

Economic spotlight

Canadian crude oil production and flows

Canada has been producing oil for over 160 years, ever since the first commercial oil well was drilled in southwestern Ontario in 1858. The country produced 1.6 billion barrels of oil in 2020, despite the sharp decline in demand at the start of the COVID-19 pandemic. Oil production has more than doubled from two decades ago. Since domestic demand has not kept up to this fast pace, Canada's oil exports have increased and become an important driver of overall exports and income for the country. This Economic Spotlight looks at Canadian crude oil production and where it all goes.

Canadian Crude Oil Production

Fourth largest producer in the world

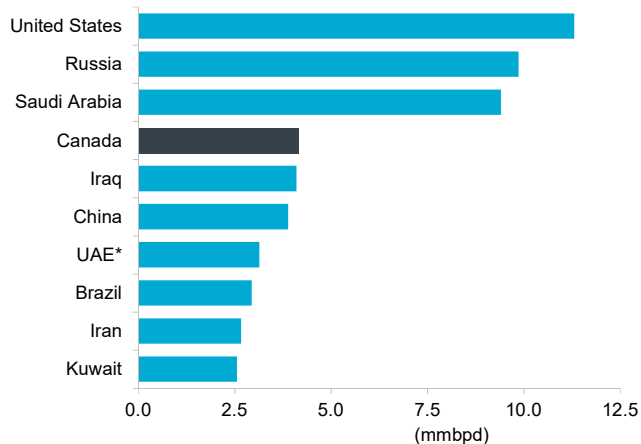
Canadian crude oil and equivalent (condensate and pentanes plus) production stood at 4.5 million barrels per day (mmbpd) in 2020, the fourth highest in the world behind United States, Russia, and Saudi Arabia (Chart 1). This was up from 14th place two decades ago. Of that amount, 80% was produced in Alberta (Chart 2), with around 10% produced in Saskatchewan and 6.3% from Newfoundland and Labrador. The remaining 3.5% of total production came from British Columbia, Manitoba, Northwest Territories, Ontario, and New Brunswick.

Largest share of output comes from the oil sands

Canadian crude oil output has risen 106% over the last twenty years, with most of the growth driven by the oil sands (or non-conventional oil), in the form of either open-pit mining or in-situ production. Compositionally, oil sands share of total production more than doubled from 28% in 2000 to 63% in 2020 (Chart 3). All oil sands production happens in Alberta. For 2020, the remaining 37% of Canadian production is

CHART 1: CANADA TOP FOUR PRODUCER

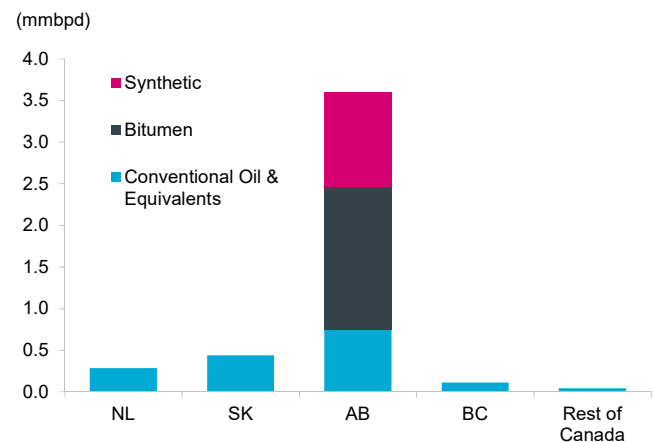
2020 top ten crude oil (including condensate) producing countries



Source: U.S. Energy Information Agency

CHART 2: ALBERTA LARGEST PRODUCING PROVINCE

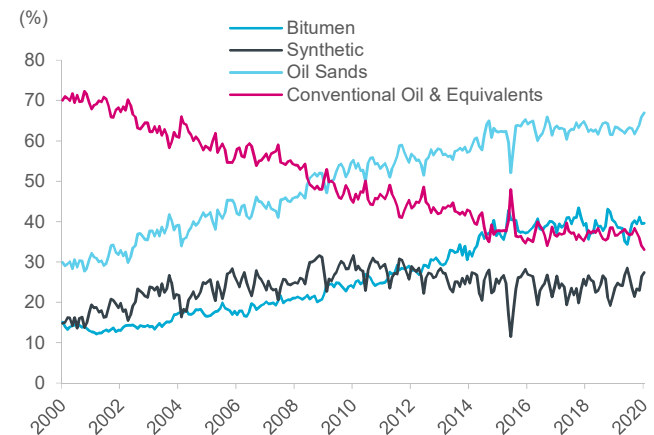
2020 Canadian crude oil production, by type and region



Source: Canadian Energy Regulator

CHART 3: BITUMEN'S GROWING IMPORTANCE OVER TIME

Share of Canadian crude oil output, by type



Source: Canadian Energy Regulator

conventional oil and equivalent products. However, this would include some other heavy conventional oil extracted by thermal in-situ methods, similarly used in the oil sands, along with some unconventional production, such as shale and tight oil.

Over a third of bitumen upgraded

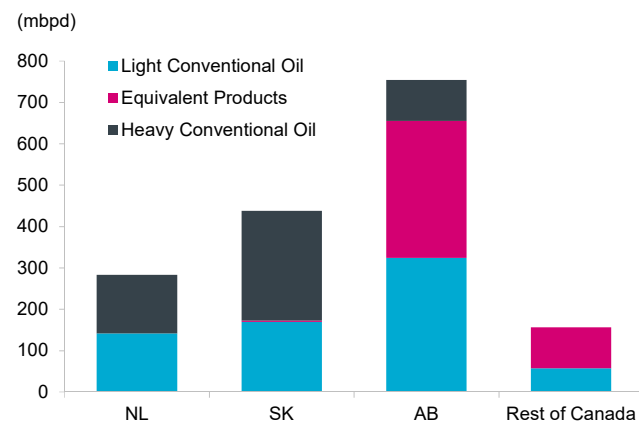
Most mined bitumen goes to onsite upgraders and transformed into synthetic crude oil (SCO). Of the 1.5 mmbpd of raw mined bitumen produced in 2020, about three-quarters was upgraded to SCO. In-situ bitumen and a growing portion of mined bitumen not sent for upgrading are blended with diluent, most commonly condensate. Given that bitumen is so thick, the blending is required to meet pipeline specifications in order to transport the bitumen to refining facilities. In Alberta, oil sands production totalled 2.8 mmbpd in 2020, of which roughly 60% shipped as diluted bitumen (dilbit) and about 40% as SCO.

Conventional oil produced all across Canada

Conventional oil and equivalent products are produced in several provinces in Canada. Total conventional crude oil and equivalent production in 2020 was 1.6 mmbpd. Over 40% of production was light crude oil, about a third was heavy crude oil, and roughly a quarter was equivalent products, which includes condensate and pentanes plus (C5+). Alberta was the largest conventional oil-producing province in 2020. Production stood over 750 thousand barrels per day (mbpd), with 87% light crude and condensate and the remaining heavy crude (Chart 4). Saskatchewan was the second largest producer, pumping 438 mbpd, with 61% heavy conventional and 39% light oil and condensate. The third highest conventional producer was Newfoundland and Labrador, which has several offshore deposits of crude oil. Newfoundland and Labrador produced 283 mbpd of crude oil. Along with these top

CHART 4: ALBERTA AND SASKATCHEWAN TOP CONVENTIONAL PRODUCERS

2020 Canadian conventional oil output, by type and region



Source: Canadian Energy Regulator

producers, other regions that have some production include British Columbia, Manitoba, Northwest Territories, Ontario, and New Brunswick. Together, these jurisdictions produced 156 mbpd in 2020 or 9.6% of total conventional oil produced in Canada.

Crude Oil Transportation Infrastructure

Major pipelines concentrated in Western Canada

Crude oil is transported to domestic and U.S. refinery markets by pipelines, rail cars, marine tankers, and trucks. About 88% (or 3.2 mmbpd) of Canada's crude oil exports in 2020 was transported by pipelines.

Pipelines are the cheapest means of transporting large volumes of crude to market. Since the bulk of Canadian crude oil production takes place in Western Canada, the majority of pipelines originate from this region. There are four main pipeline systems, namely: the Enbridge Mainline system, TC Energy's Keystone Pipeline, the Trans Mountain Pipeline, and the Enbridge Express-Platte system (Map 1, Page 3). There are other pipeline systems that transport smaller volumes of crude oil, such as the Milk River Pipeline and the Rangeland/Aurora Pipeline system.

- The Enbridge Mainline system, which is Canada's largest transporter of crude oil, delivers Western Canadian crude to refining markets in the U.S. Midwest, Ontario, Québec, and U.S. Gulf Coast via interconnected pipelines (such as the Enbridge Line 9 to Ontario and Québec and the Seaway Pipeline to the U.S. Gulf Coast).
- The TC Energy Keystone Pipeline transports crude oil to refining markets in the U.S. Midwest and U.S. Gulf Coast.
- The Trans Mountain pipeline, which is the only crude oil pipeline that goes to Canada's West Coast, transports crude oil and refined products to refineries and terminals in both British Columbia and Washington State via the Puget Sound Pipeline. Crude oil is also exported to offshore markets in Asia and the U.S. West Coast from Trans Mountain's Westridge Marine Terminal in Burnaby, British Columbia.
- The Enbridge Express-Platte pipeline system delivers crude oil to the U.S. Rocky Mountain and U.S. Midwest regions.

According to the Canadian Energy Regulator, available pipeline takeaway capacity from Western Canada rose from 3.95 mmbpd in September 2018 to 4.36 mmbpd in 2020 because of debottlenecking and optimization efforts on existing pipelines. Capacity is set to rise meaningfully in the coming years, with the completion of two pipeline expansions:

- Enbridge's Line 3, part of Enbridge's Mainline, has operated under reduced capacity for some time because its age and safety issues. The Line 3 Replacement project will see capacity restored to its original nameplate capacity of 760 mbpd. Construction on the Canadian proportion

of the project was completed in late 2019; meanwhile, construction on the U.S. part wrapped up this year and entered into service on October 1st, 2021.

- Currently under construction, the Trans Mountain Expansion will twin the existing Trans Mountain pipeline and more than double the capacity to the Canadian West Coast.

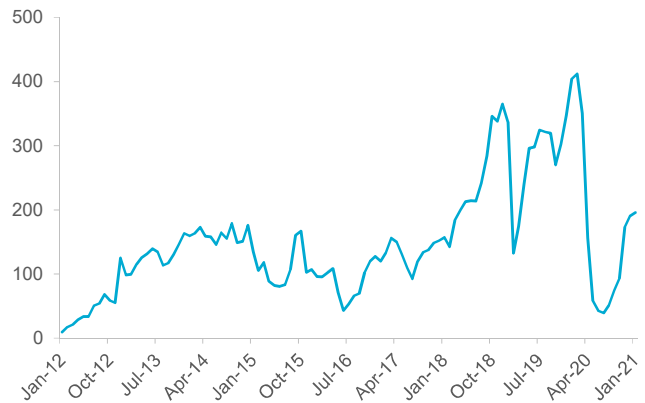
Growth in crude-by-rail

When production outpaced pipeline takeaway capacity in Western Canada, oil producers turned to railcars to transport their output to refinery markets across North America. While crude-by-rail (CBR) accounted for only 4.6% of Canada's crude oil exports in 2020, it increased significantly from 2012 (Chart 5), when it accounted for 2.0% of Canada's crude oil exports, and peaked at 7.5% in 2019. It serves as an important relief valve when production outstrips pipeline capacity, as it did in 2018, and remained an important avenue during the Alberta government's mandated production limits in 2019. CBR set a record high of 412 mbpd in February 2020, two months after total Canadian production hit a monthly high of 5.0 mmbpd in December 2019. The arrival of the COVID-19 pandemic and lower demand tapered the use of CBR in the remainder of 2020. However, CBR remains an important transportation option for producers as production continues to grow. CBR

is a more expensive transportation option than pipeline. The Canadian Energy Regulator estimated that it costs US\$15-22 per barrel to move crude from Alberta to U.S. refineries versus US\$5-10 per barrel by pipeline.

CHART 5: CRUDE-BY-RAIL IMPORTANT FOR EXPORTS

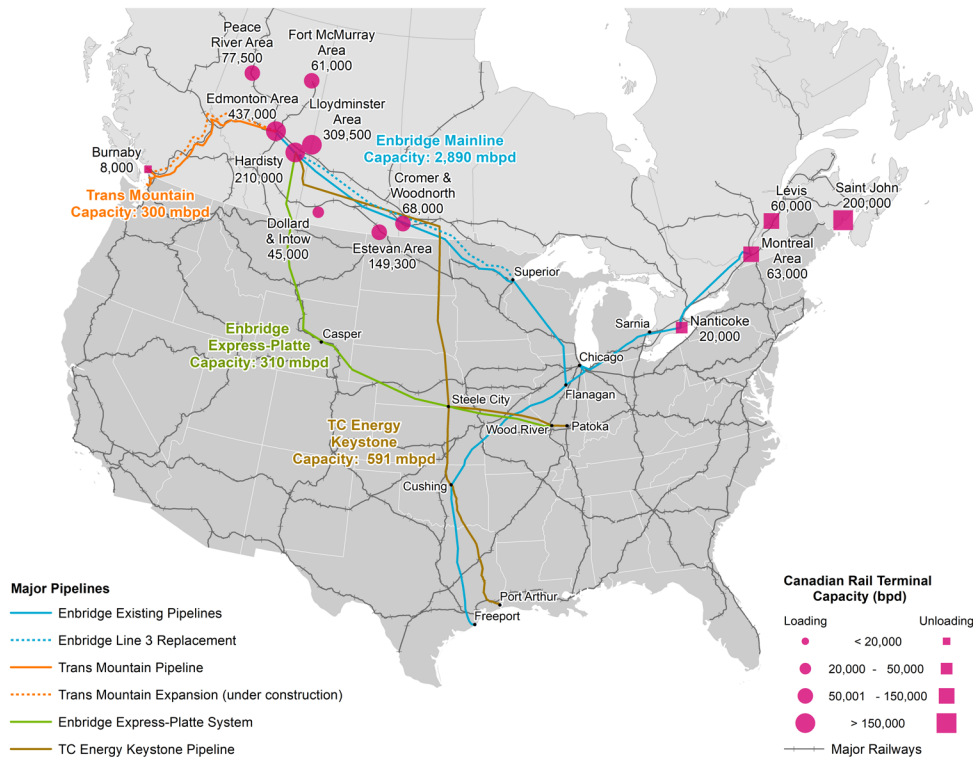
Canadian crude oil exports by rail (mbpd)



Source: Canadian Energy Regulator

MAP 1: MOST PIPELINES OUT OF WESTERN CANADA DESTINED FOR THE U.S.

Major Canadian crude oil pipelines and rail terminals



Sources: Canadian Association of Petroleum Producers, Canadian Energy Regulator, Natural Resources Canada, Natural Earth, Alberta Energy Regulator, U.S. Energy Information Administration, Alberta Treasury Board and Finance



The rapid growth in CBR exports over the past nine years was facilitated by the construction of new and expansions of existing rail loading facilities. Most of which are concentrated in Alberta, particularly in the Edmonton and Hardisty areas that are major hubs for crude oil storage and exports out of the province (Map 1). According to the Canadian Association of Petroleum Producers, these expansions boosted rail-loading capacity in Western Canada from about 180 mbpd at the beginning of 2013 to more than 1.1 mmbpd by 2019.

Crude Oil Flows

Canada produces more crude than it consumes

While Canada is a major producer of crude oil, it refines less than 25% of its domestic oil production and exports the rest. This is because of a number of factors, including domestic demand, availability of feedstock in each of the region, transportation infrastructure (such as pipelines and tidewater access), refinery configuration, and proximity of refineries to markets. Overall, Canada has a refining capacity of about 1.9 mmbpd, which ranks 11th in the world.

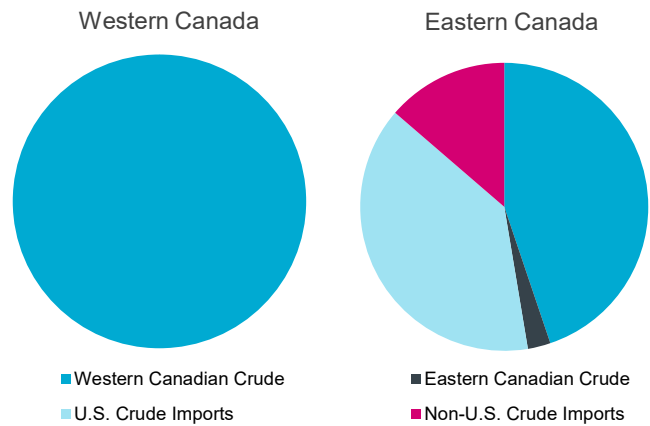
Canadian refineries can be organized into two regions: Eastern Canada (comprising Ontario, Québec, New Brunswick, and Newfoundland and Labrador) and Western Canada (comprising Alberta, British Columbia, and Saskatchewan). Eastern Canada hosts eight refineries with 1,212 mbpd in capacity. Meanwhile, Western Canada has seven refineries with a total capacity of 701 mbpd. Western Canada also has a couple of small asphalt refineries in addition to a number of bitumen/heavy oil upgraders located in Alberta and Saskatchewan. In recent years, capacity has increased modestly with the completion of the Sturgeon Refinery in Alberta, the first new refinery built in Canada since 1984. It has around 80 mbpd of nameplate capacity and can process up to 50 mbpd of bitumen.

Eastern Canada a net crude oil importer

Eastern Canada produces very little oil, besides offshore production, below its domestic fuel needs. To make up the gap, the region imports crude from Western Canadian, U.S. and other countries (Chart 6). Over half of Eastern Canada's crude imports comes from international sources, with the majority from the U.S., while the rest comes from about half a dozen or so other countries in much smaller volumes. Western Canadian oil feeds over two-fifths of Eastern Canada's refineries. Some Eastern Canadian production also supplements Eastern refineries intake.

CHART 6: EASTERN CANADA RELIES ON IMPORTED OIL

2020 Canadian crude oil inputs, by crude source



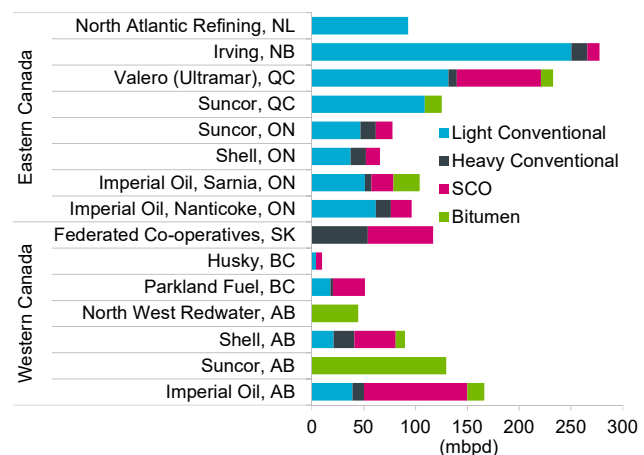
Sources: Canadian Energy Regulator, Statistics Canada, Alberta Treasury Board and Finance

Atlantic Provinces dependent on world supply

Refineries in Atlantic Canada are mostly configured to process lighter crudes (Chart 7). Refineries found in this area rely much greater on international imported crude oil, despite Newfoundland and Labrador offshore production. They also have very limited access to Western Canadian oil. Imports in 2020 were primarily from the U.S. with small amounts from Saudi Arabia, Nigeria, and Norway. Due to weak demand caused by the pandemic, the Newfoundland refinery was idle for most of 2020, leading to a 27% drop in the Atlantic Canada's imports compared to 2019.

CHART 7: EASTERN REFINERIES TOOLED TOWARDS LIGHTER CRUDE OILS

2016 Canadian crude oil refinery inputs, by refinery and crude type



Sources: Canadian Energy Research Institute, Statistics Canada

Over 90% of Newfoundland’s offshore oil production was exported – to either the U.S. or other countries – instead of processed at the two refineries in the area. Both refineries were built prior to offshore development and configured mostly for imported oil. Even ignoring market considerations and refinery configurations, offshore production would be insufficient to supply the two refineries, which have a combined nameplate capacity of 450 mbpd versus production of 283 mbpd.

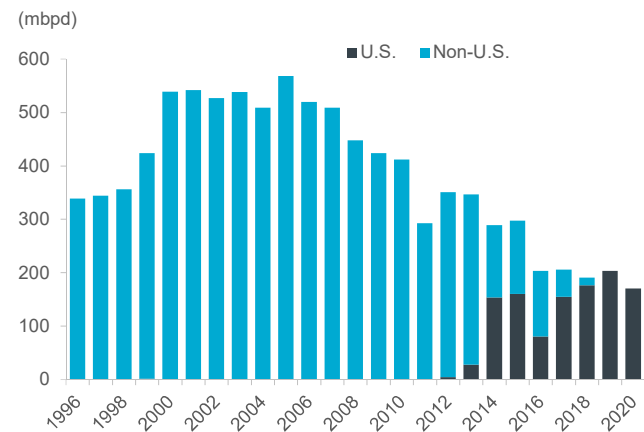
Ontario and Québec using more Western crude

Unlike in Atlantic Canada, refineries in Ontario and Québec use a mix of crude oil types. They also process oil from a variety of Canadian and foreign sources, with the latter mostly imported from the U.S. These refineries are increasingly using more Western Canadian feedstock compared with ten years ago. In Ontario, this was facilitated by the expansion of the Enbridge pipeline system from 2005 to 2010 and the reversal of the Enbridge Line 9A back to its eastward flow in 2013. Meanwhile, the reversal of Enbridge Line 9B and Line 9 capacity expansion in 2015 provided Québec refineries more access to Western Canadian feedstock.

U.S. supply remains a key input for refineries in both provinces. The pipeline reversals also led to increased access to cheaper U.S. crudes, pushing non-U.S. imports completely out of the Ontario refining market and reducing the reliance of Québec refiners on non-North American supplies. Roughly 86% of Ontario’s crude demand was met by Western Canadian sources, while the remaining 14% was imported from the U.S. in 2020. In Québec, foreign sources of crude oil outside the U.S. were eliminated in the past two years (Chart 8), with less than half coming from the rest of Canada and the remaining from the U.S.

CHART 8: QUÉBEC’S INTERNATIONAL IMPORTS DECLINING

Québec’s international crude oil imports



Source: Statistics Canada

Western Canada exports

In contrast to other areas of Canada, Western Canada is largely self-sufficient for oil and refineries exclusively use feedstock produced from within the region. The region also has the refining capacity to process more oil sands than other refineries in Canada. Thus, most oil produced in Western Canada was exported to the U.S. Midwest. (Map 2, Page 6) Western Canadian exports to the U.S. amount to over 90% of Canadian international crude oil, of which nearly 70% was exported to PADD II in 2020.

Canadian export growth driven by heavy crude

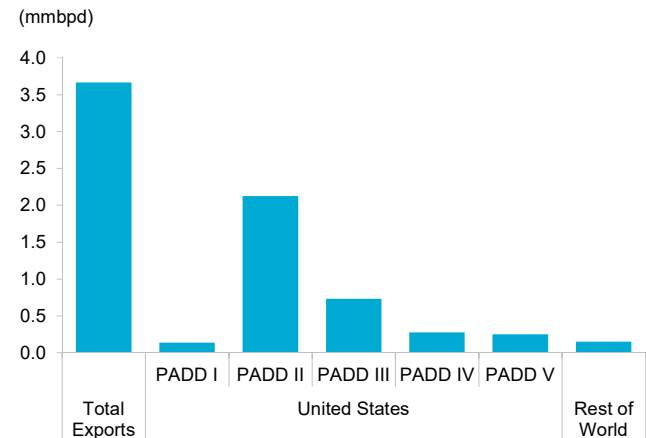
Given Canada’s relatively small domestic market, the majority of its production is destined for export. Canadian crude oil exports totalled 3.7 mmbpd in 2020. Although this declined slightly from the previous year, because of reduced demand from the global pandemic, it remained up 20% from five years ago. The majority of those exports in 2020 were heavy crude oil (includes heavy conventional and diluted bitumen exports), which accounted for 77% of all crude oil exported from Canada. Over the past five years, heavy crude oil exports increased 29%, fuelled by strong growth in bitumen production. Meanwhile, light crude oil exports (includes light conventional and SCO exports) were relatively unchanged in 2020, down by only 1.3% since 2015. The value of Canadian exports of crude oil and bitumen totalled CAD\$51 billion in 2020, representing 7.9% of Canada’s total exports (goods plus services) in the same year.

U.S. remains Canada’s primary oil market

Canada’s crude oil exports depend highly on the demand of one country. In 2020, over 95% of total crude oil exports from Canada were delivered to the U.S. (Chart 9), with the overwhelming majority from Western Canada. Most of

CHART 9: CRUDE OIL EXPORTS HIGHLY CONCENTRATED

2020 Canadian crude oil exports to major destinations

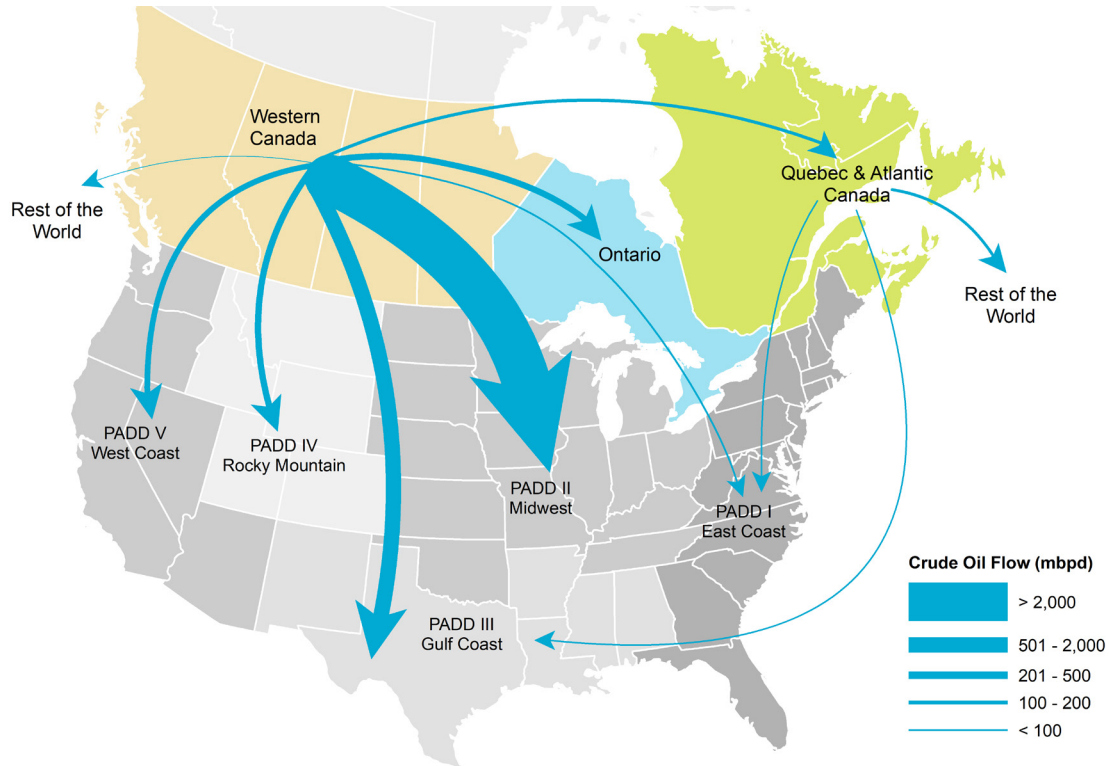


Source: Canadian Energy Regulator



MAP 2: VAST MAJORITY OF CANADIAN OIL EXPORTED TO THE U.S. MIDWEST

2020 Canadian crude oil flows



Sources: Canadian Energy Regulator, Statistics Canada, Alberta Treasury Board and Finance

Newfoundland and Labrador’s oil was also exported to the U.S., however it can sell its crude around the world since it is seaborne. With easy access to tidewater, Newfoundland production makes up the majority of Canada’s non-U.S. crude exports. Canada exported roughly 150 mbbpd to the rest of world versus 3.5 mmbpd to the U.S. in 2020.

Canadian exports increasing to most PADDs

The U.S. market is organized into five refining regions called Petroleum Administration for Defense Districts or PADDs. PADD I is the U.S. East Coast, PADD II is the U.S. Midwest, PADD III is the U.S. Gulf Coast (USGC), PADD IV is the U.S. Rocky Mountain region, and PADD V is the U.S. West Coast (including Alaska and Hawaii). In terms of refining capacity, PADD III is the largest, followed by PADD II, PADD V, PADD I, and PADD IV.

With most of Canada’s pipeline capacity ending in the U.S. Midwest, it receives the majority of Canada’s crude oil exports to the U.S.. In 2020, 60% of exports were destined for U.S. Midwest refineries and were up 19% compared to 2013 levels due to the expansion of the Alberta Clipper Pipeline in 2014 and 2015. There was export growth to the other PADDs with exception of the U.S. East Coast, which

declined 32% from 2013, as a result of less Canadian CBR being delivered to the region.

Despite having the smallest amount of refining capacity in the U.S., the Rocky Mountain region receives about half of their total crude receipts from Western Canada. Exports to this region increased by 15% since 2013. The region received 273 mbbpd, or 7.8%, of Canadian exports in 2020.

The U.S. West Coast is unique because it has no pipeline access to the vast majority of the lower 48’s production. This region does receive some CBR from the other PADDs. Despite restricted access to U.S. crude and declining production from California and Alaska, it has access to global sea-borne supplies. In addition, refineries in Washington State also have access to Western Canadian oil from the Trans Mountain pipeline. Canadian imports into the state represent 90% and 26% of the state and PADD V’s total imports from Canada, respectively. Canada exported 248 mbbpd to this region, up 27% from 2013.

U.S. pipeline expansions improve access to USGC

The USGC has the largest refining capacity in the U.S. and one of the largest refinery centers in the world designed to process heavy crude. Canada’s access to this market



improved significantly following the completion of new and expanded pipelines between the U.S. Midwest and USGC since 2014. These additions were aimed at relieving a build-up of supply in Cushing, Oklahoma (the main crude oil storage hub in the U.S.) brought about by strong growth in both U.S. shale oil and Canadian oil sands production:

- The Gulf Coast Extension (also known as the Cushing MarketLink) of the Keystone Pipeline between Cushing, Oklahoma and Port Arthur, Texas became operational in early 2014.
- This followed by the completion of the Houston Lateral pipeline in 2016, which extended the Keystone Pipeline to refineries in the Houston area.
- In addition, the reversal and expansion of the Enbridge Seaway Pipeline as well as the completion of the Seaway Twin pipeline also boosted capacity between Cushing, Oklahoma and Freeport, Texas by 2014.

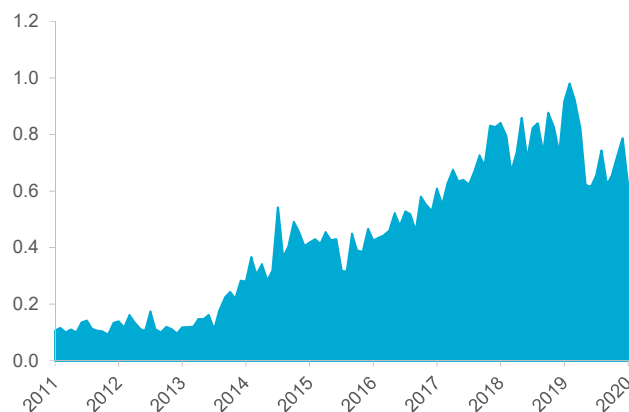
In total, these expansions installed more than 1.5 mmbpd of additional pipeline capacity between Cushing, Oklahoma and the USGC market. As a result, Canadian crude oil exports to the USGC experienced strong growth, making it the second largest export destination for Canadian crude after the U.S. Midwest. Canadian crude exports into this region reached 731 mbpd in 2020, a six-fold increase from 2013 (Chart 10). In terms of total USGC imports, Canadian crude represents 29%. The recently cancelled Keystone XL pipeline, intended to link into the expanded Keystone network, would have provided 830 mbpd of additional access to the USGC. However, the reversal of Capline Pipeline that is expected to be completed in 2021 will add an extra 1.2 mmbpd of pipeline capacity to deliver both heavy and light crude oil from the Midwest and Cushing, Oklahoma, to South Louisiana.

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CHART 10: U.S. PIPELINE EXPANSIONS LEAD TO MORE CRUDE OIL EXPORTS TO THE USGC

Canadian crude oil exports to the U.S. Gulf Coast

(mmbpd)



Source: Canadian Energy Regulator