PEMBINA institute

# The oilsands in a decarbonizing Canada

## A more carbon-intensive source of oil

Extracting and refining oilsands bitumen uses a lot of energy, resulting in higher greenhouse gas (GHG) emissions per barrel than other crudes. As oilsands account for 64 % of all Canadian oil production, Canada produces the fourth most carbon-intensive oil on earth, after Algeria, Venezuela and Cameroon. Canada's oil production emits, on average, 70% more GHG emissions than the average crude produced globally.[1]

**17%** increase in overall emissions intensity for extraction

The emissions intensity of mining operations increased by 9% between 2002 and 2016, and this trend will continue as producers access deeper, lower-quality bitumen. Although the emission intensity of in situ operations remained relatively stable over the same period (+1%), this extraction method still produced 43% more GHG emissions than surface mining in 2016. Because in situ has become the dominant form of extraction, overall oilsands emissions intensity has increased by 17% between 2002 and 2016 (Figure 1), and is expected to keep growing in the future. Most of the easiest reductions — such as energy efficiency measures that pay for themselves — have already been instituted on the extraction side, and achieving further reductions will be significantly more costly.

Transforming bitumen into transportation fuels also requires more processing than conventional crudes, which translates into additional carbon emissions at the refining stage. Bitumen can only be processed in refineries equipped for heavy oil. An alternative is to upgrade the bitumen and convert it to synthetic crude oil, a product selling at a different price, which can be processed by any refinery.

More recent mining projects claim their emissions intensity is on par with that of the average barrel refined in North America. While projects that combine new technologies and access to better quality resources can achieve noteworthy performance, they only marginally influence the overall emissions trend of the sector, which is dominated by more carbon-intensive in situ projects. Furthermore, there is a notable difference in quality between bitumen and the average crude refined in North America, the latter being much less energy-intensive to refine.

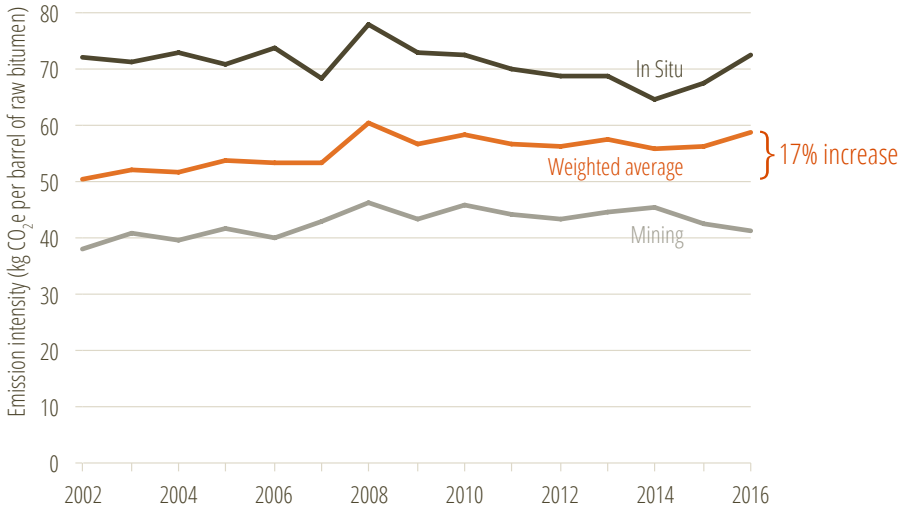
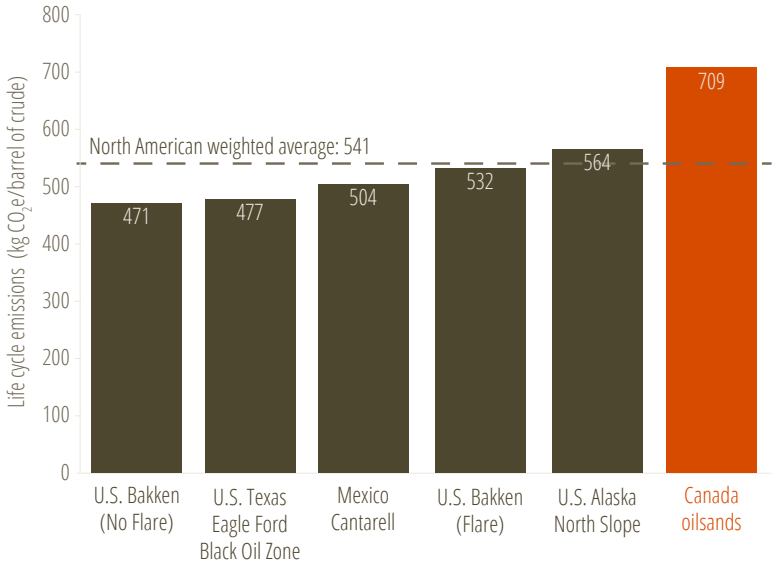



Figure 1. Emissions intensity of oilsands extraction

Data sources: Alberta Government,[2] Environment and Climate Change Canada[3]

Note: Emissions from upgrading are not represented.

**31%** higher carbon emissions than the average N. American crude




Upgrading has become 46% less carbon intensive between 2002 and 2016,[2,3] but the process should be evaluated separately from extraction, because the characteristics of synthetic crude are quite different from bitumen and only about 42% of overall bitumen production can be upgraded.[4,5,6]

Recent research suggests that from the point of extraction to the point of combustion, most oilsands crude is associated with 31% more carbon emissions than the average North American crude (Figure 2).

### Figure 2. LIfe cycle emissions of the oilsands and a few representative U.S. crudes

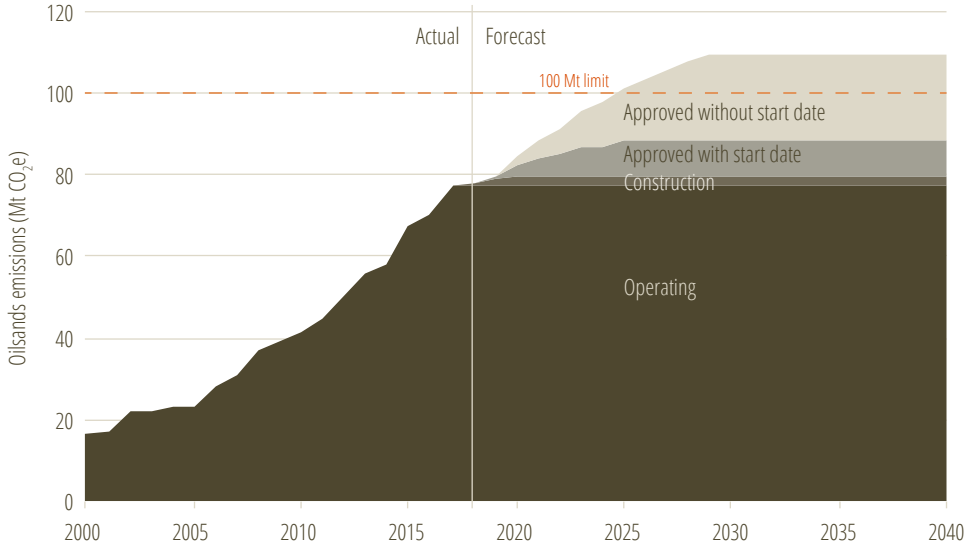
Data source: Carnegie Endowment for International Peace[7]

Note: The analysis assumes each crude is refined without any blending with other crudes, which is not a current practice in refineries. While crudes included in this analysis only represent about 37% of the North American production and 24% of the oilsands production, results are comparable to other existing studies.

## Emissions will keep increasing

In 2016, the Alberta government passed the Oil Sands Limit Act, which establishes a firm limit for oilsands carbon emissions. When regulations are created that enable the act to come into force, emissions associated with oilsands extraction and upgrading cannot exceed 100 million tonnes (Mt) of $CO_2$ per year by law, with an additional 10 Mt provision for newly built upgraders. In 2018, emissions were estimated at 77 Mt. Currently, the energy regulator has granted approvals that cumulatively add up to 131 Mt if all projects proceed — a figure that rises to 167 Mt when including projects seeking approval. Considering only projects under construction and a portion of those approved, Pembina Institute analysis suggests the 100 Mt limit will be reached in 2025 (Figure 3).

**2025** emissions from oilsands will reach 100 Mt limit




### Figure 3. Actual and forecast emissions from the oilsands

Source: Pembina Institute[8]

Note: Assumptions are presented and discussed in the source referenced. This analysis does NOT consider projects currently being reviewed by the regulator, and assumes that only 50% of approved projects without a start date will proceed.

# Oilsands could represent more than 80% of Canada's carbon emissions by 2050

Oilsands emissions have doubled since 2005, and are expected to double again by 2030.

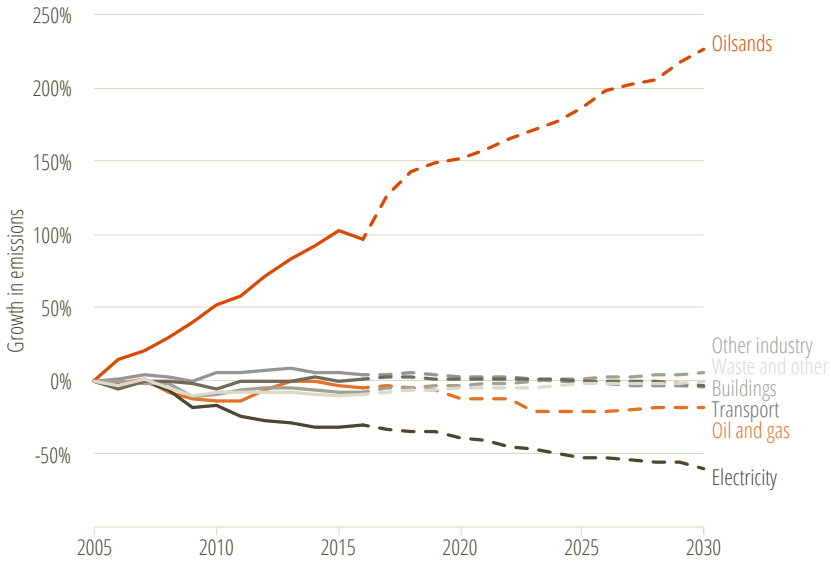



Figure 4. Emissions growth by Canadian economic sector since 2005

Data source: Environment and Climate Change Canada[9]
Note: The agricultural sector is included in Other industry.

Emissions from the oilsands are a fast-growing share of a shrinking budget. While Canada has been able to stabilize or decrease emissions from other economic sectors, those from oilsands production have nearly doubled between 2005 and 2016 (Figure 4). A continuation of this trend would severely jeopardize Canada's ability to meet its 2030 emissions target under the Paris Agreement.

Historically, Canada has struggled to deliver on its carbon emissions reduction commitments. The 2020 GHG emissions target is out of reach, and a recent report from Environment and Climate Change Canada shows the country is not on track to achieve the 2030 emissions reduction target of 30% below 2005 levels.[9] Canada needs to show it can reverse its poor performance and stay on track to meet the self-set targets that keep us away from tipping over ecological limits caused by dangerous temperature increases.

Emissions from the oilsands industry represented over 10% (72 Mt) of Canada's overall emissions in 2016, and accounted for 39% of oil and gas sector emissions (which accounts for 26% of Canada's total emissions).[3] Under current emissions forecasts, the oilsands subsector will represent 115 Mt in 2030, or over 22% of Canada's climate budget (512 Mt). If Canada follows through on its commitment to reduce emissions by 80% by 2050, oilsands frozen at 2030 levels would then account for 79% of Canada's emissions (Figure 5).

Percentage of Canada's climate budget potentially represented by oilsands:

22% in 2030

79% in 2050

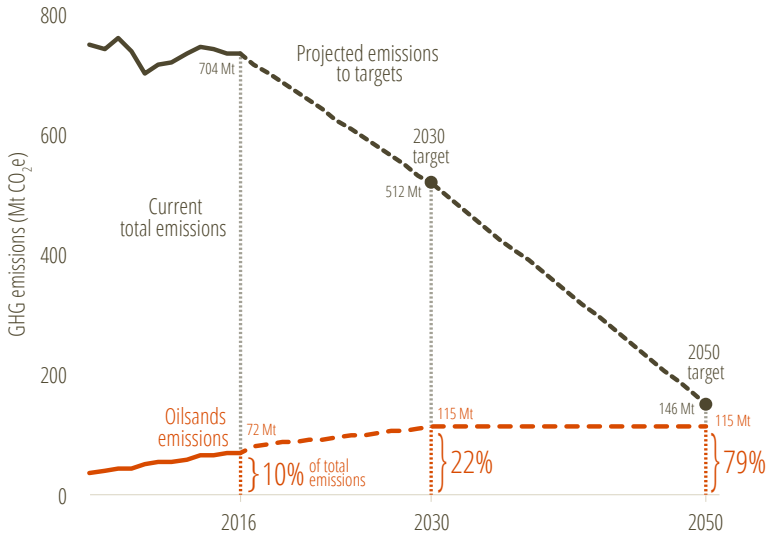



Figure 5. Share of the oilsands emissions in Canada's carbon budget

Source: Environment and Climate Change Canada[3,9]

Note: ECCC indicates that oilsands will emit 115 Mt in 2030, which includes emissions under the 100 Mt oilsands limit plus emissions exempt from the limit, such as indirect emissions from electricity and those from new upgrading capacity. In this analysis, oilsands emissions are supposed to remain at 2030 levels until 2050.

## Technological solutions have limits

Industry is actively trying to reduce the carbon footprint of the oilsands. Many in situ technologies promise to reduce the carbon intensity of bitumen extraction by up to 80% while reducing capital and operating costs.[10] Some solvent-based technologies could come with additional environmental benefits, such as reduced water consumption. Although these sound promising on paper, there are important limitations:

> Most promising technologies are not yet commercially available, and will only apply to a small fraction of operations.

- Promising technologies that could cut emissions by more than half cannot be used to retrofit existing operations — they only apply to new projects. Since output from new projects is not expected to represent more than 10% of overall production in a given year,[11] the adoption of any breakthrough technology will only marginally lower the carbon emissions of the overall sector.
- The applicability and the performance of many of these technologies are highly dependent on the characteristics of a reservoir, which can greatly vary.
- Technologies that deliver the largest climate benefits are still in development and are not commercially proven yet. Other potential environmental impacts from such technologies should be assessed before large-scale deployment.

## Endnotes


1. Masnadi et al, "Global carbon intensity of crude oil production," Science 361, no. 6405 (2018). http://science.sciencemag.org/content/361/6405/851
2. Alberta Environment and Parks, Oil Sands Information Portal, "Total Oil Sands Production Graph," 2018. http://osip.alberta.ca/library/Dataset/Details/46
3. Environment and Climate Change Canada, National Inventory Report 1990-2016: Greenhouse Gas Sources and Sinks in Canada, Table A10–2 (2018). http://www.publications.gc.ca/site/eng/9.506002/publication.html
4. Oil Sands Magazine, "Bitumen & heavy oil upgraders," 2018. http://www.oilsandsmagazine.com/projects/bitumen-upgraders
5. Oil Sands Magazine, "Thermal in-situ facilities," 2018. http://www.oilsandsmagazine.com/projects/thermal-in-situ
6. Oil Sands Magazine, "Mining operations," 2018. http://www.oilsandsmagazine.com/projects/oilsands-mining
7. Carnegie Endowment for International Peace, Oil-Climate Index, "Viewing total emissions," 2016. http://oci.carnegieendowment.org/#total-emissions
8. Pembina Institute, Teck Frontier Mine: Review of greenhouse gas emissions and climate change commitments (2018). https://www.ceaa-acee.gc.ca/050/documents/p65505/125100E.pdf#page=139
9. ECCC, Canada's National Reports to the United Nations Framework Convention on Climate Change (2017). http://unfccc.int/files/national_reports/national_communications_and_biennial_reports/application/pdf/82051493_canada-nc7-br3-1-5108_eccc_can7thncomm3rdbi-report_en_04_web.pdf
10. Canadian Energy Research Institute, Economic Potentials and Efficiencies of Oil Sands Operations: Processes and Technologies, 2017. https://ceri.ca/studies/economic-potentials-and-efficiencies-of-oil-sands-operations-processes-and-technologies
11. National Energy Board, Canada's Energy Future 2017 Supplement: Oil Sands Production, 2017. http://www.neb-one.gc.ca/nrg/ntgrtd/ftr/2017lsnds/index-eng.html



PEMBINA institute

**Benjamin Israel, Jan Gorski and Morrigan Simpson-Marran**



October 2018