Canadian Energy Centre

CANADIAN OIL IS GETTING "CLEANER":

OVERALL EMISSIONS INTENSITY DOWN BY 10 PERCENT SINCE 2000,

OIL SANDS EMISSIONS INTENSITY DOWN BY NEARLY 23 PERCENT

Introduction

Many people are interested in whether a barrel of oil produced by the Canadian upstream oil sector is becoming "cleaner" on an emissions per barrel basis.

To answer this important question, this CEC Fact Sheet examines Environment and Climate Change Canada (ECCC) historical greenhouse gas (GHG) emissions intensity numbers, expressed as kilograms of CO2e (CO2e) per barrel, for the Canadian upstream oil sector (defined as the sum of the oil sands subsector and the conventional oil subsector).

Historical emissions intensity of Canada's upstream oil sector

Emissions intensity is the emission rate of a given pollutant relative to the intensity of a specific activity or industrial production process. Emissions intensity is determined by dividing the amount of absolute emissions by some unit of output, such as GDP, energy used, population, or barrel of oil produced.

Reducing emissions intensity means reducing the amount of greenhouse gases (GHGs) emitted per unit of output.

Overall Canadian oil GHG emissions intensity per barrel down by over 10 percent since 2000, oil sands GHG emissions intensity down by nearly 23 percent, and conventional GHG emissions intensity down by over 32 percent

Using ECCC numbers drawn from the 2019 National Inventory Report (NIR), the overall GHG emissions intensity of Canadian oil production rose from just under 59 kilograms of CO2e per barrel in 1990 to just over 72 kilograms of CO2e per barrel in 2000, an increase nearly 23 percent. Then, between 2000 and 2019, the GHG emissions intensity of oil from the Canadian upstream sector fell to just under 65 kilograms of CO2e per barrel in 2019, an overall reduction in those two decades of over 10 percent (see Figure 1).

Blending the oil sands subsector and the conventional oil subsector into a measure of total GHG emissions intensity for the Canadian upstream oil sector masks some important trends unfolding in the two subsectors. Note that for oil sands mining, ECCC uses the crude bitumen produced from surface mining to calculate intensity. For oil sands upgrading, ECCC uses the volume of synthetic crude oil (SCO) produced for calculating intensity. And, for in-situ bitumen, ECCC uses the volume of bitumen produced at in-situ facilities for calculating intensity. When calculating the overall oil sands intensity, ECCC uses the total SCO production volume plus the total volume of non-upgraded bitumen production, as some of the bitumen produced at in-situ facilities and surface mines is upgraded into SCO.

In the oil sands subsector, GHG emissions intensity rose from just over 116 kilograms of CO2e per barrel in 1990 to just over 117 kilograms of CO2e per barrel in 1992. After 1992, the oil sands subsector GHG emissions intensity fell to just under 104 kilograms of CO2e per barrel by 2000 (a decline of over 11 percent) and then fell again to just under 80 kg of CO2e per barrel by 2019, an overall decline of nearly 23 percent from 2000 levels (see Figure 1).

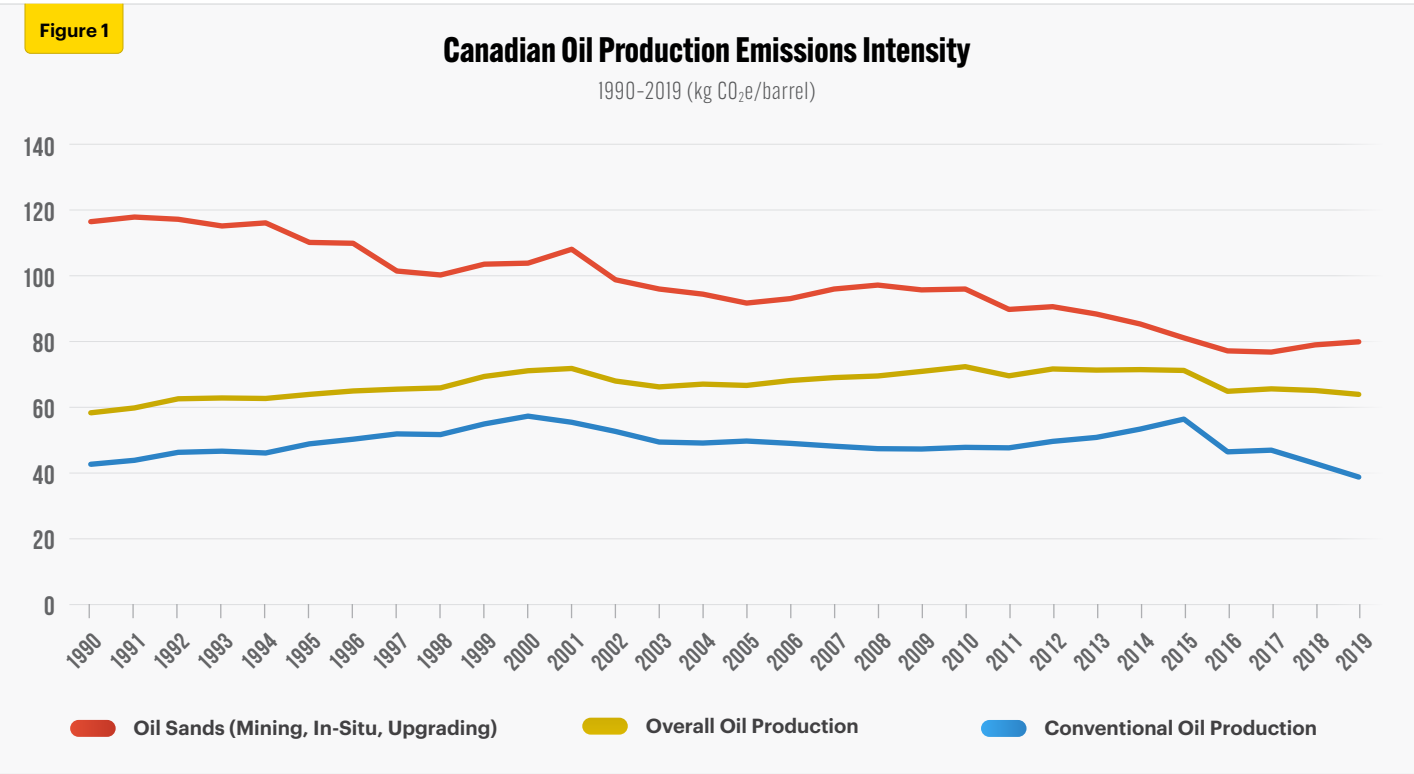
Meanwhile, in the conventional oil subsector, GHG emissions intensity grew from just under 44 kilograms of CO2e per barrel in 1990 to just under 59 kilograms of CO2e per barrel in 2000, an increase nearly 35 percent. However, since then, the GHG emissions intensity in the conventional oil sector has fallen—to just under 40 kilograms of CO2e per barrel in 2019, a decrease of over 32 percent in those two decades (see Figure 1).

How developments in Canada's oil sands subsector have influenced overall emissions intensity

Clearly the reason that the GHG emissions intensity of the overall Canadian upstream oil sector didn't drop more between 2000 and 2019 is that oil sands production increased as a fraction of overall oil production.

Using production data from Statistics Canada and the Alberta Energy Regulator (AER), we find that in 2000, the country's total oil production was about 2 million barrels per day, with production from the oil sands subsector comprising about 610,000 barrels per day, or 30 percent of total upstream oil production. In 2000, the split in oil sands subsector production was 57 percent mining and 43 percent in-situ. In contrast, by 2019, Canada's total upstream oil production was 4.4 million barrels per day, with oil sands production at 3.1 million barrels per day, or over 70 percent of total oil production. In-situ production was about 50 percent of total oil sands production in 2019.

Figure 1



Source: Derived from Environment and Climate Change Canada, 2021a.

Note: Intensities are based on total subsector GHG emissions and relevant production amounts. They represent overall averages, not facility intensities.

A look at historical milestones in the Canadian oil sands subsector reveals the rapid changes that have occurred, particularly since 1990 (see Table 1).

In 1990, total Canadian upstream oil production was about 1.5 million barrels per day. Of that, about 345,000 barrels per day, or 23 percent, came from the oil sands subsector. Furthermore, in that year oil sands production was largely from mining operations (65 percent), with the remainder (35 percent) from Cyclic Steam Stimulation (CSS) in-situ projects.

In 1990, the only large-scale oil sands plants in operation were the mining operations at Alberta's Suncor Base Plant and Syncrude Mildred Lake Plant. There was also an Imperial CSS in-situ plant at Cold Lake, Alberta. In 1990, in-situ/SAGD (Steam Assisted Gravity Drainage) as a method for oil sands recovery was largely in its infancy; only a few small pilot in-situ/SAGD demonstration projects were being co-funded at that time through the Alberta Oil Sands Technology and Research Authority (AOSTRA) and the private sector.

Table 1

Canadian Oil Sands Subsector Milestones

1960s to 2019

Year	Milestone
1960s	Early in-situ pilot tests begin in the Peace River and in the Cold Lake areas. The ones in Cold Lake used the Cyclical Steam Stimulation (CCS) bitumen recovery method.
1967	Great Canadian Oil Sands (GCOS) Ltd. begins production.
1974	Alberta Oil Sands Technology Research Authority (AOSTRA) is established to promote the development of new oil sands technologies.
1978	Syncrude Canada opens its oil sands mining and bitumen upgrading facility. Together with GCOS Ltd., total mined bitumen increases to more than 90,000 barrels per day.
1979	Private sector and AOSTRA partnership leads to the commercialization of bitumen in-situ recovery.
1984	AOSTRA initiates the Underground Test Facility as an in-situ Steam Assisted Gravity Drainage (SAGD) bitumen recovery facility.
1985	Commercial production begins at Imperial's Cold Lake Cyclic Steam Stimulation (CSS) project.
1987	AOSTRA opens its Underground Test Facility (UTF) to test in-situ oil sands technology, most notably SAGD methods.
1990	Total Canadian upstream oil production is about 1.47 million barrels per day. Of that, about 345,000 barrels per day, or 23 percent, comes from the oil sands subsector. Oil sands production is largely from mining operations (65 percent), with the remainder (35 percent) from CSS projects.
1995	The National Task Force on Oil Sands Strategies presents its final report to the governments of Canada and Alberta. The Task Force recommends that the Canadian and Alberta governments develop a generic set of harmonized tax and royalty measures based on the economic profits of oil sands projects.

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Table 1 continued

1995	Total Canadian upstream oil production is about 1.81 million barrels per day, with oil sands subsector production comprising about 430,000 barrels per day, or 24 percent of total upstream oil production. The split between mining and in-situ production in the oil sands subsector is 69 percent mining and 31 percent in-situ.
1996	Foster Creek, near Cold Lake, operated by Encana (predecessor of Cenovus), becomes the first commercial SAGD project.
1997	The Alberta government implements a "Generic Oil Sands Royalty Regime" for oil sands projects, including new projects or expansions of current projects.
2000	Total Canadian upstream oil production is about 2 million barrels per day, with the oil sands subsector production comprising nearly 610,000 barrels per day, or about 30 percent of total upstream oil production. The split between mining and in-situ production in the oil sands subsector is 57 percent mining and 43 percent in-situ.
2001	Encana's Foster Creek plant near Cold Lake becomes the first commercial oil sands project to use SAGD technologies.
2001	Syncrude Aurora North reaches start-up.
2002	In Alberta, Cenovus Christina Lake SAGD reaches start-up as does Suncor MacKay Lake SAGD.
2004	Suncor Firebag SAGD reaches start-up. For the first time, total annual bitumen production reaches over 1 million barrels per day.
2005	Total Canadian upstream oil production is about 2.35 million barrels per day, with the oil sands subsector production comprising about 1 million barrels per day, or 42 percent of total upstream oil production. The split between mining and in-situ production in the oil sands subsector is 59 percent mining and 41 percent in-situ.
2009	CNRL Horizon Project north of Fort McMurray, Alberta, reaches start-up.
2010	Total Canadian upstream oil production is about 2.7 million barrels per day, with the oil sands subsector production comprising nearly 1.5 million barrels per day, or 55 percent of total upstream oil production. The split between mining and in-situ production in the oil sands subsector is 53 percent mining and 47 percent in-situ.
2012	In-situ bitumen production exceeds mined production for the first time in Canada. In-situ production is about 1 million barrels per day, or 52 percent, and mined production is about 930,000 barrels per day, or 48 percent of total upstream oil production.
2015	Total Canadian upstream oil production is about 3.6 million barrels per day, with oil sands subsector production comprising nearly 2.4 million barrels per day, or 65 percent of total upstream oil production. The split between mining and in-situ production in the oil sands subsector is 46 percent mining and 54 percent in-situ.
2019	Total Canadian upstream oil production is over 4.4 million barrels per day, with oil sands subsector production at 3.1 million barrels per day, or over 70 percent of total oil production. In-situ production is about 50 percent of total oil sands production.

Source: Derived from the Oil Sands Discovery Centre, undated; and the Canadian Association of Petroleum Producers, 2021.

Thus, 2000 seems an appropriate year to compare trends in emissions intensity in the Canadian upstream oil sector because of the rapid changes occurring in the oil sands subsector and the lack of reliable data back in 1990.

The World Resources Institute (WRI) notes: "Choose a base year or base period for which representative, reliable, and verifiable emissions data are available to enable comprehensive and consistent tracking of emissions over time" (WRI, 2014).

According to IPICEA (the global oil and gas industry association for environmental and social issues), API (the American Petroleum Institute), and OGP (the International Association of Oil & Gas Producers): "Companies that have not yet begun (or have only recently begun) to report emissions will usually find it difficult to reliably estimate their emissions as far back as 1990. For other companies, the amount of reorganization that has occurred within the petroleum industry since 1990 makes it difficult to quantify base year emissions that occurred that long ago (IPICEA, API and OGP, 2011)

And finally, the Government of Canada notes: "Since 2005 was adopted as a base year for Canada's targets, many of the metrics in this report are presented in that context, in addition to the 1990 base year as required by the UNFCCC Reporting Guidelines" (Canada, 2020).

Summing Up: Canada's upstream oil sector is becoming cleaner on an emissions per barrel basis

Clearly, since 2000, the Canadian upstream oil sector is becoming cleaner on an emissions per barrel basis.

- Between 2000 and 2019, the GHG emissions intensity of the Canadian upstream sector fell from just over 72 kilograms of CO2e per barrel to just under 65 kilograms of CO2e per barrel, an overall reduction of over 10 percent.
- Between 2000 and 2019, the GHG emissions intensity of the oil sands subsector fell from 104 kilograms of CO2e per barrel to just under 80 kilograms of CO2e per barrel, a decline of nearly 23 percent.
- Between 2000 and 2019, the GHG emissions intensity in the conventional oil sector has fallen from just under 59 kilograms of CO2e per barrel to just under 40 kilograms of CO2e per barrel, a decrease of over 32 percent.

Another factor closely related to Canada's cleaner oil is the country's high ESG rating among major oil producing nations. According to the Bank of Montreal,

> Canada is among the most responsible of the major oil producing countries overall. Based on reputable third-party assessments, Canada continues to top global ESG ratings given performance across a full spectrum of factors from environmental policy to social progress/welfare, political stability, regulatory oversight and corporate governance... we have aggregated rankings on three main ESG categories for the world's top-15 oil reserve holders. Benchmarks used include the Yale/Columbia Environmental Performance Index (EPI), Social Progress Imperative's Social Progress Index, and World Bank's Worldwide Governance Indicators. Canada ranks #1 in all measures when compared to the world's top oil reserve holders. The country also ranks third overall among the world's current top oil producing regions, next to Norway and the U.K. (Bank of Montreal, 2021)

As GHG emissions intensity in the Canadian upstream oil sector continues to decline, along with Canada's highly rated ESG performance, Canadian oil has the potential to become the barrel of choice on the world stage.

Notes

This CEC Fact Sheet was compiled by Lennie Kaplan at the Canadian Energy Centre (www.canadianenergycentre.ca). The author and the Canadian Energy Centre would like to thank and acknowledge the assistance of Philip Cross and two anonymous reviewers in reviewing the original data and research for this Fact Sheet. Image credits: Nataliia Kvitovska from Unsplash.com

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