Confronting carbon lock-in: Canada's oil sands

SEI brief. May 2018

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Key messages

- **Most of Canada's major existing oil sands projects are resilient to a decline in oil prices, and are therefore "locked in."**
- **Current and future oil sands projects may contribute to a long-term global oversupply of oil, driving down global oil prices and thus slowing the necessary low-carbon transition outside Canada.**
- **Expanding oil sands production beyond current levels could increase global emissions by 50 to 150 million tonnes CO_2 annually by 2030.**
- **How Canada manages oil sands production levels may have as much effect on global greenhouse gas emissions as the efforts Canada makes to reduce fossil fuel use within the country.**

For the last decade, Canada's oil and gas sector has featured prominently in conversations about the country's climate goals (Harrison 2010). Oil and gas production in Canada emits about 180 million tonnes of carbon dioxide equivalent (t CO_2e) annually, more than any other sector, and about one-quarter of the country's total greenhouse gas (GHG) emissions (ECCC 2018b).

Much of the oil and gas extracted in Canada comes from the province of Alberta (NRC 2014), which contains the nation's largest oil resource: the oil sands. These deposits contain thick, heavy bitumen – at least 100 billion barrels – that can be processed into crude oil (NRC 2014; Rystad Energy 2017). The oil sands are also the greatest contributor to Canada's oil and gas sector emissions, making up 72 million t CO_2e of the sector's 180 million t CO_2e total (ECCC 2018b). (The remainder of the sector's emissions are from natural gas production and processing, conventional oil production, and oil and gas transportation and refining.) Furthermore, producing a barrel of crude oil from the oil sands emits substantially more GHG emissions per barrel than most other means of producing oil; this is because bitumen is energy-intensive to extract and "upgrade" (Oil Climate Index 2016).

Because of these high emissions levels, how the oil and gas sector evolves in the future will substantially affect Canada's ability to reduce national emissions from the current level of about 700 million t CO_2e. The country has set two goals: one to reduce emissions 30% from 2005 levels by 2030 (ECCC 2016b) and another to reduce emissions 80% from 2005 levels by 2050 (ECCC 2016a).

The federal government and the provincial government of Alberta have argued that production of the oil sands can continue – or even expand – while the country works to meet these emission-reduction goals. As support for this reasoning, policy-makers point to the legislated annual cap on oil sands emissions of 100 million t CO_2e (Bennett 2017; Cheadle 2016).

Photo (above): A large power shovel excavates sand loaded with heavy oil from an Alberta oil sands open pit mine near Fort McMurray, Canada © DAN_PRAT / GETTY

Researchers, however, have argued that oil sands production is incompatible with climate goals for two primary reasons. First, continued oil sands emissions – even at the capped level of 100 million t CO_2e – would place all of the burden of reducing national emissions on other sectors of Canada's economy. In other words, mining and processing crude oil from oil sands is so energy- and emissions-intensive that even with large declines in energy intensity, the process would put Canada's in-country emissions goals at risk (Harvey and Miao 2018; Hughes 2016; Hughes 2018; MacLean 2017; Scott and Muttit 2017). Furthermore, continuing oil sands emissions at this capped level – or a greater level, since emissions from upgrading are not included under the cap – could preclude the country from enhancing its ambition and setting a deeper target. Such enhancement will ultimately be necessary for all major economies in order to meet the globally agreed goal of limiting warming to "well below" 2°C, while striving to limit warming to 1.5 °C, as outlined in the Paris Agreement (UNEP 2017).

The second main finding from researchers is that a low carbon transition consistent with the Paris Agreement would use much less oil, potentially affecting the global demand for crude derived from the oil sands (Harvey 2017; Jaccard et al. 2018). Since lower oil demand could be met by other, less GHG-intensive oil sources – and at a lower cost – the oil sands are, at best, an economically inefficient way of producing oil. More critically, a decline in oil demand could leave the oil sands "stranded," without a durable market, putting investors and communities at risk of economic disruption (Carbon Tracker 2014). For example, one widely cited modelling analysis found that about 80% of Canada's oil reserves would remain underground in a global low-carbon transition, meaning "next to no" new oil sands projects would proceed in this scenario (McGlade and Ekins 2014).

Continued production of the oil sands may lead to an oversupply of oil in global markets, making a low-carbon transition more difficult and undermining global climate action.

This paper explores a third dimension that increases the urgency of managing the oil sands: carbon "lock-in" (Unruh 2002). We find that producers such as Syncrude, Canadian Natural Resources, and Suncor may be able to continue extracting and processing oil sands at relatively low costs. The exploitation of these deposits may therefore be locked in, resisting the oil price drops that would come with reduced global oil demand. Furthermore, continued production of the oil sands has climate consequences, as doing so may lead to an oversupply of oil in global markets, thereby making the low-carbon transition more difficult outside Canada, and undermining global climate action.

The global implications of Canada's oil production are not necessarily unique to oil sands, either. New oil development from the Bakken Shale in Saskatchewan or new oil production from gas-heavy plays in the Montney shale in British Columbia and Alberta could similarly contribute to carbon lock-in and slow the global transition away from oil.

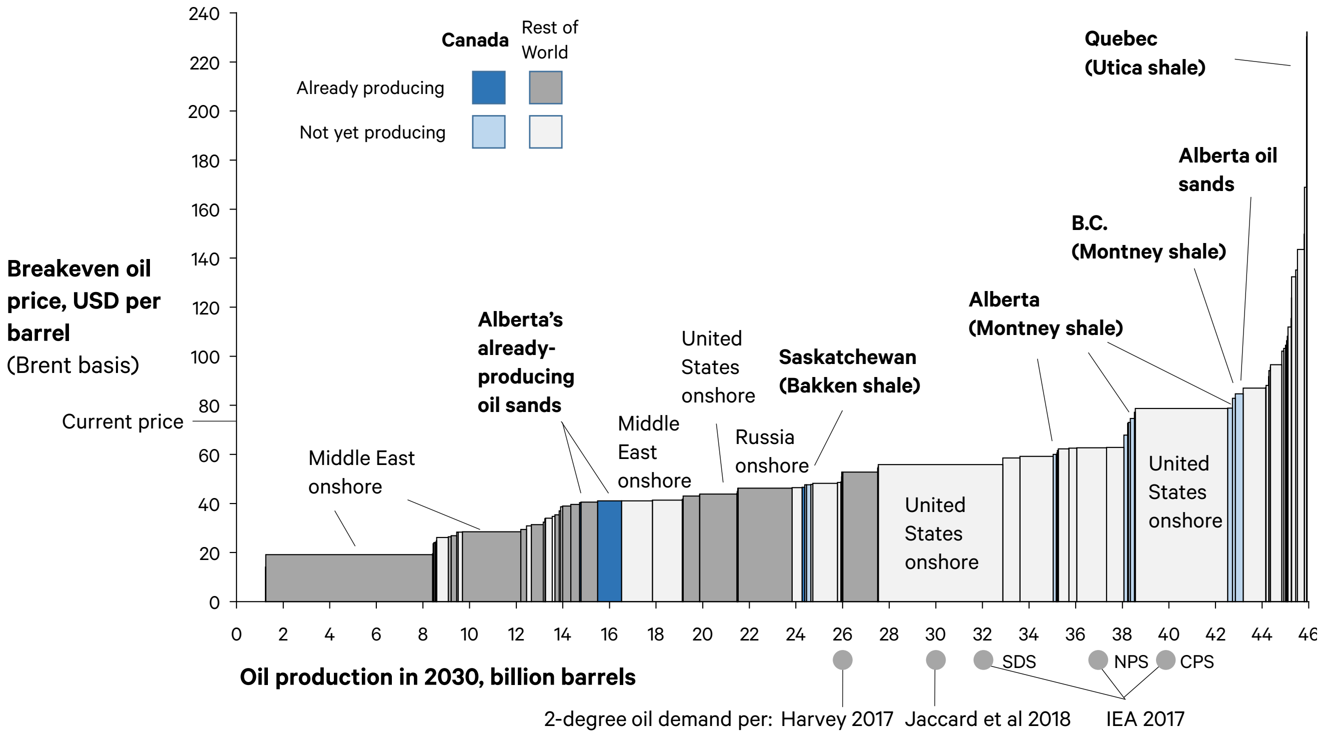
This discussion brief first describes the economics of Canada's oil resources – with a focus on the oil sands – and then describes how continued production affects the broader oil market. We find that limiting the country's oil production could have climate benefits as great – or greater – than the measures in Canada's existing climate action plan, the Pan-Canadian Framework.

This brief closes with a discussion of possible policy approaches to managing Canada's oil resources under a fixed carbon budget. These approaches deserve further research and consideration by policy-makers in Canada.

The economics of Canada's oil resources

With decades of experience, and considerable supporting infrastructure in place, Canada's oil sands are now able to produce bitumen and crude oil at competitive costs. For example, existing oil sands projects – such as Suncor's Millennium mine near Fort McMurray or Syncrude's Mildred Lake deposits – only need to cover their operating costs to continue operation. This means that the average barrel costs about USD 40 to produce, when operating costs (such as processing equipment and staff) are combined with associated administrative costs, royalties or taxes, and a modest profit (Rystad Energy 2017). At recent prices of USD 60 to USD 70 per barrel, the existing oil sands mines can thus continue operating and enable returns to investors, even taking

Figure 1. Cost curve of global oil production in 2030, with Canadian fields identified.



Prices are listed in Brent crude terms. The calculation of breakeven price for each field includes any discount for the actual price received by each producer; for example, oil sands projects are assumed to receive between $5 to $15 less per barrel compared to the Brent prices shown, to account for quality differences relative to other crudes. Dots along bottom axis show global 2-degree-consistent oil demand per Harvey (2017) and Jaccard et al (2018), plus oil demand in the IEA's Sustainable Development Scenario (SDS), New Policies Scenario (NPS), and Current Policies Scenario (CPS).
Source: Rystad Energy (Rystad Energy 2017), plus oil demand scenarios from IEA (IEA 2017), Simon Fraser University (Jaccard et al. 2018), and University of Toronto (Harvey 2017)

into account the likelihood that crude oil derived from oil sands will continue to receive less per barrel than other crudes because of quality differences. We consider that discount here implicitly, following a similar method to that of the Canadian Energy Research Institute (Millington and Murillo 2015), and we report prices on a Brent basis, the international benchmark for oil prices, to facilitate comparison to fields around the world.

To put these costs for oil sands projects in perspective, USD 40 per barrel is considerably higher than the cost of extracting oil from existing fields in the Middle East, which averages USD 20 to USD 30 per barrel (Figure 1). But it is USD 3 to USD 5 per barrel below the average cost of oil from existing fields in many other major world regions, including major U.S. and Russia deposits (Figure 1).

This slim cost advantage of oil sands is critical to the deposit's long-term viability and to its resiliency to oil price shocks. These fields can continue operating by covering only their ongoing, operating costs because – like any already-existing fields – they benefit from having the large build-out of capital behind them, with those costs "sunk".

As a result, existing projects, including most of Alberta's oil sands, are now able to continue operating, with resiliency to future price fluctuations below USD 50 per barrel. This will continue if sufficient transport capacity – such as rail lines and pipelines – are available, subject to unforeseen oil market development. These oil sands projects are thus "locked in" and will continue producing, even as they may push against Canada's climate goals and the long-term global need to nearly entirely phase out fossil fuel use by mid-century (Rogeli et al. 2015).

By contrast, for a new project to proceed, investors must foresee oil prices high enough to support the cost of building out new supporting infrastructure, which can require prices at least USD 20 per barrel higher than operating costs. Further, expected prices must be high enough to allow some risk buffer, including the risk that eventual production may not rise to anticipated levels.

Figure 1 displays these breakeven prices for new projects for both Canada and the rest of the world as lighter-coloured blocks, which generally require an expected oil price in the neighbourhood of USD 60 and higher.

Table 1, below, provides greater detail on the existing and prospective new oil projects in Canada. The table lists the top twenty projects that oil industry consulting service Rystad Energy foresees producing oil in 2030. As seen in the table (and consistent with Figure 1), the average cost of producing oil from Canada's existing largest oil projects – all oil sands projects in Alberta – averages about USD 40 per barrel. (No already-producing conventional oil projects remain in the top twenty in 2030, though the Hebron and Hibernia fields off the coast of Newfoundland are expected to remain substantial producers.)

By contrast, Rystad Energy expects the major new (not-yet-producing) projects in Canada to largely be in deposits other than the oil sands. As shown in Table 1, major new projects include three in Saskatchewan (Bakken, Viking, and LLoyd) and an offshore project in Newfoundland, in addition

Table 1. Top 20 crude oil producing projects in Canada in 2030, as foreseen by Rystad Energy

Project	Primary Operator	Province	Stage of Development	Production in 2030, million barrels	Breakeven price, USD (Brent basis)
Already producing projects					
Mildred Lake	Syncrude	Alberta	Already producing	105	40
Athabasca	Canadian Natural Resources	Alberta	Already producing	97	33
Horizon	Canadian Natural Resources	Alberta	Already producing	90	32
Kearl	ExxonMobil	Alberta	Already producing	86	54
Millennium Mine	Suncor	Alberta	Already producing	73	36
Christina Lake	Cenovus	Alberta	Already producing	65	26
Cold Lake	ExxonMobil	Alberta	Already producing	63	54
Fort Hills	Suncor	Alberta	Already producing	63	54
Firebag	Suncor	Alberta	Already producing	60	32
Surmont	ConocoPhillips	Alberta	Already producing	56	46
Jackfish	Devon Energy	Alberta	Already producing	35	35
Christina Lake	MEG Energy	Alberta	Already producing	32	32
Other	Canadian Natural Resources	Alberta	Already producing	32	32
Primrose	Canadian Natural Resources	Alberta	Already producing	30	39
Weighted average of above					**40**
Not yet producing projects					
Bakken shale	Crescent Point Energy	Saskatchewan	Undiscovered	98	39
Viking	Teine Energy	Saskatchewan	Undiscovered	51	53
Bay du Nord	Statoil	Newfoundland	Discovery	34	61
Meadow Creek	Suncor	Alberta	Discovery	32	126
Lloyd	Husky Energy	Saskatchewan	Discovery	30	61
Weighted average of above					**58**

Source: Rystad Energy. Breakeven prices are averages for each project, and may not reflect variations in breakeven prices for individual fields within each project. Note that all already-producing oil sands fields in Alberta are displayed in Figure 1 as a single block at the average (USD 40/barrel) cost.

to a new Meadow Creek oil sands project. Smaller potential new oil sands projects also exist but are not shown in Table 1, such as Teck's Frontier project and Suncor's Lewis project, both of which Rystad expects to have breakeven oil prices of USD 80 per barrel or above. (Also not shown in Table 1 are substantial new gas projects in the Montney shale, which extends across British Columbia and Alberta and would also produce substantial quantities of oil as natural gas liquids or condensate.)

Which projects in Table 1 end up being viable depends on global oil demand and, in turn, oil prices. There are numerous perspectives on global oil demand, which depend on expectations about economic growth and travel behaviours in developing economies – as well as on competition from oil alternatives, namely electric or hydrogen vehicles, and plastics not made from fossil fuels. Nevertheless, in nearly all foreseen scenarios – even those that meet the stringent Paris Agreement goals of limiting warming to "well below 2 degrees C" – demand appears sufficient to allow the continued exploitation of existing oil sands projects, at least through 2030.

This anticipated resilience, or lock-in, of the oil sands can be seen in Figure 1, where the existing oil sands projects are insulated against even lower demand scenarios – namely, the IEA's Sustainable Development Scenario (SDS), as well as scenarios by researchers at Simon Fraser University (Jaccard et al. 2018) and the University of Toronto (Harvey 2017). The oil sands projects have relatively low costs compared to the next most-costly sources, U.S. and Russian oil. (For a discussion of two possible factors that could put existing oil sands projects at greater risk, see Box 1.)

The climate benefit of constraining oil supply

The discussion above finds that existing production in Canada's largest oil reserves – the oil sands of Alberta – may be substantially locked in, insulated from the decreased oil demand that would occur under a global low-carbon transition.

This carbon lock-in has climate consequences. By continuing to produce (and, in this case, export) oil, Canada is contributing a fossil fuel that is ultimately burned, releasing substantial quantities of CO_2 emissions. One approach to tallying this global impact is to add up the carbon contained in each barrel of oil produced, regardless of whether each barrel is burned domestically or in international markets (Lee 2017). Each barrel of oil – regardless of oil produced (e.g. oil sands or shale oil) – contains carbon that, once burned, releases at least 400 kg CO_2 (IPCC 2006). Hence, the global CO_2 contribution could be easily tallied.

Here, we use a complementary approach, drawn from economic analyses of global oil markets (Bordoff and Houser 2015; Metcalf 2018; Perloff 2007). Instead of counting all of the carbon contained in each barrel of Canadian oil produced, we also consider how the oil market would operate if Canada did not produce those barrels. In other words, we consider that if Canada did not produce the oil, some other country might, and that the "net", or incremental CO_2 emissions impact would be only the added consumption that results from Canada's production.

These interactions of supply and demand can be modelled using basic economic tools. Namely, we use a simple equation composed of economic "elasticities", or parameters that describe how consumer demand and producer supply change in response to price. The equation is simple and transparent: for each barrel of oil newly extracted, the change in global oil consumption is given by the ratio of the elasticity of demand to the difference in the elasticities of demand and supply (Erickson and Lazarus 2014), as is described in more detail in Box 2.

Using this approach, and following other recent explorations of oil markets (Erickson and Lazarus 2018a; Erickson and Lazarus 2018b), we find that, for each barrel of Canadian oil produced, global oil consumption would increase between 0.2 and 0.6 barrels compared to if Canada did not produce the oil.

Multiplying by the carbon content of each barrel, this translates into a net CO_2 effect of continued Canadian oil production of 80 to 240 kg CO_2 per barrel. To understand how this would add up

BOX 1. TWO FACTORS COULD INCREASE RISK TO EXISTING OIL SANDS PROJECTS

Green paradox behavior by lower-cost producers, or subsidy reform in Canada

A couple of factors could put existing oil sands projects at greater risk. One is if even lower-cost producers, especially those in the Middle East, moved production earlier than otherwise planned, producing much more than indicated in Figure 1. This scenario is explored by Harvey (2017), who finds that Middle East producers have so much oil that they could, in theory, ramp up production rapidly in the near term, outcompeting other producers to fulfil nearly all global demand for oil through mid-century. This outcome could occur if producers exhibited "green paradox" behaviour, aggressively competing for market share before the oil demand virtually disappears later in the century due to the strong implementation of climate policy (Bauer et al. 2018; Sinn 2012).

The second factor is that oil sands might be more costly and less competitive than they appear, particularly if one considers direct and indirect public subsidies. For example, research has found that the viability of many oil projects depends heavily on subsidies, including tax preferences, provision of government services (such as infrastructure), and transfer of clean-up liability or spill risks from the oil industry to the public (Erickson et al. 2017). If policy-makers in Canada fulfil their commitment to phase out fossil fuel subsidies by 2025 (G7 2016), or impose much higher carbon pricing than currently applied, the cost of producing oil from the oil sands could increase, elevating the risk that they will be unable to cover their cash costs. Or, if other regions (such as the U.S. or Russia) increase subsidies, or see costs decrease because of technological developments, they may be able to out-compete Canadian oil sands.

across all Canadian oil production, we must look at how much oil production might be avoided. This involves looking at alternative scenarios of Canada oil production.

At present, Canada produces about 1.5 billion barrels of crude (or crude-equivalent) oil annually. The National Energy Board foresees that figure to rise to over 2 billion barrels of crude by 2030 (Figure 2), assuming that supporting oil transportation capacity exists (e.g. pipelines), and that oil prices increase to about USD 80 per barrel before 2030 (NEB 2017).

For simplicity, here we evaluate two alternative scenarios: one, in which Canada instead holds oil production at 1.5 billion barrels annually, and another, where Canada returns national oil production to the 2005 level of 0.9 billion barrels, by 2030. These two scenarios involve leaving 0.6 and 1.2 billion barrels of oil undeveloped in 2030, relative to the 2030 reference levels of 2.1 billion barrels, as depicted in Figure 2.

Keeping oil production to 1.5 billion barrels annually would avoid an estimated 50 to 150 million t CO_2 globally, using the estimate that every barrel not developed avoids 80 to 240 kg CO_2. If Canada returned oil production to 2005 levels, it would avoid 94 to 280 million t CO_2. Note that because these figures do not include any avoided emissions from producing each barrel in Canada (or elsewhere), the actual GHG emissions benefit would likely be greater, and some of which would accrue to Canada's own, in-country GHG emissions inventory.

Regardless, to put these prospective emission reductions into context, Canada's current climate action plan calls for sectoral actions that reduce emissions by 5 to 55 million t CO_2e in 2030 per sector, and which total 175 million t CO_2e in 2030, by the calculations of the Canadian Government (Table 2). From that perspective, the global CO_2 emission reductions (largely outside Canada) that could result from limiting Canadian oil production could be substantial, as they could be on a similar scale as Canada's in-country actions.

BOX 2. MODELLING THE GLOBAL OIL MARKET

Restricting Canada's oil production would decrease global oil consumption

In this briefing paper, we estimate how much global oil consumption would decline for each barrel of Canadian oil left undeveloped. We purposefully use a simple approach rather than a complicated oil market model, so that readers may understand (and, if desired, debate) our assumptions. Namely, we assume that the oil market follows basic microeconomic theory, as well as that oil prices and consumption levels are set by the interaction of global oil supply (including the Canadian oil sands) and global oil demand (Erickson and Lazarus 2014; Perloff 2007). Specifically, we assume that the following relationship holds, where Δ Production is the quantity of oil left undeveloped, Δ Consumption is the change in global consumption that results, and Ed and Es are long-term elasticities of demand and supply, respectively:

$$\Delta Consumption \cong \frac{E_d}{E_d - E_s}\ \Delta Production$$

For oil demand, the elasticity of demand is negative, which means that the higher the oil price, the less of it consumers will use. A higher price influences consumers' decisions about what kind of cars are purchased and how often (and far) they drive the vehicles, as well as commercial decisions such as how to ship goods or whether to use oil or alternate fuels in industrial facilities.

On the supply side, the elasticity is positive: higher oil prices increase the incentive to produce more and, ultimately, to explore for more oil.

To parameterize this equation, we use two alternative storylines about how the global oil market could evolve. In one storyline, consistent with current "business as usual" oil market outlooks (Rystad Energy 2017), we define the elasticity of supply to be quite low, 0.2, while the elasticity of demand is also fairly low (but in the opposite direction) at -0.3. In this oil market, and using the equation above, each barrel of Canadian oil left undeveloped results in a drop in global oil consumption of 0.6 barrels. This finding is consistent with our prior analysis of the oil sands under a business-as-usual market (Erickson and Lazarus 2014).

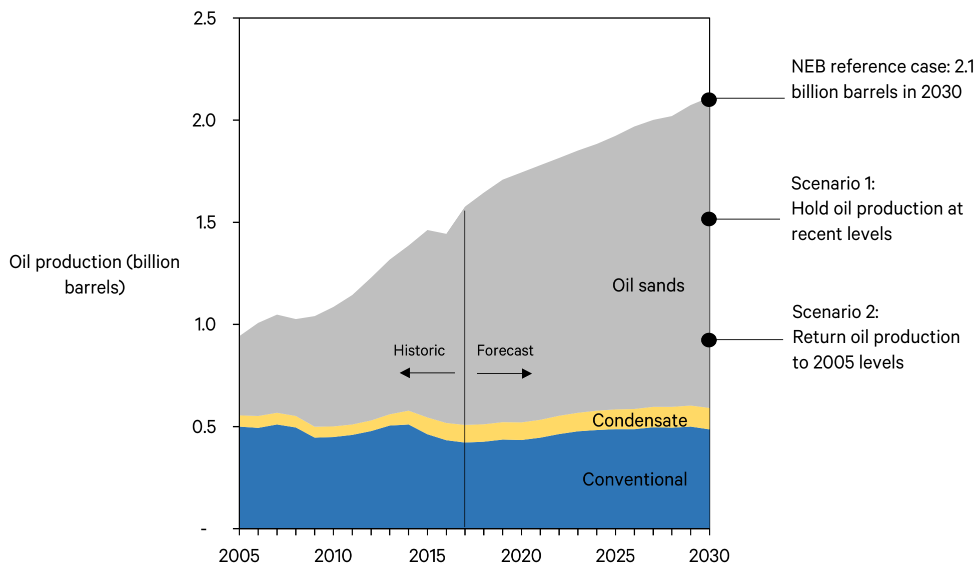
In the other storyline, we imagine instead that the oil market is plentiful relative to demand, such that future oil prices are lower. Here, the supply curve is much "flatter", with an elasticity of supply of 1. We also assume demand is slightly less price responsive at this lower demand level. In this scenario, we assume an elasticity of demand of -0.25, so for each barrel of Canadian oil sands left undeveloped, global oil consumption drops just 0.2 barrels.

Together, these two storylines provide a range of 0.2 to 0.6 barrels of potential consumption impacts for each barrel of Canadian oil left undeveloped. For further discussion of the choice of elasticities and a literature review of findings of other modelling teams, see Erickson and Lazarus (2018a; 2018b).

Of course, these CO_2 reductions would occur largely in other countries, due to changes in global oil markets. Slight increases in the price of oil, over time, would lead consumers to use less oil and, therefore, emit fewer GHG emissions. These particular reductions would not be easily included, or tracked, in Canada's official GHG emissions accounting, because they would not be readily verifiable, at least not according to existing rules for when and how the "credit" for GHG emission reductions may be shifted internationally (Prag et al. 2013).

This uncertainty in accounting need not be a barrier, however. Canada could begin a complementary, parallel accounting of the oil it leaves undeveloped and the CO_2 emissions

Figure 2. Recent Past and Future Reference Case for Canadian oil production



Source: National Energy Board (NEB 2017) with scenarios by the author.

associated with that oil internationally, along with transparent assumptions about what incremental CO_2 reduction may occur globally as a result.

Such parallel accountings have recently been proposed for the UNFCCC (Piggot et al. 2017). Inputs to the UNFCCC's Talanoa Dialogue process also have emphasized a need for "international coordinated policy action" on "managing fossil fuel production" (UNFCCC 2018, para.135), in recognition of the role that limiting fossil fuel supply can play in low-carbon transitions. Furthermore, accounting for the broader impact of Canada's oil development could help the country unify its energy and climate policies, allowing for more transparent and integrated policy-making across energy, climate, and other objectives (Palen 2014).

Table 2. Estimates of GHG abatement in 2030 due to prospective Canada policy actions

Policy	Policy details	Emission reduction in 2030
Measures analysed in this report		
Hold oil production at 1.5 billion barrels annually (Scenario 1)	0.6 billion barrels reduction relative to NEB reference case	50-150 million t CO_2
Return oil production to 2005 levels (Scenario 2)	1.2 billion barrel reduction relative to NEB reference case	94-280 million t CO_2
Measures analysed by Canadian government		
Power sector decarbonization	Coal phase-out	17 million t CO_2e
Building efficiency	Federal appliance efficiency standards, Quebec new building standards, BC climate plan, carbon pricing	28 million t CO_2e
Transportation efficiency	Federal heavy duty vehicle regulations, clean fuel standard	15 million t CO_2e
Industry, including oil & gas	HFC regulation, methane regulation for oil and gas, Alberta cap on oil sands emissions	56 million t CO_2e
Agriculture, waste	Not specified	4 million t CO_2e
Purchase international allowances	Purchase of allowances by BC and Quebec through Western Climate Initiative	55 million t CO_2e

Source: Author analysis, ECCC (ECCC 2018a)

Discussion and conclusions

Our findings demonstrate that most major existing oil sands projects are resilient to fluctuations, or even a decline, in oil price, and are therefore "locked in". Therefore, the major, existing oil sands projects are unlikely to be physically stranded or cease production, even if they do not meet the financial benchmarks that investors expect.

Other researchers have pointed out that continued production from the oil sands may put Canada's emission-reduction goals and climate leadership at risk.

Here, we have shown another dimension to the risk posed by the oil sands: they may contribute to a global over-supply of oil and essentially drive down global oil prices, slowing the necessary low-carbon transition outside Canada.

This global emissions effect can be quantified. Using simple economic tools, we have shown that Canada is contributing about 50 to 150 million t CO_2 to global emissions by planning to continue the oil sands expansion, instead of holding production at current levels of 1.5 billion barrels annually. The emission reductions would be even greater if Canada reduced oil production further, back to 2005 levels. Further, this estimate does not include the additional, substantial emission reductions that would occur in Canada due to reduced production of the oil sands, which would be an even more direct contribution to Canada's own emissions goals.

Leaving oil undeveloped is only beginning to become a common and accepted component of countries' climate action plans (Green and Denniss 2018). For example, Belize, Costa Rica, France, and New Zealand – none of them substantial oil producers – have all announced intentions to stop new oil and gas exploration. Without question, it can be difficult – even for perceived climate leaders like Canada – to acknowledge the climate damages caused by producing large quantities of oil that, in this case, amounts to much more oil than Canada uses in-country.

But a long-term, global effort to meet climate goals will require oil producers, especially wealthy producers with aspirations for climate leadership (such as the U.S. and Norway), to phase out oil production. In theory, oil producers could count on reduced demand to bring about a transition away from oil production. However, the risks of such an approach are numerous – for the climate, as well as for communities in Canada (and elsewhere) that depend on oil extraction and might otherwise be stranded if and when major reductions in demand materialize. A more pro-active approach may be required: to purposefully limit oil expansion, and eventually to phase it down.

Some signs of such momentum are already emerging in Canada. For example, Quebec's Environment Minister has said she would prefer to stop exploration for oil and gas in the province (Shields 2018). Canada has committed to phasing out fossil fuel subsidies by 2025, which presumably would include support for the oil sands. And some proposals have been introduced to manage Alberta's oil sands in a way that does not maximize production, but instead provides a revenue stream to transition the workforce and clean up the pollution legacy of these deposits (Nikiforuk 2016).

By seriously considering limits to the expansion of the country's oil industry, the Canadian federal government could help decrease the risks of carbon lock-in, have a tangible effect on global CO_2 emissions, and demonstrate it is ready to increase its ambition under the Paris Agreement .

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Published by:
Stockholm Environment Institute
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This discussion brief is an output of the SEI Initiative on Fossil Fuels and Climate Change. The author thanks Michael Lazarus, Danny Harvey, and Adam Scott for helpful comments on this draft, and Emily Yehle for editing support. Financial support for this research was provided by the New Venture Fund, as well as the Swedish International Development Cooperation Agency.