Prairies garner 2.1 percent of all Canada's gains in GDP as a result of the simulated increase in investment and 1.2 percent from higher production. In absolute terms, this represents \$213.7 million and \$123.9 million, respectively. The Prairie's share of job growth is slightly higher than its GDP gains, at 2.3 percent and 2.9 percent, respectively.

Few of the benefits of higher oil sands investment and production reach the Atlantic provinces. Altogether they generate about \$55 million of GDP from oil sands investment and \$40 million from production, which represent 0.6 percent of the Canada-wide gains from investment and 0.4 percent from production. The Atlantic region's share of employment gains is slightly larger than its increase in GDP, at 0.7 percent for investment and 1.1 percent for production. Within the Atlantic provinces, New Brunswick gains the most in both GDP and employment.

The jobs added by oil sands growth pay well

Canada-wide, the employment gains from both higher oil sands investments and production pay well above the average. The 81,734 jobs generated by expanding investment in the oil sands by \$10 billion pay an average of \$77,682 a year (including wages and salaries and supplementary benefits). The 38,237 jobs attributable to a \$10 billion increase in oil sands output have an average

renumeration of \$84,133. Most of the difference occurs in Alberta, where the very high pay for people directly involved in oil sands production lifts the average income from more output to \$96,043 compared with \$81,811 from investment. The differences in the income generated by production versus investment are negligible within the other regions of Canada, although there are important differences between the regions.

It is worth noting that the average labour income paid for the jobs created by the oil sands in BC and the Prairies is around \$60,000, up to \$5000 less than in Ontario but nearly \$5000 more than in Quebec. Pay in all these provinces is well below the average in Alberta.

As a general rule, the average pay in a region declines as the benefits shift from job creation directly in the oil sands (which largely happens in Alberta) to indirect benefits from supplying inputs into production (where Ontario leads every region outside of Alberta) and to the benefits from the consumer spending induced by the direct and indirect effects. This scale reflects how pay levels decrease from the most lucrative, which involve work directly in the oil sands, to mostly well-paying jobs in industries that supply inputs into oil sands activity (such as manufacturing and business services), to relatively low-paying jobs in consumer services (such as retail and food) that benefit only indirectly from the higher incomes of workers in the previous two groups.

To illustrate how pay scales decline as direct inputs into the oil sands decrease, it is useful to compare the ratio of the total increase in GDP in a province from all three types of benefits to their increase only from direct and indirect benefits. This comparison shows the marginal contribution of more consumer spending, which usually centres around low-paying industries such as retailing or accommodation and food services. For example, in the case of higher oil sands production, the ratio of total benefits to direct and indirect benefits in Alberta is 1.10, meaning that the increase in GDP from induced consumer spending accounts for only 10 percent of its increase in GDP. The ratios for BC, the Prairies, and Ontario are all around 1.50, implying nearly half their increases come from consumer spending rather than more lucrative work supplying the oil sands with materials or services. Quebec is the most reliant on consumer spending rather than supplying the oil sands, with a ratio of 1.63. As a result, the pay related to oil sands activity on average is highest in Alberta and the lowest in Quebec.

These same patterns generally hold true for higher oil sands investment, with the exception of the Prairies. The ratio of total benefits to direct and indirect benefits is the lowest in Alberta at 1.26, reflecting the fact that it gets most of its benefits from actual activity in the oil sands or in supplying them and relatively little from the spin-off effect on consumer spending. Ontario and BC have similar ratios of 1.79 and 1.76 respectively. Quebec is the most reliant on

consumer spending with a ratio of 1.96, implying that Quebec benefits almost as much from induced gains in consumer spending as from supplying inputs into more oil sands investments.

It is noteworthy that the ratio of all growth from oil sands investment to growth excluding induced consumer spending is 1.57 for the Prairies. This is almost in the middle between Alberta and the other provinces, with most of the difference due to Saskatchewan (with a ratio of 1.48 versus 1.85 for Manitoba). This low ratio for Saskatchewan is because investment in the oil sands requires more purchases from suppliers in Saskatchewan than from Manitoba, totalling \$96 million. This may reflect the location of a large steel manufacturer in Saskatchewan which specializes in the type of equipment used in the construction of oil sands facilities. The work in such manufacturing typically is high value and well-paying.

Conclusion

The oil sands are a uniquely Canadian success story and an increasingly rare example of innovation in Canada. To protect the large investments already made in the oil sands against its demonization by its opponents, further innovation will be required to further lower operating costs and emissions. The track record of relentless innovation by the industry suggests such an outcome is eminently possible. It will then be important for the industry and governments in Canada to set the public record straight on what this industry has accomplished and its importance to Canada's economy. This paper is a contribution to a better understanding of the oil sands.

About the author



Philip Cross is a Munk Senior Fellow at the Macdonald-Laurier Institute. Prior to joining MLI, Mr. Cross spent 36 years at Statistics Canada specializing in macroeconomics. He was appointed Chief Economic Analyst in 2008 and was responsible for ensuring quality and coherency of all major economic statistics. During his career, he also wrote the “Current Economic Conditions” section of the Canadian Economic Observer, which provides Statistics Canada’s view of the economy. He is a frequent commentator on the economy and interpreter of Statistics Canada reports for the media and general public. He is also a member of the CD Howe Business Cycle Dating Committee.

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Endnotes

- 1 For a description of how the input-output tables can be used to analyze the oil and gas sector, see Wang (2020).
- 2 The Horizon project cost over \$10 billion spread over five years (see Krugel 2012). Horizon has a production schedule of 50 years (Hussain 2015). Other comparable projects included Total’s \$11 billion Joslyn mine. Mega projects were staggered to avoid construction at the same time, which would have created shortages of labour and material (Morgan 2014). See also Imperial Oil’s Kearn and Sunrise by Husky Energy.
- 3 The Canadian Energy Research Institute (2011) provides an example of studying the impact of investment spending as it is spread out over several years.
- 4 For example, IHS Markit estimates the discount cost Canadian producers \$14 billion in 2019. See <https://www.canadianenergycentre.ca/canadas-pipeline-capacity-woes-slashed-at-least-14-billion-from-oil-producers-bottom-line/>.
- 5 However, *The Economist* did refer to the oil sands in 2014 (*The Economist* 2014).
- 6 Figure 1 shows the supply of oil sands measured in cubic metres rather than as a percentage of GDP because the data for supply extend from 1985 to the present, while the GDP data stop in 2007. However, the supply and production of the oil sands is virtually the same, so the two concepts are used interchangeably.
- 7 Similarly, almost all investment in oil refining in North America in recent decades has been directed at expanding existing facilities, partly because of the difficulty of obtaining permits due to NIMBYism. So, while critics cite the absence of new refineries as a sign of a dying industry, refining capacity has actually increased (see Cross 2013).

- 8 Available at Statistics Canada, Table 14-10-0201-01. Employment by industry, monthly, unadjusted for seasonality.
- 9 Available at https://www.capp.ca/wp-content/uploads/2019/11/2019_Crude_Oil_Forecast_Markets_and_Transportation-338794.pdf.
- 10 In fact, innovation has flourished in Canada's oil industry more broadly. North America's first oil well was dug in Ontario in 1857, Canada was first to refine kerosene, and it built the world's first oil pipeline between Petrolia and Sarnia in 1862 (Gould 1976, 60).
- 11 For example, Bloc Québécois leader Yves-François Blanchet denounced Alberta's "toxic oilsands," Premier Francois Legault called oil "dirty energy," and the National Assembly unanimously passed a resolution that the Energy East pipeline was "not socially acceptable" in Quebec (Patriquin 2019).
- 12 BP and Royal Dutch Shell publicly argued about which international oil company first identified climate change as a risk (Yergin 2011, 499).
- 13 Available at Statistics Canada, Table 34-10-0036-01: Capital and Repair Expenditures, Non-Residential Tangible Assets by Industry.
- 14 Almost all these jobs are full time; expressed in terms of Full-Time Equivalents (FTEs) the increase from raising production is 31,901 jobs versus 72,269 for investment. Almost all employment directly in the oil sands and its suppliers (such as manufacturing, transportation, and finance) are full-time jobs. Most part-time jobs are the result of the induced effect of higher consumer spending, which creates jobs in services such as retailing and restaurants where part-time employment predominates.

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