



## Canadian Refining Industry

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# Summary of the Canadian Refining Industry

## Introduction to the Canadian Refining Industry

- Refineries are a critical piece of Canada's energy story. Crude oil is the second largest type of energy consumed in the country, and refineries are the key step in turning the raw commodity into high-value final products. They also represent a key part of the Canadian economy. In 2022, Canada exported \$22 billion worth of refined petroleum products abroad.

## Industry Overview

- Across the country, Canada has 16 operating refineries, not including upgraders. Canada's refinery capacity is primarily located in Eastern Canada, near large population centers, and in Alberta, near major oil-producing regions.
- There is a co-dependency between Canada and the United States with regard to refineries. In Canada, refineries in the east are configured to handle lighter conventional crude oil, typical of that produced in the United States. The United States now makes up nearly three-quarters of oil imports needed for Canadian refineries. In the United States, many refineries have been configured with coking capabilities to handle the heavy sour crudes typical of those produced in Western Canada. Canadian refineries have limited heavy oil refining capacity, making Canada dependent on the United States for refining these barrels.

## Energy Security

- Over the past decade, Canada has strengthened its continental energy security by reducing reliance on overseas oil and increasing the share of imports from the United States. The only refinery still importing meaningful overseas oil is the Irving Oil refinery in New Brunswick.
- Refineries in Eastern Canada depend on production from Canada and the United States, and any curtailment of production would cause an energy shortage. Over the past several years, the Michigan State Government threatened to stop the operation of a key Enbridge pipeline segment (Line 5) that would have resulted in an energy shortage in Eastern Canada. In December 2023, however, state officials approved a tunnel under the Straits of Mackinac. A final approval from the US Army Corps of Engineers would allow Enbridge to proceed in building the tunnel and ultimately continue operating the pipeline.

## Sustainability

- Canada has 22 operating ethanol/biodiesel biorefineries, with three large renewable diesel facilities completed or under construction.
- Several policies have been enacted to lower GHG emissions at Canadian refineries and in the fuels. In Canada, the Clean Fuel Regulations, which came into force in summer 2023, should increase the adoption of alternative, lower-carbon fuels such as biofuels.

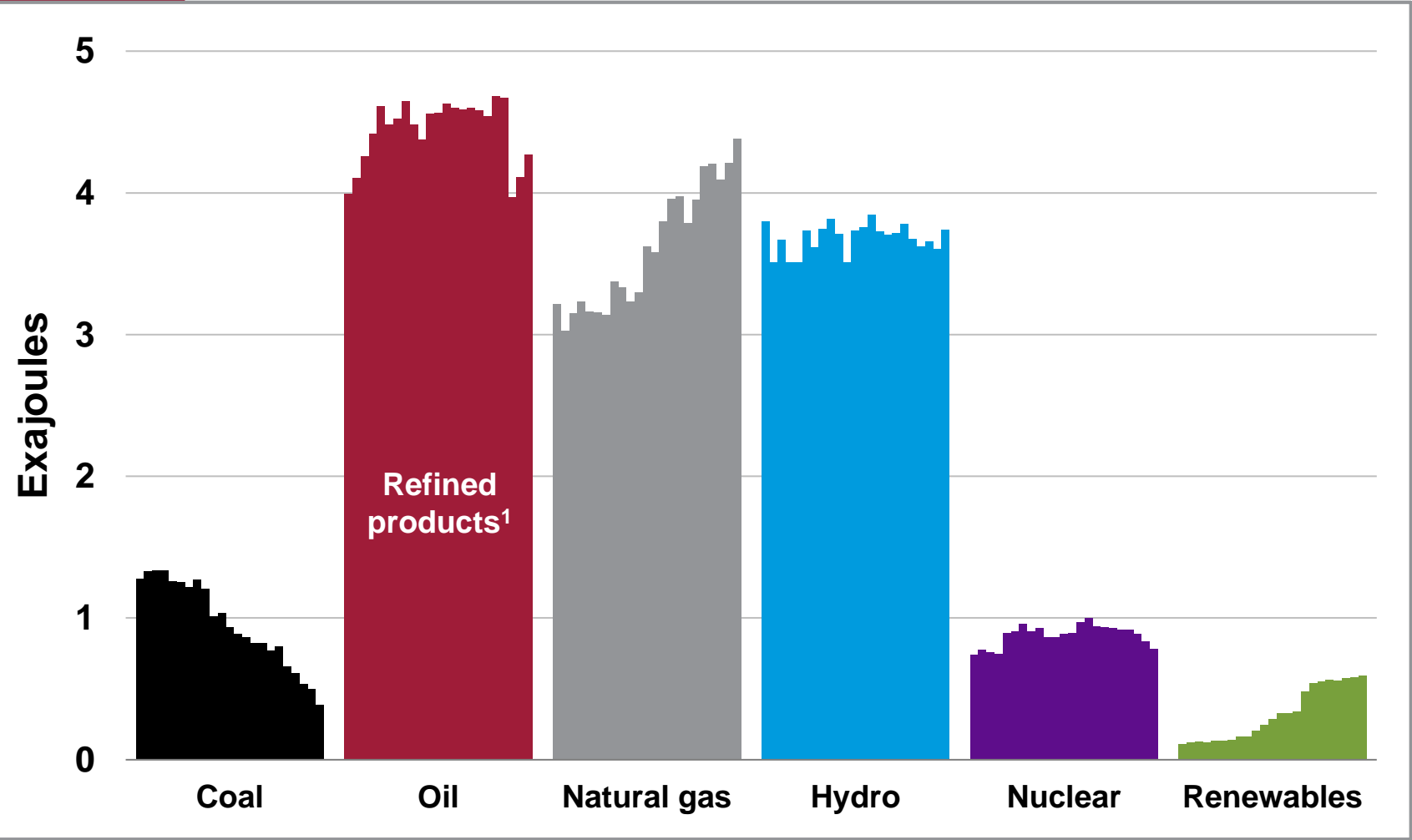
Source: Canada Energy Regulator, Statistics Canada





# Introduction to the Canadian Refining Industry

# Canada's Energy Consumption by Product | 2000 to 2022

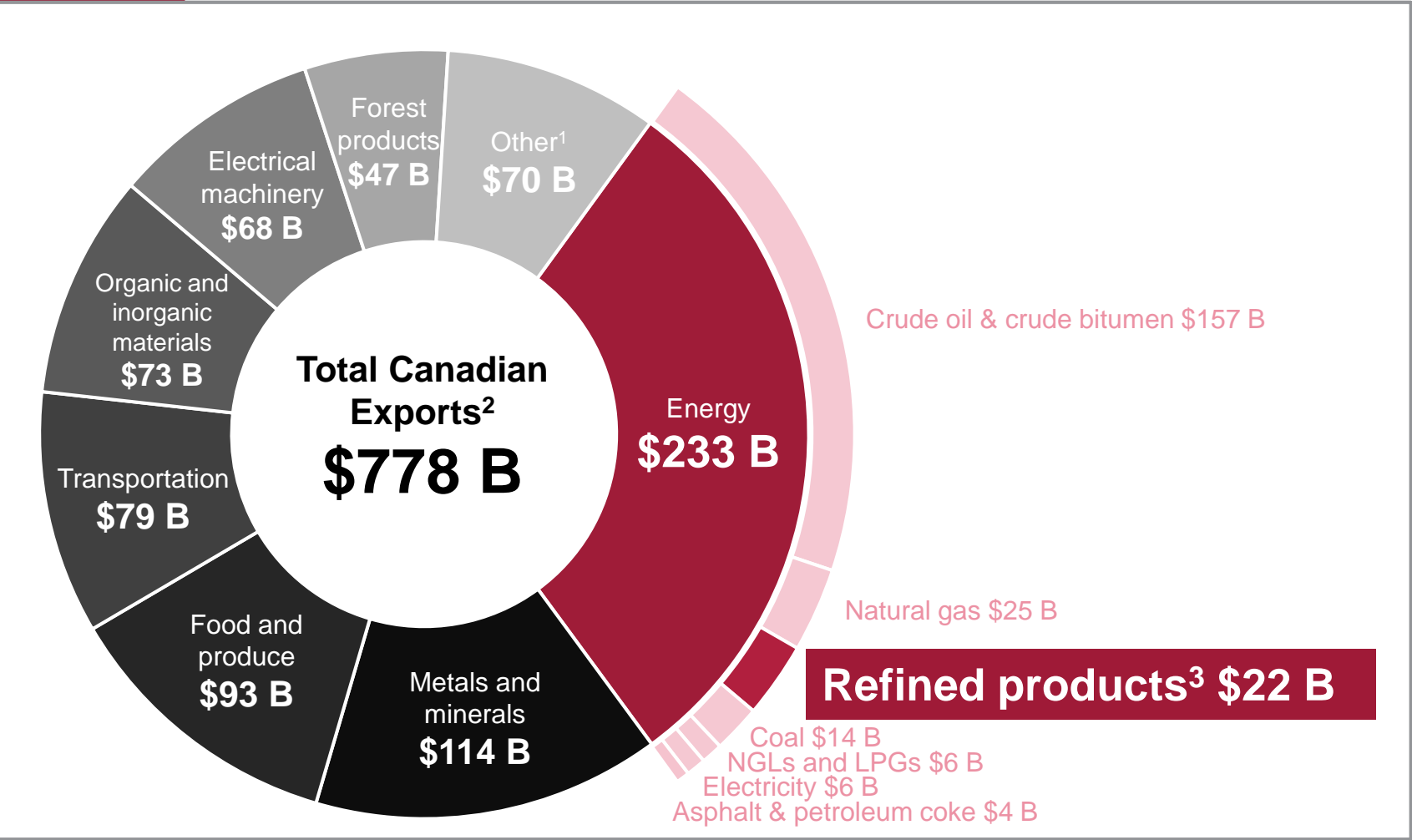


- Crude oil represents the second largest source of energy consumed in Canada, accounting for 30% of energy use on an exajoule basis.
- Refineries produce refined products like gasoline, diesel, and jet fuel, transforming raw crude oil into useful fuels and products that are consumed in cars, trucks, airplanes, locomotives, and trains and used for other industries.
- As of 2022, Canada's consumption of refined products from crude oil has not recovered to the pre-pandemic levels.

Source: Energy Institute's Statistical Review of World Energy (2023), International Energy Agency

<sup>1</sup> Almost all oil consumed is in the form of refined products

# Annual Value of Canadian Exports by Category | 2022



- \$22 billion worth of refined products from refineries were sold globally last year, representing roughly 3% of the total Canadian export market.
- This makes the exports of refined products larger than some other significant industries in Canada, including iron and steel (\$15 B), plastics (\$22 B), pharmaceuticals (\$14 B), fertilizers (\$18 B), paper and paperboard (\$11 B), and aircraft and spacecraft (\$13 B).
- For comparison, refined product exports are about a third of Canada’s total vehicle exports, which totaled \$66 billion in 2022.

Source: Statistics Canada. Canadian International Merchandise Trade Web Application

<sup>1</sup>Other includes medicine, medical, textiles, and animal products  
<sup>2</sup>Exports include re-exports  
<sup>3</sup>Includes gasoline, diesel, fuel oils, kerosene, jet fuel, lubrication oils

# Timeline of Refining in Canada

**Kerosene** – Working out of Saint John, New Brunswick, Canadian Abraham Gesner develops methods to refine liquid fuels into kerosene. His patents were eventually bought by Standard Oil and helped launch the modern refining industry.

1840s

**First Canadian refinery** – James Miller Williams, considered the “Father of the Canadian Oil Industry”, first started refining oil and bitumen in Ontario, opening the country’s first large refinery in Hamilton in 1860.

1860s

**Imperial Oil** – Formed out of the merger of 16 refiners in Southwestern Ontario, Imperial Oil became Canada’s first major oil and gas company to produce and distribute petroleum products.

1880s

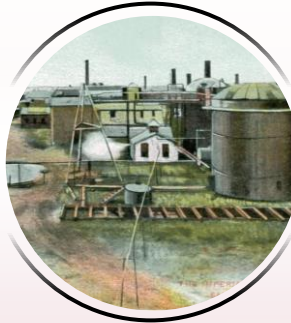
**Turner Valley** – Following the discovery of the Turner Valley oil field with the Dingman #1 well, the Turner Valley Gas Plant opened. This was Western Canada’s first gas processing facility and oil refinery.

1914

**Western Canada** – Kickstarted by the discovery of oil from the Leduc #1 well, major oil companies invested in Canadian refining and marketing, significantly expanding capacities in Western Canada.

1950s

**Imperial Oil’s refinery in Sarnia, Ontario (Est. 1910)**



**Parkland’s refinery in Burnaby, British Columbia (Est. 2010s)**



1970s

**Oil Crisis** – As a result of the 1973 oil crisis, there was a push to improve vehicle efficiencies and switch from oil to natural gas and electricity. This contributed to a rationalization in refining capacity from 1973 to 1983.

1990s

**Quality mandates** – A second rationalization took place in part because of fuel quality mandates, including the removal of lead from fuels, which made for challenging economics, especially for smaller, less efficient refineries.

2000s

**Blending mandate** – Several provinces introduce blending mandates, requiring ethanol to be blended into gasoline and other renewable content, including biodiesel, to be blended into diesel.

2023

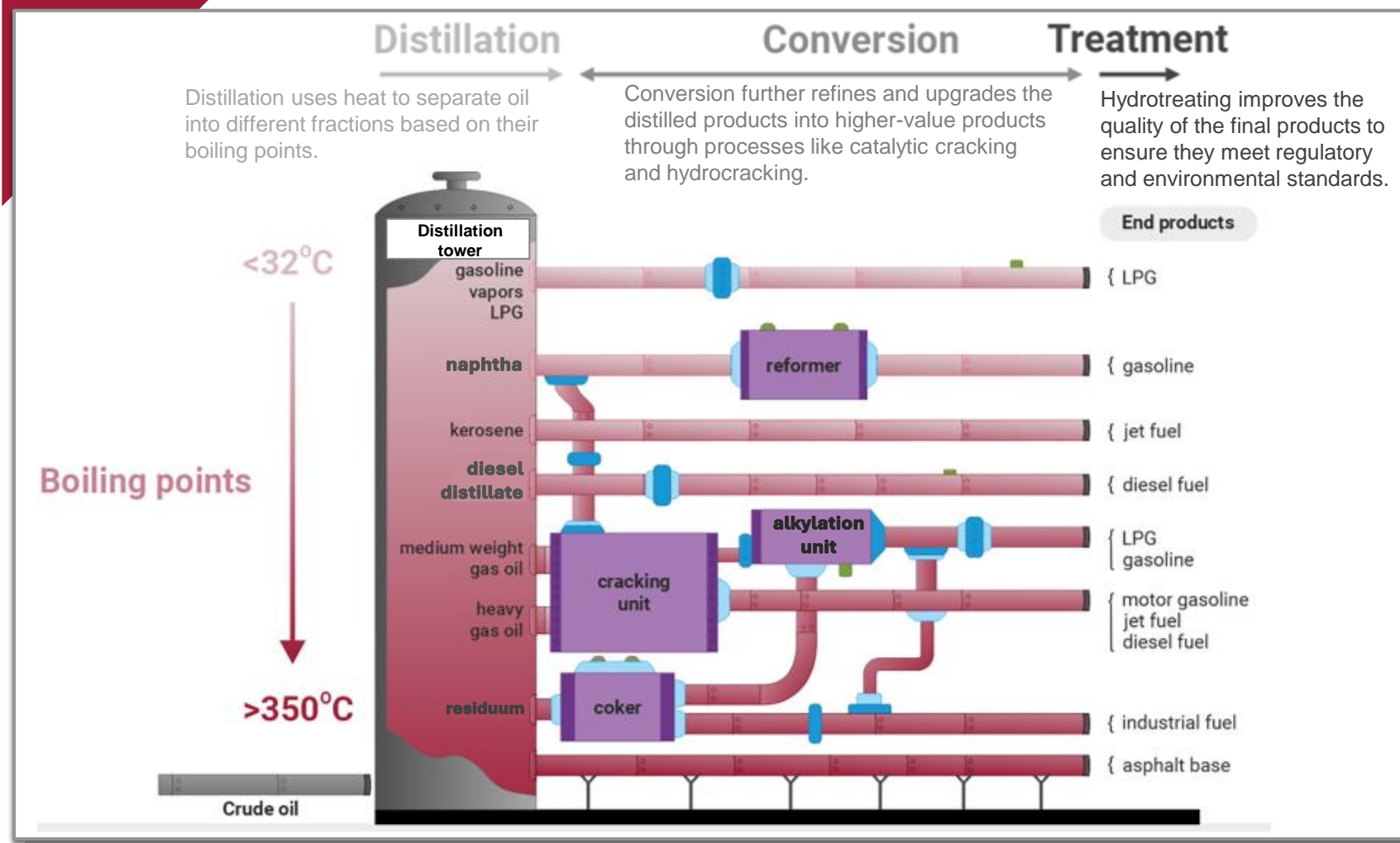
**Clean Fuel Regulations** – Beginning in 2023, the federal Clean Fuel Regulations came into force to reduce the carbon intensity of transportation fuels across the country, creating demand for alternative fuels and decarbonization.

2020s

**Renewable diesel** – Renewable diesel refineries are operating or proposed by companies including Parkland, Braya Renewables, Varennes Carbon Recycling, Co-op, Tidewater Renewables, and Imperial Oil to produce fuels made from organic feedstocks.



# The Refining Process Turns Crude Oil Into High-Value End Products



- Various grades of crude oil are utilized in the refining process to yield a diverse mix of refined products. The physical and chemical properties of crude oil will dictate the amount of refining that is required.
- For example, lighter crude oil with high API gravity is generally easier to process and yield products such as gasoline and jet fuel, while heavier crude oil with lighter API gravity requires additional refining and yield products such as asphalt and heavy fuel oils.
- Refineries typically operate with a varied crude slate to produce a diverse mix of products and is often dependent on market dynamics.



# Refined Product Output of Canadian Refineries and End Uses | 2023



- Refineries produce many diverse products used in modern society.
- Transportation fuels including gasoline, diesel, jet fuel, and fuel oil are essential for enabling transportation and mobility.
- Petrochemical feedstocks like naphtha, propylene, and benzene are produced by refineries and later transformed into plastics, synthetic fibers, medicine, and more used in everyday products.
- Petroleum coke, still gas, lubricants, and waxes are all used for various industrial and consumer products.
- Different types of

Source: Government of Canada

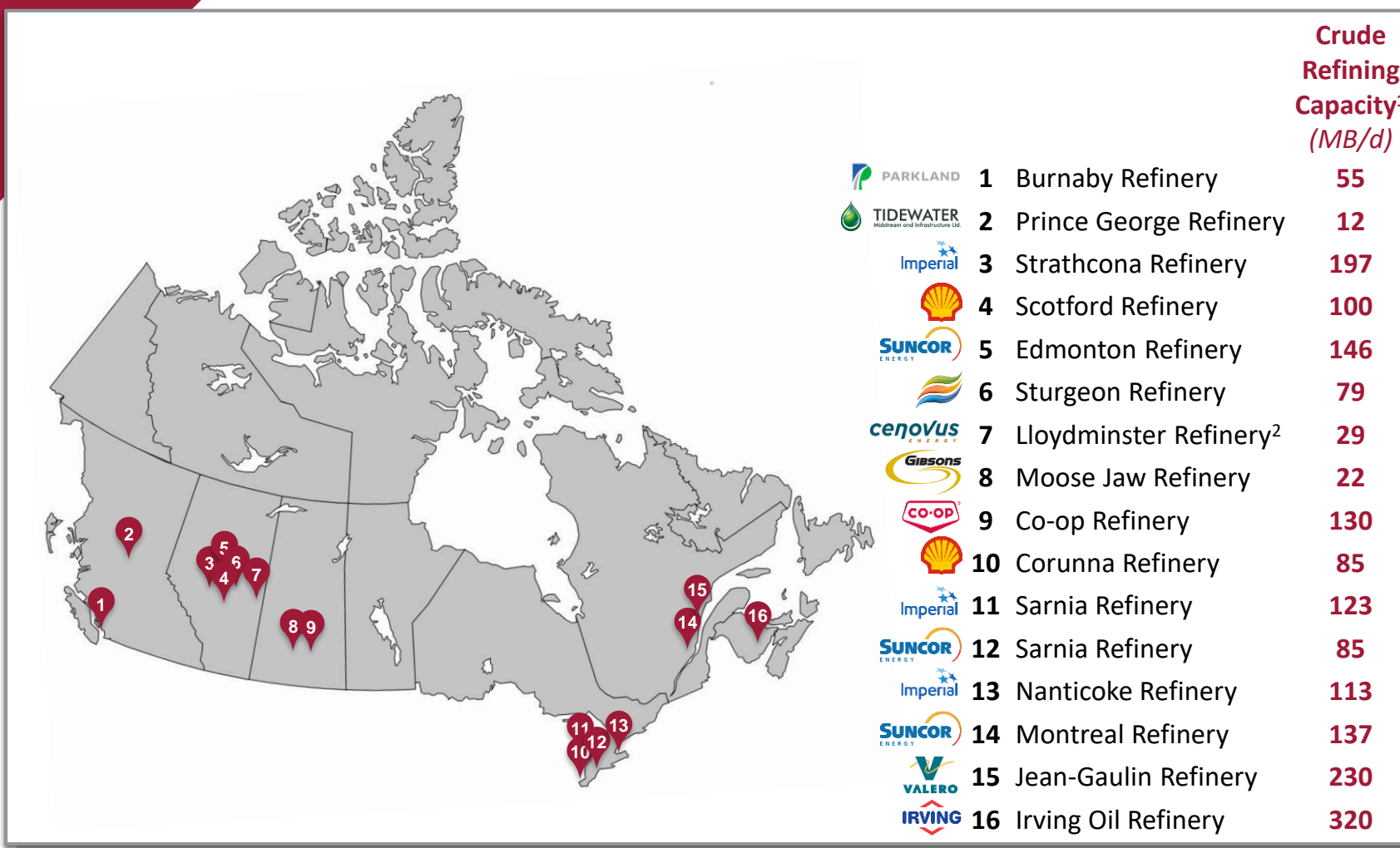
Note: Percentages reflect January to July 2023 output



# Canadian Industry Overview

**CAPP** CANADA'S OIL & NATURAL GAS  
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# Major Crude Oil Refineries Operating in Canada



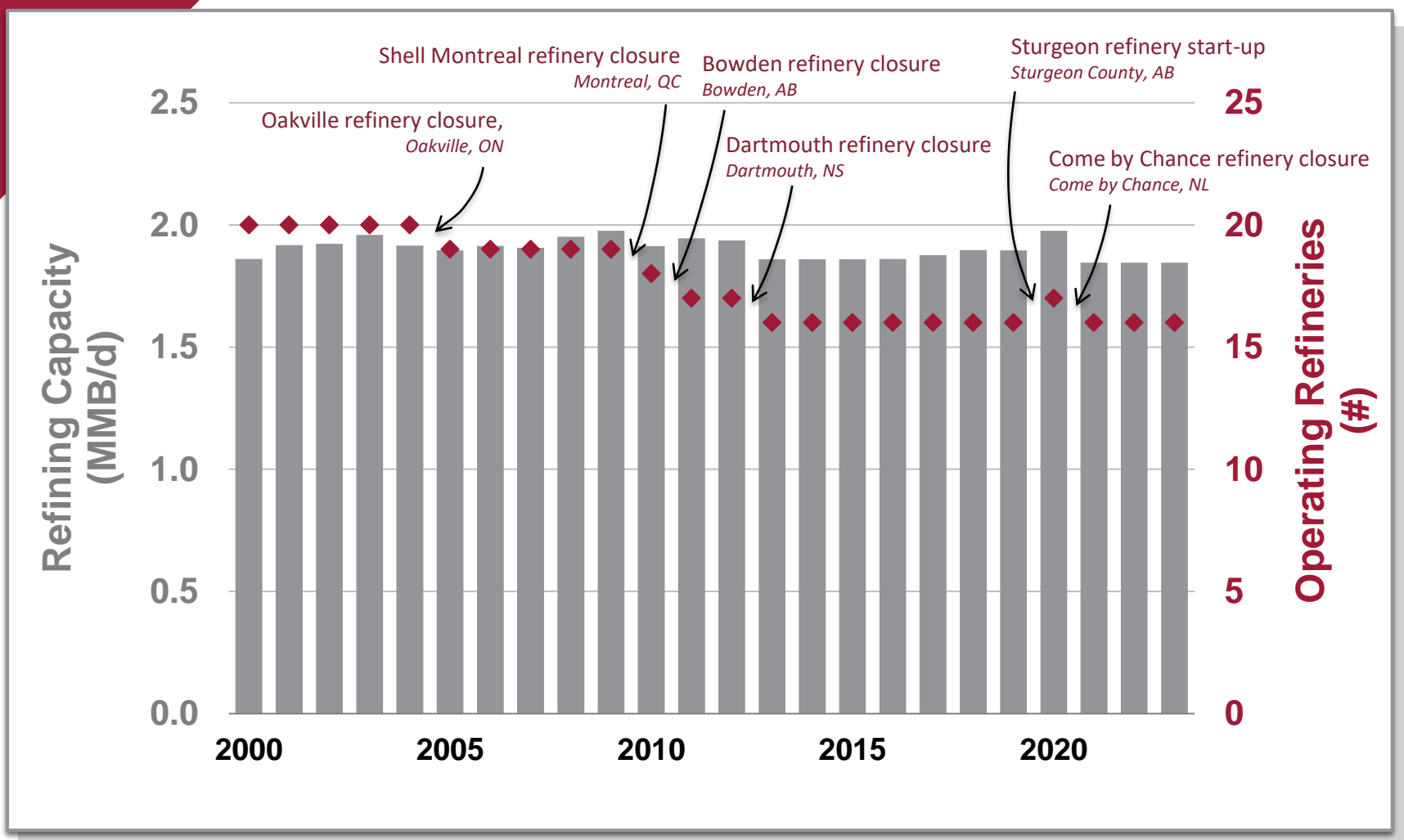
- There are 16 active refineries in Canada, spanning the country from coast to coast, with cumulative refining capacity of roughly 1.9 MMB/d.
- In Eastern Canada, refineries help service the large population centers of Toronto, Ottawa, and Montreal. Some of the country's first refineries were built in Sarnia, which still hosts three operating facilities today.
- In Western Canada, the large refineries are found near Edmonton and Alberta's Industrial Heartland. Some of these refineries have been configured to increase the consumption of synthetic crude oil (SCO) produced from the oil sands.

Source: Canada Energy Regulator, Company Reports

<sup>1</sup> Refinery capacities are current as of January 1, 2023

<sup>2</sup> Asphalt refinery

# Canada's Operating Refineries and Total Capacity | Annual | 2000 to 2023

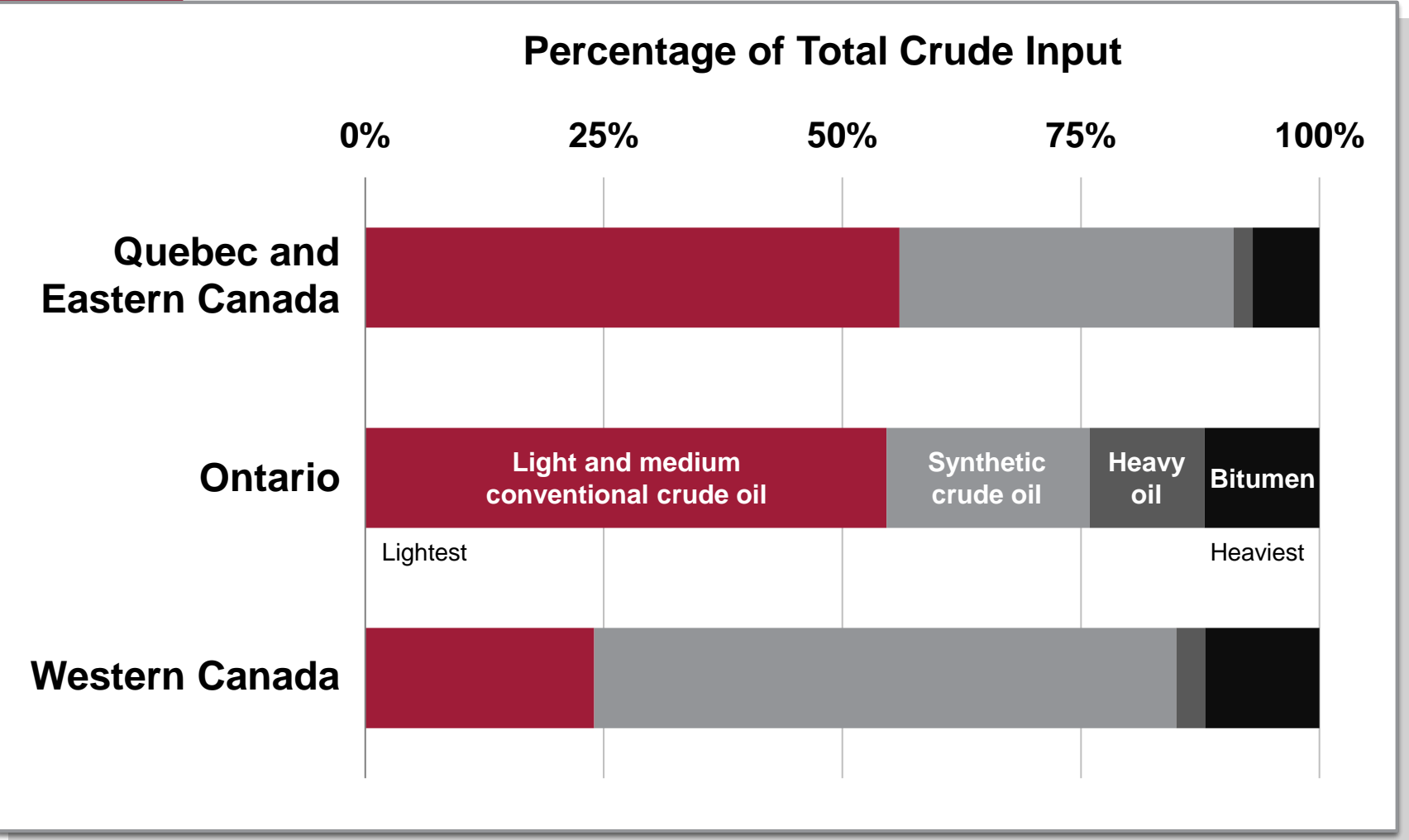


- Canada's refining capacity has stayed relatively flat since 2000 despite a net reduction in the total number of operating refineries.
- Several refineries have shut down in Quebec and Eastern Canada, with the Come by Chance refinery being the latest closure; however, the facility is now being repurposed to produce renewable diesel.
- The Sturgeon refinery in Alberta was the first refinery built in Canada in over 30 years and began refining bitumen into diesel in 2020.
- The Irving refinery, Canada's largest, is under strategic review for possible sale.

Source: Canada Energy Regulator, North West Refining



# Geographic Differences in Refining Configurations by Inputs in Canada

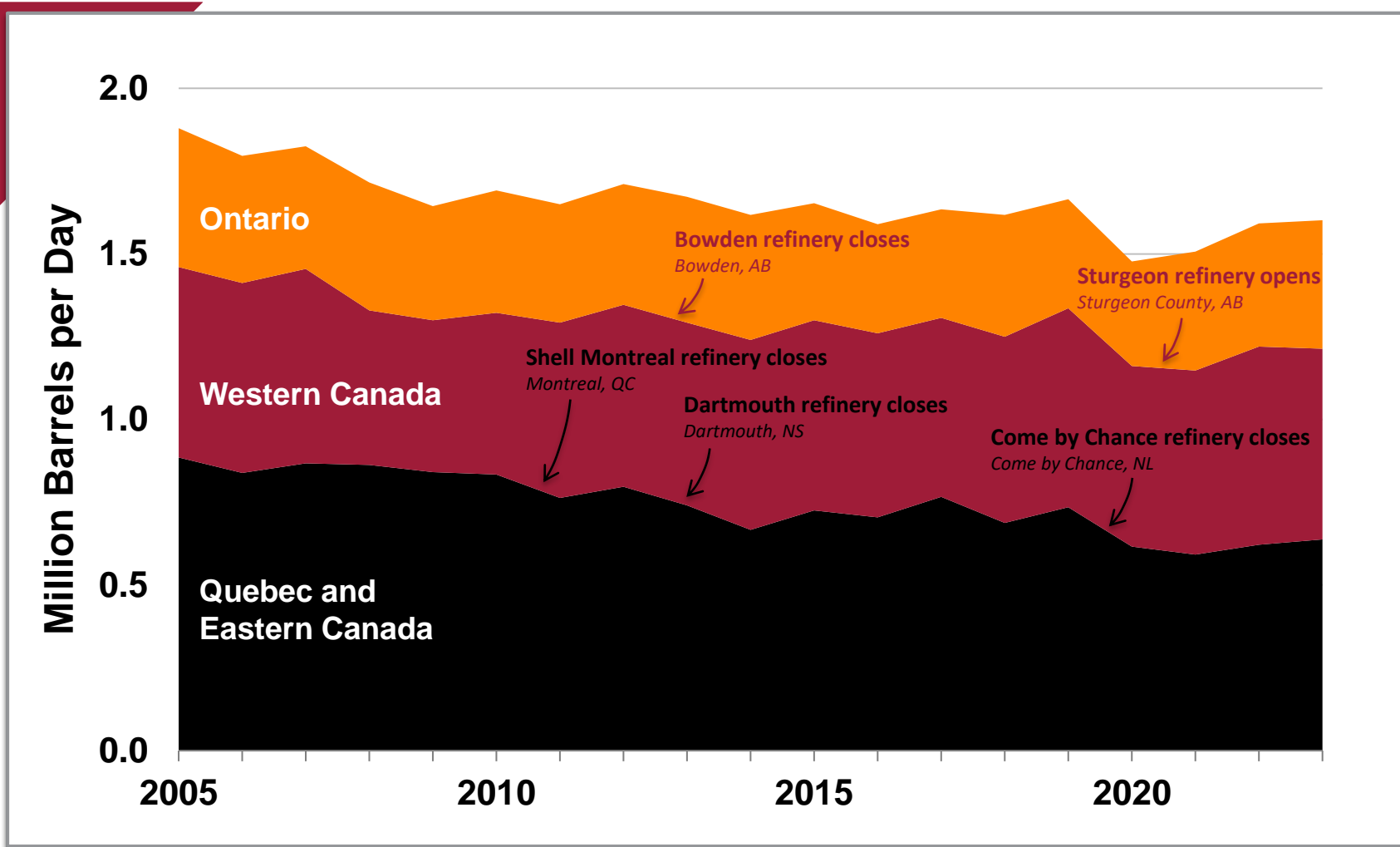


- Refineries are configured to handle specific blends of crude oil. Most of Canada’s refinery capacity is less complex and, therefore, cannot convert heavy crude oils into refined products.
- Refineries in Ontario, Quebec, and Eastern Canada were designed to handle more light conventional oil, typical of Eastern Canadian production, synthetic crude oil (SCO), and US imports.
- Western Canadian refineries have been designed to handle conventional light and SCO (a very light oil produced by upgraders in the oil sands). A relatively small amount of heavy oil and bitumen can be refined.

Source: Canada Energy Regulator

Note: Approximate APIs – Light oil > 30°API ; SCO 30-35°API; medium oil 22-30°API; and heavy oil < 22°API

## Annual Average Canadian Refinery Crude Oil Runs | Annual | 2005 to Q3/2023\*

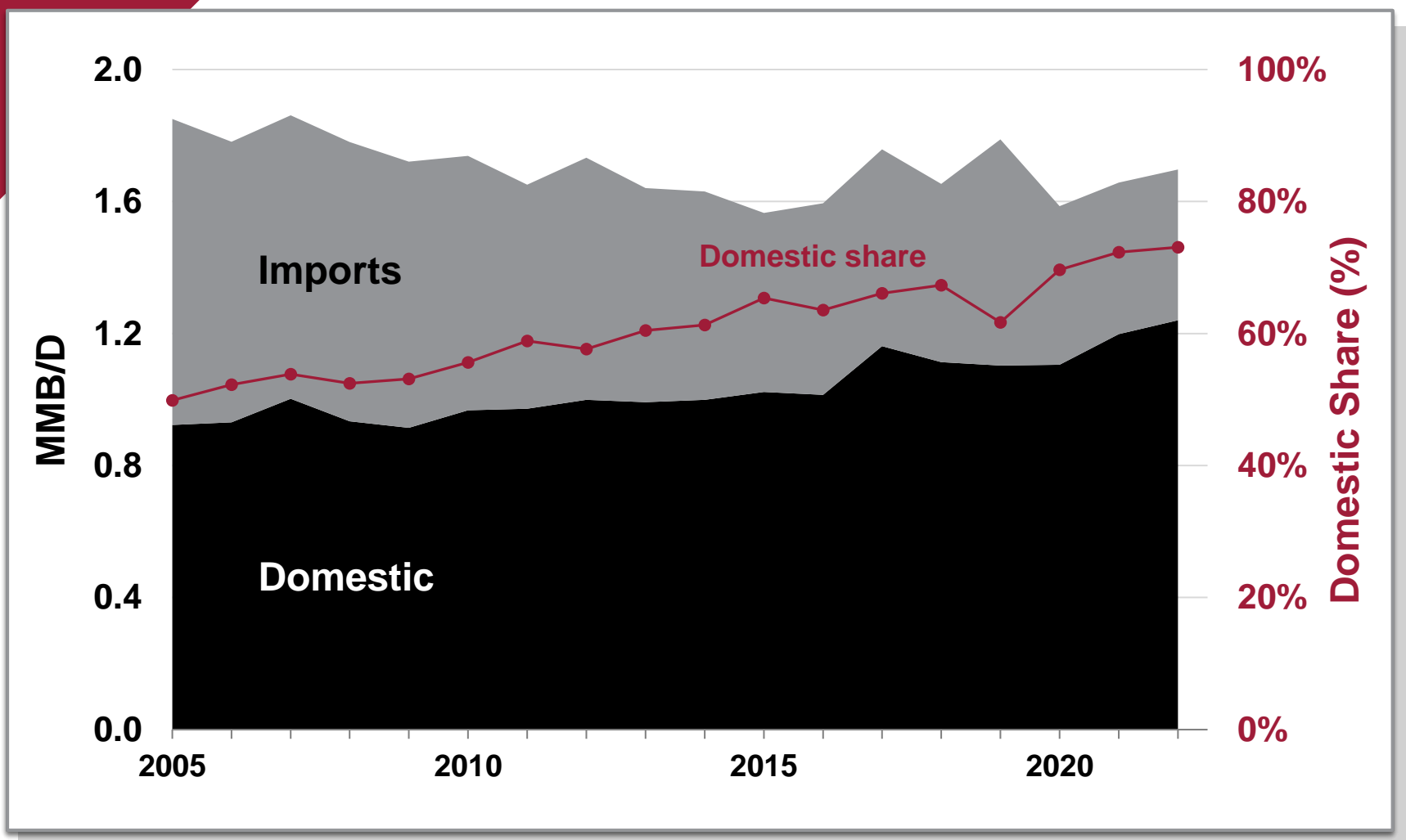


Source: Canada Energy Regulator

\*2023 data is YTD average up to Aug 2023

- Over the past two decades, Canada has reduced the amount of crude oil it refines domestically, down 15% since 2005.
- The drop has predominantly come from Quebec and Eastern Canada, which has seen the closure of three major refineries since 2005.
- Western Canadian refining has been slightly up since 2005. Although the Bowden refinery was closed (6,700 B/d), the opening of the Sturgeon refinery (50,000 B/d) more than offset the loss.

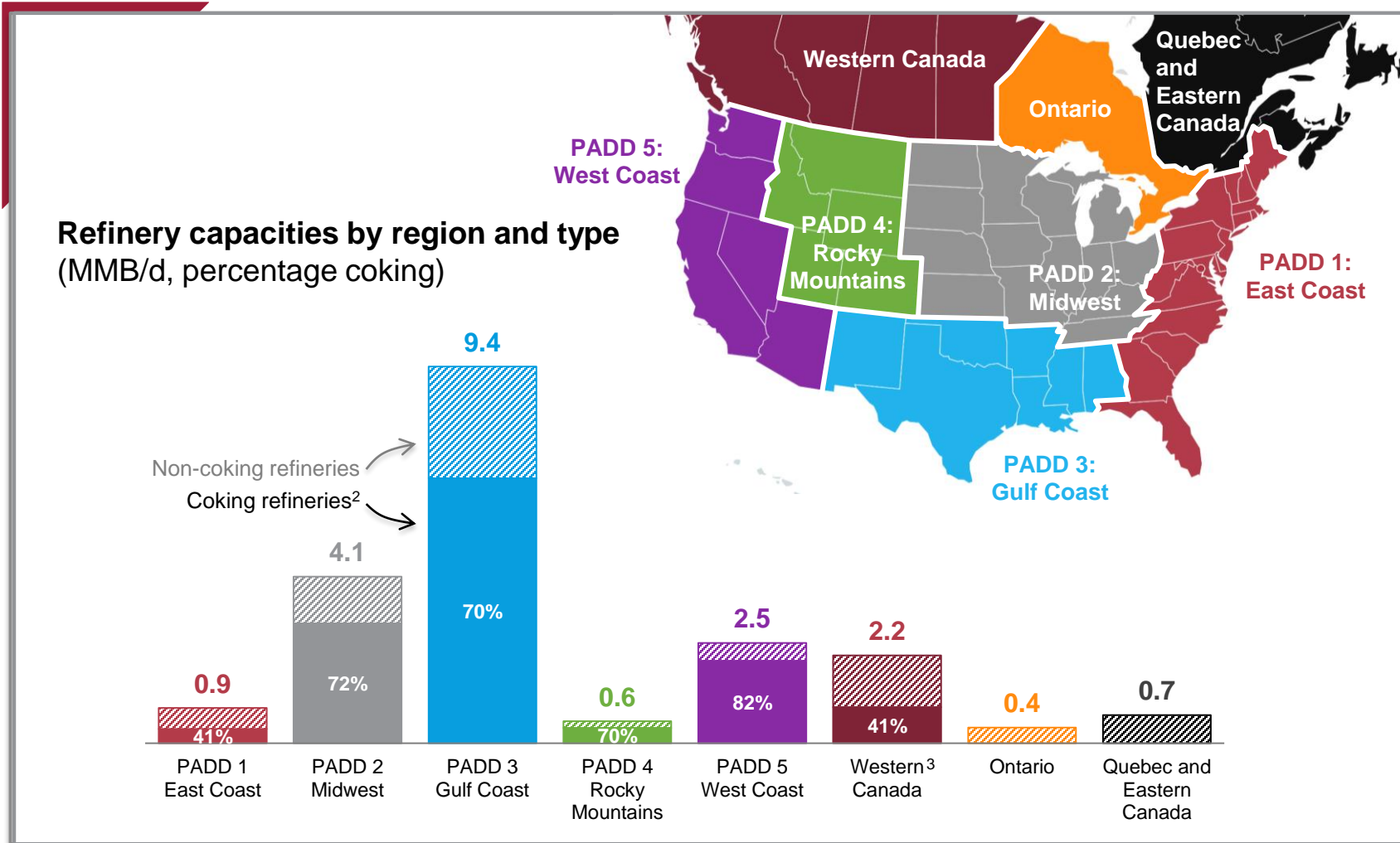
# Annual Canadian Refinery Throughput by Origin of Crude | Annual | 2005 to 2022



- Canada has increasingly supplied its refineries with domestically produced oil, accounting for nearly three-quarters of refinery throughput as of 2022.
- Crude oil imports have reduced because of the closing of several refineries in Eastern Canada, which had relied on foreign oil.
- Additionally, the opening of the Sturgeon refinery in Alberta allowed Western Canada to refine more of its own domestically produced crude oil.

Source: Statistics Canada. Table 25-10-0063-01

# North American Refining Capacities<sup>1</sup> by Region and Complexity | 2022



- The regions with high amounts of 'coking' refineries can convert larger amounts of heavy oils into light refined products.
- Many of the US refineries in PADD 2 (Midwest) and PADD 3 (USGC) were designed specifically to handle heavy oils, originally to process Mexican and Venezuelan crude oils that have been gradually substituted for more Canadian heavy oil.
- PADD 5 (West Coast) can also process heavier oils, however Canadian crude oil has limited access to this region now.
- The United States depends on Canadian heavy oil for its refinery feedstock, given its complex refineries, pipeline connectivity, and few alternatives.

Source: North American Cooperation on Energy Information, US Energy Information Administration

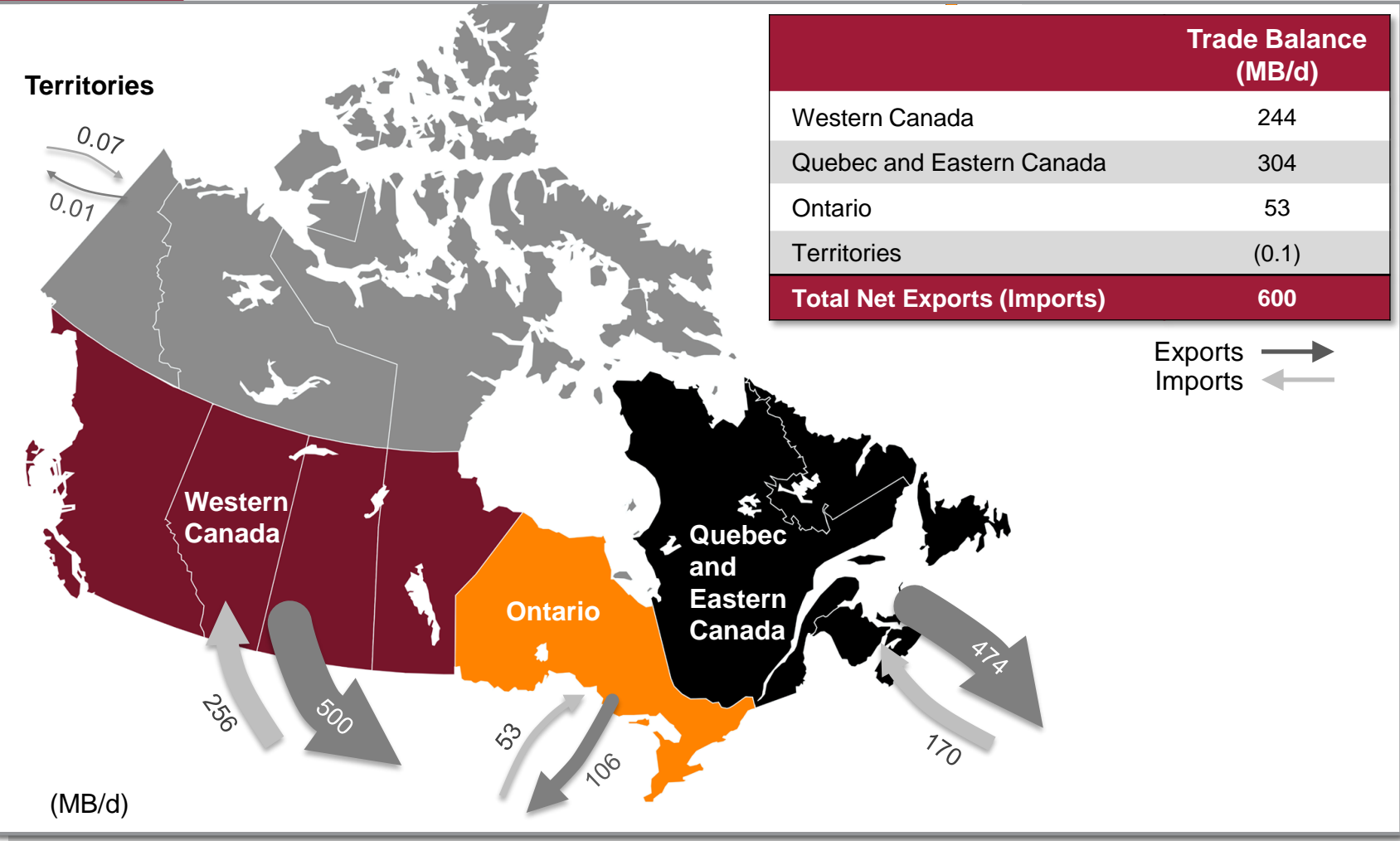
<sup>1</sup> Refinery capacities are current as of January 1, 2023

<sup>2</sup> Assumes any refinery with a coker that is more than 10% of the crude unit capacity can consume some amount of heavy oil

<sup>3</sup> Western Canada data includes five Upgraders with aggregate processing capacity of ~1.4 MMB/d



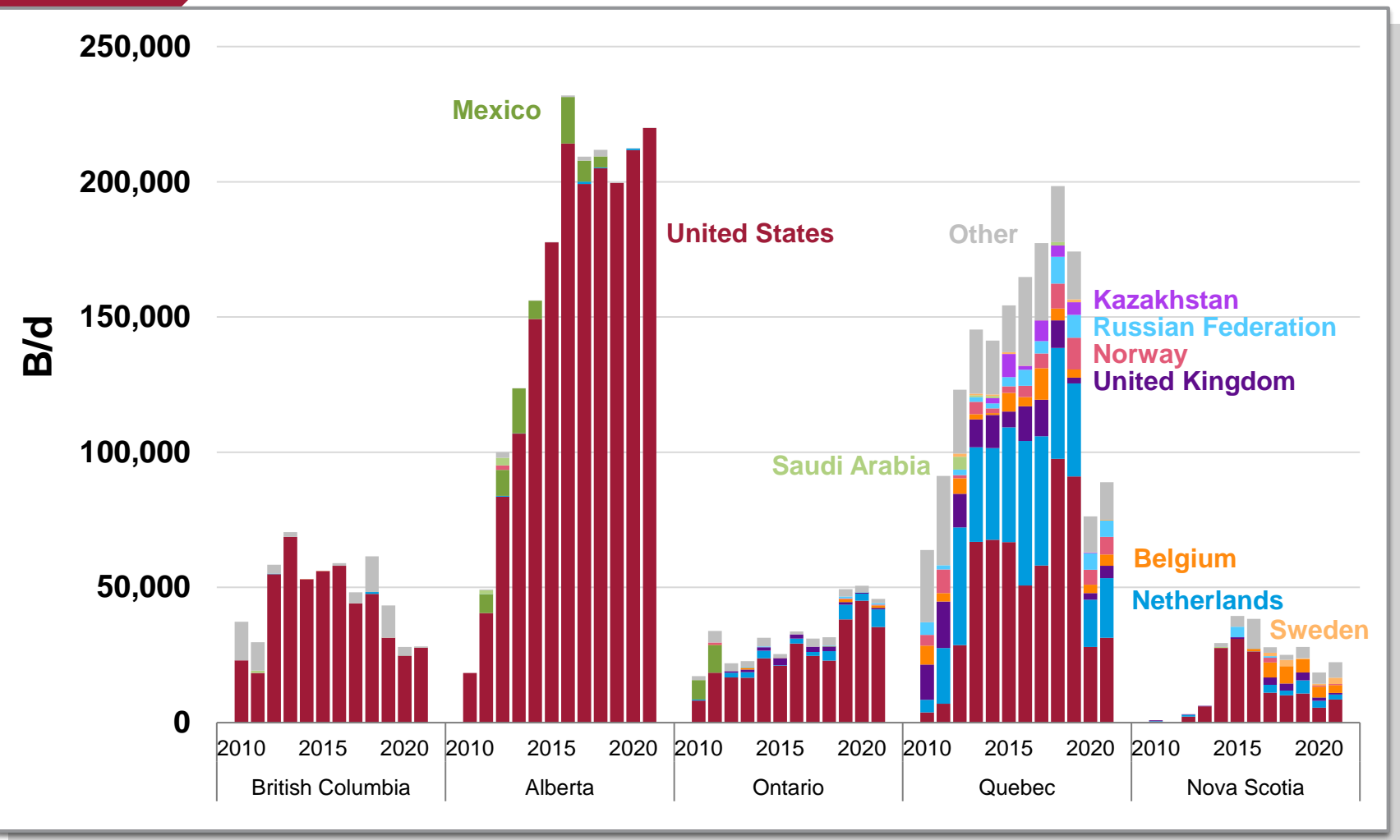
# Regional Refined Petroleum Product Trade Balance | 2022



- Canada and the United States are highly integrated and interdependent in our refined product trade.
- Overall, Canada is a net exporter of refined petroleum products. Yet it still relies on importing nearly 480 MB/d of products, mostly from the United States.

Source: Statistics Canada. Table 25-10-0081-01

# Canadian Refined Petroleum Product Imports by Province | Annual | 2010 to 2021



- The trade dynamic on refined petroleum product (RPP) imports changes considerably from west to east.
- In Western Canada, almost all RPPs comes from the United States. By contrast, both Quebec and Nova Scotia are both highly dependent on foreign, overseas RPP import.

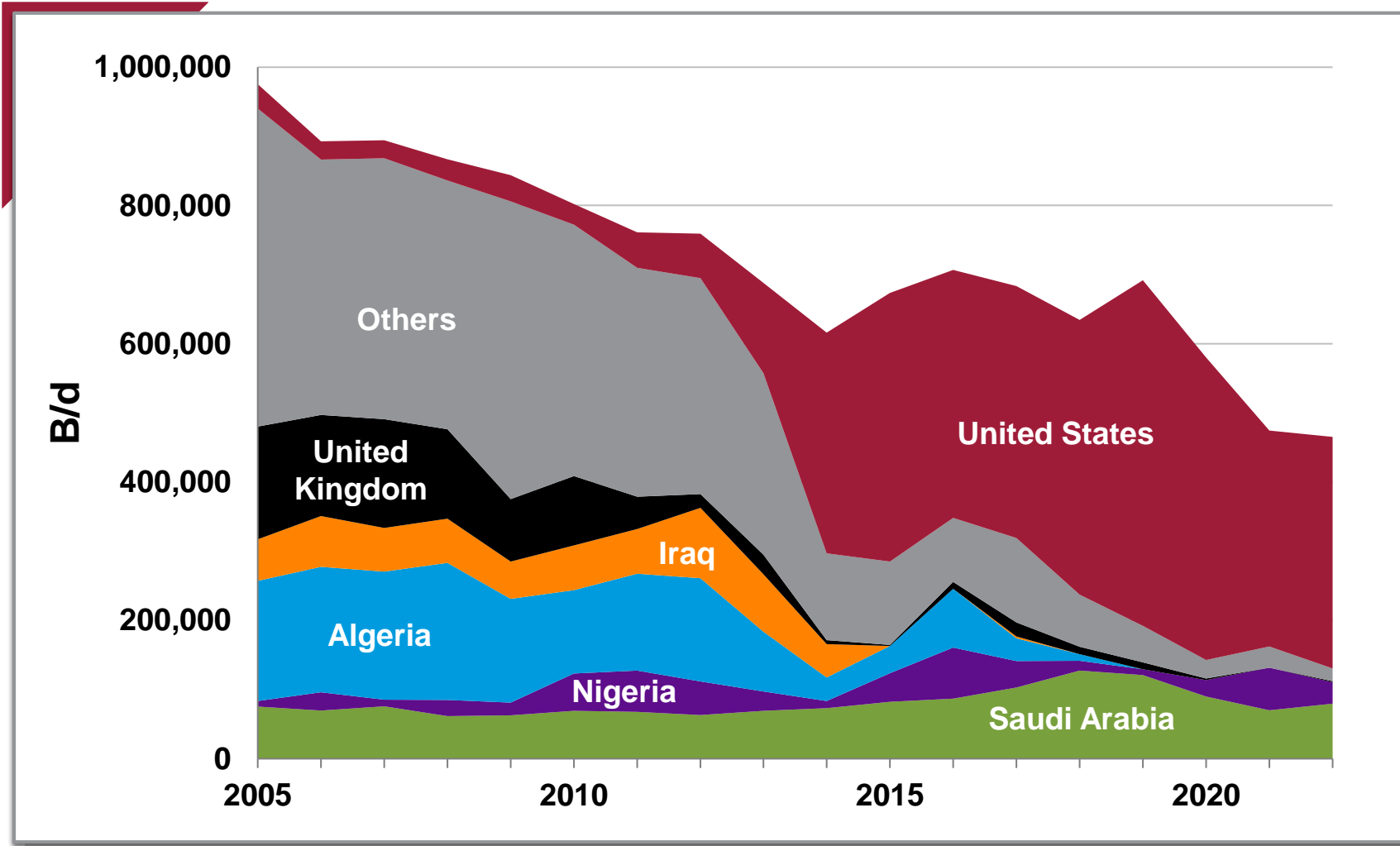
Source: Canadian International Merchandise Trade database, Canada Energy Regulator



# Energy Security

**C<sup>+</sup>PP** CANADA'S OIL & NATURAL GAS  
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# Total Canadian Foreign Oil Imports by Country | Annual | 2005 to 2022

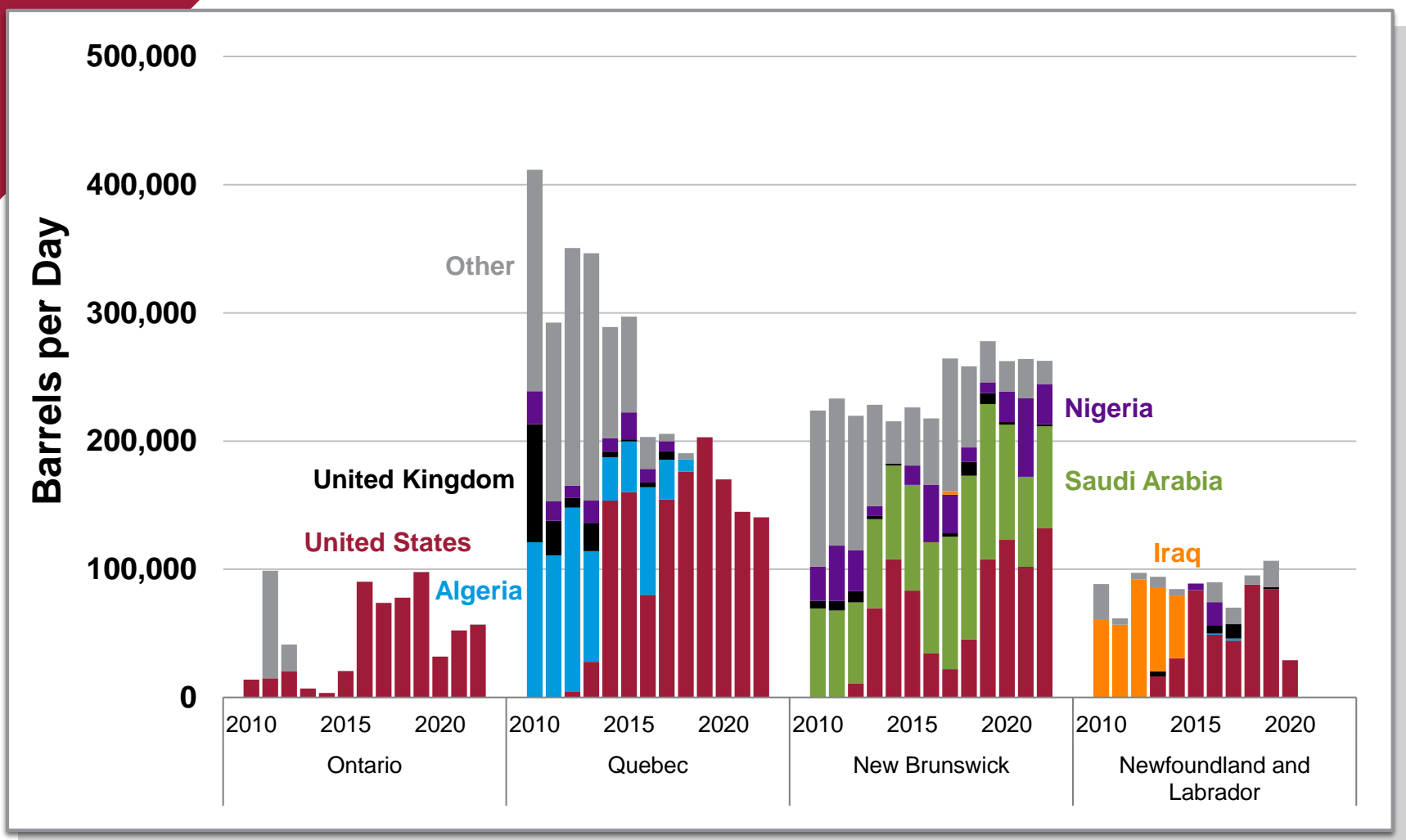


- Canada has increased its energy security by reducing overall reliance on foreign oil imports. Since 2005, oil imports have been reduced by more than 50%.
- Further, the share of imports coming from the United States has grown more than 1,000% since 2010, increasing continental energy security. The reversal of Enbridge Line 9 in the 2010s allowed more US crude oil to flow into Eastern Canada.
- Most provinces import nearly exclusively from the United States. The only Canadian refinery that still relies heavily on overseas imports is the Irving Oil refinery in New Brunswick.

Source: Canadian International Merchandise Trade database



# Canadian Crude Oil Imports by Province | Annual | 2010 to 2022



- Canada still imports significant volumes of crude oil, last year importing roughly 450,000 B/d of foreign oil, with 32% still coming from overseas imports.
- With the closure of the Come by Chance refinery, New Brunswick now receives almost all of the overseas imports.
- Quebec and Ontario are highly dependent on the oil delivered from the Enbridge Mainline. This presents an energy security risk to the region, which would be exposed if Mainline pipeline flows were curtailed. For example, Ontario would have suffered a crude oil shortage if the state of Michigan stopped the operation of a key part of the Mainline (Line 5).

Source: Canadian International Merchandise Trade database

# Enbridge Mainline Pipeline: Critical Energy Infrastructure for Canada



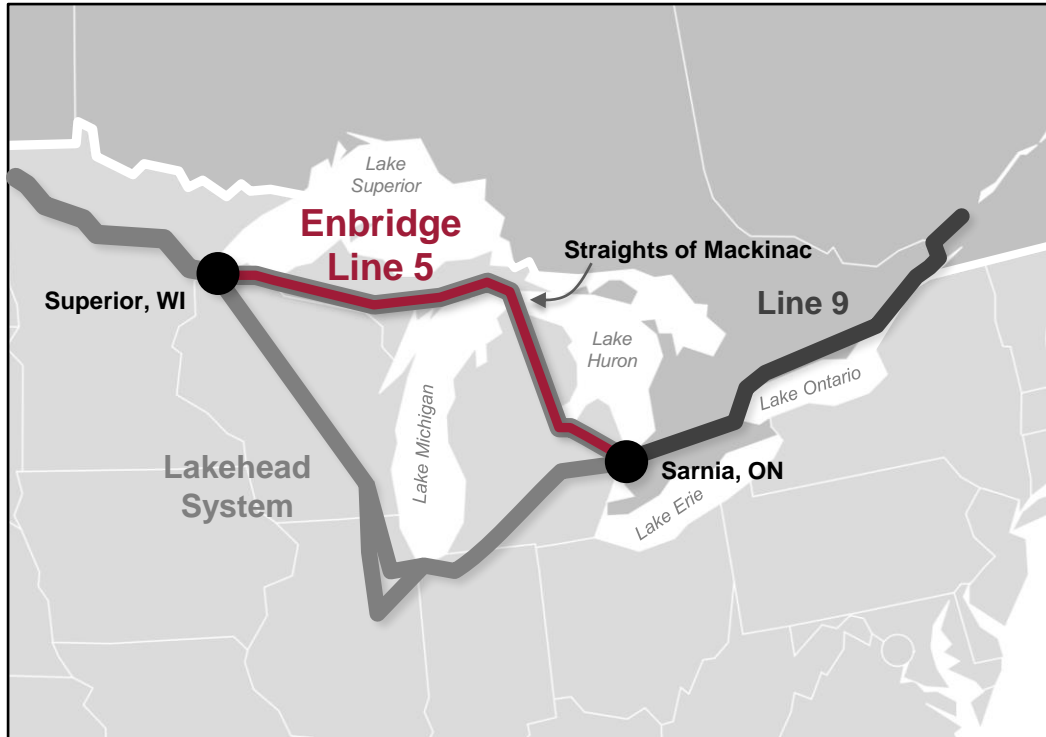
*Originating in Edmonton, Alberta, the Enbridge Mainline moves crude oil, refined products, and natural gas liquids through a connected pipeline system. At Superior, Wisconsin, the system splits into Line 5, going north of Lake Michigan, and Lines 6, 14, and 61, going around the southern tip of the lake. The two routes then coalesce and terminate in Sarnia, Ontario, where it is interconnected with Line 9, which is terminated in Montreal, Quebec.*

The Enbridge Mainline is Canada's largest transporter of crude oil, accounting for roughly 70% of all Western Canadian Sedimentary Basin exports to Eastern Canada and the US Midwest markets.

- The original pipeline was built in 1950, connecting Edmonton, Alberta to Superior, Wisconsin. The line was then extended in 1953 to connect to Sarnia, Ontario. There have since been many offshoots and other lines that go south or east, connecting to refineries across Eastern Canada and the US Midwest.
- Prior to constructing the Enbridge Mainline, several politicians, including C.D. Howe, pushed for an all-Canadian route north of the Great Lakes to increase Canadian energy security by linking Western Canada's supply with refineries in Ontario and Montreal. However, the routes through the United States were chosen because of lower project costs and faster timelines.
- After the initial line connecting Edmonton to Superior was completed, C.D. Howe said of its energy security role, the pipeline was "an essential factor in our preparedness program for the defense of Canada."

Source: Canada Energy Regulator, Enbridge

# Enbridge Line 5 Pipeline: Illustrating Canada's Energy Security Risk



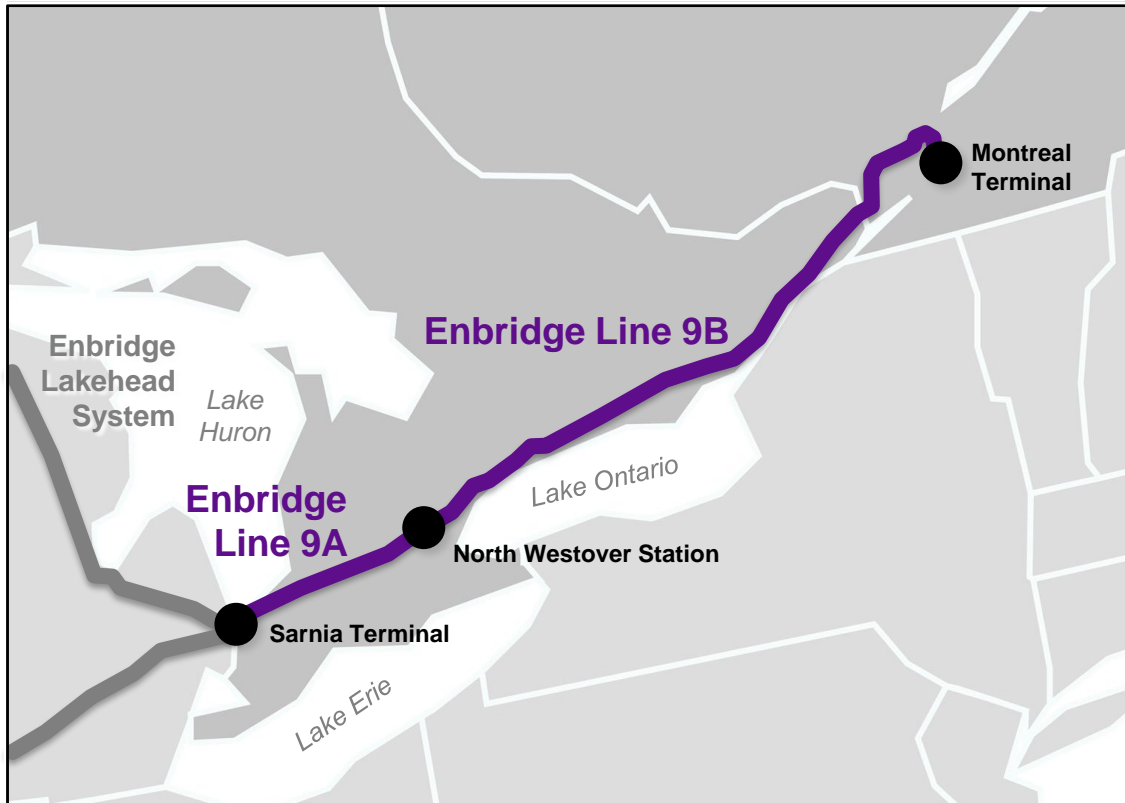
*The Enbridge Line 5 pipeline is a strategic piece of Canadian infrastructure, delivering crude oil to key refineries in eastern provinces and states. The future operations of the pipeline were challenged by the State of Michigan in 2021.*

The Enbridge Line 5 pipeline is a critical link for Ontario and Quebec to receive crude oil. In 2021, Michigan's governor ordered a shutdown of the pipeline, which would have caused energy shortages in Eastern Canada. This situation illustrates the risk of Canada's key infrastructure transiting the United States.

- Line 5 is part of the Enbridge Mainline system and one of the offshoots of the Lakehead System. The pipeline transports up to 540,000 B/d of crude oil and natural gas liquids. It moves more than half of the crude oil used in Ontario and 66% of what gets consumed in Quebec. It's also critical for Ohio and Michigan to provide heating oil and propane.
- In 2021, Michigan Governor Gretchen Whitmer ordered a shutdown of Line 5 due to concerns about a pipeline leak and potential oil spill under the Straits of Mackinac that could affect the Great Lakes.
- In December 2023, Michigan regulators approved a key permit that would protect the Great Lakes by encasing the pipeline in a concrete tunnel under the Straits of Mackinac. This would allow the pipeline to continue operating and delivering crude oil to Eastern Canada.

Source: Canada Energy Regulator, Reuters

# Enbridge Line 9 Pipeline: A Lesson About Canadian Energy Security



*The Enbridge's Line 9 pipeline connects refineries in Sarnia to Montreal. The flow of oil through the pipeline has been reversed multiple times.*

- **1976:** Line 9 opens, built for energy security purposes and to carry Western Canadian and US crude oil to refineries in Quebec.
- **1999:** By the 1990s, there was a lack of crude oil from Western Canada (before the growth from the oil sands) and oil delivered by the pipeline could not compete with overseas supply, being economically more attractive. Therefore, the flow of Line 9 was reversed by Enbridge to transport crude oil from Montreal to refineries in Sarnia. This made Ontario more dependent on overseas oil but also provided optionality for the region versus Canada and the United States only.
- **2012-2015:** When crude oil from Canada and the United States became abundant following the growth of the oil sands and shale plays, the flow was reversed again. The reversal happened in two phases, starting with Line 9A and then 9B. This allowed crude oil from Western Canada and the United States to once again feed refineries in Quebec and displace overseas oil.

These reversals teach an important lesson: projects built for energy security won't work if the economics and supply availability aren't supportive.

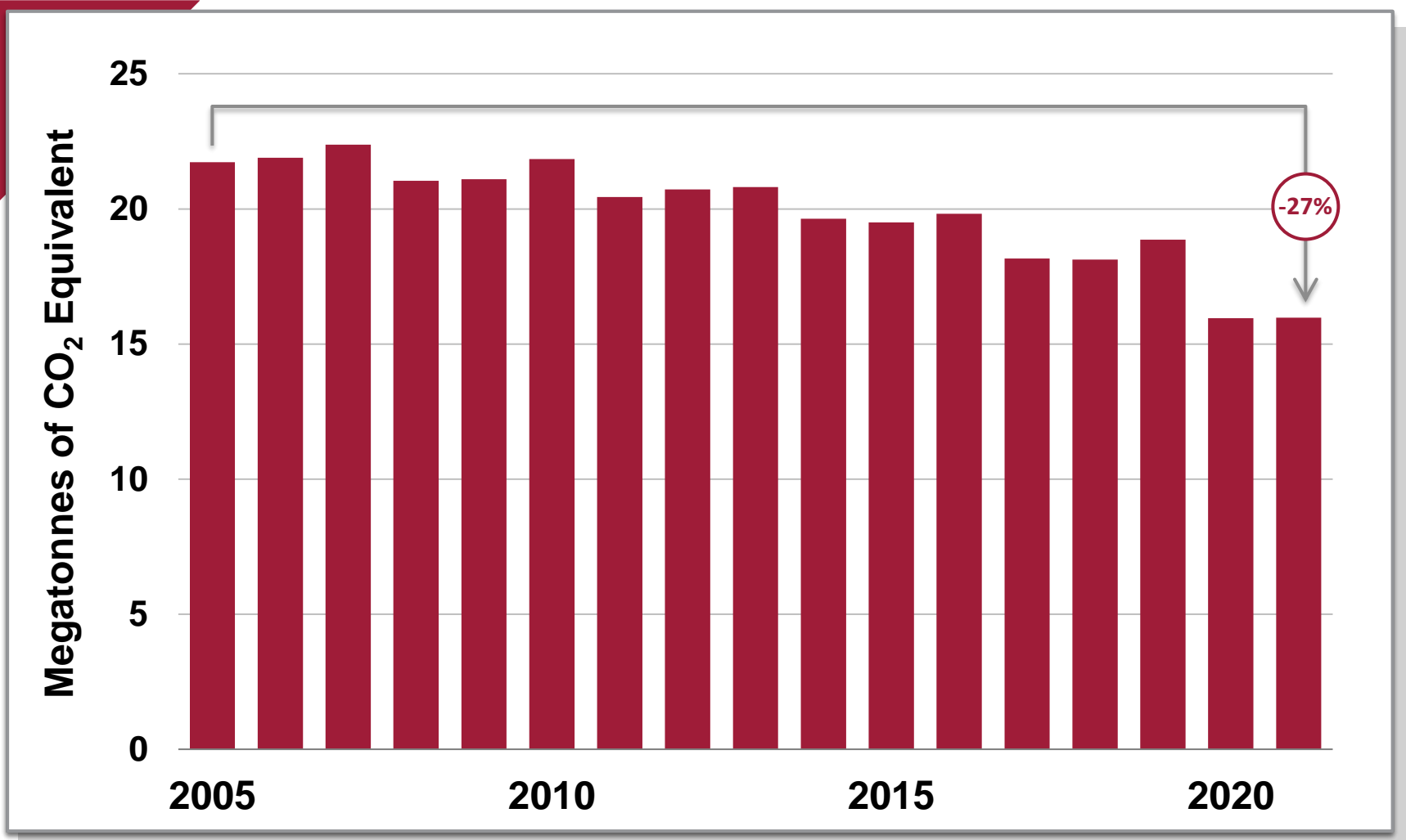
Source: Canada Energy Regulator





# Biorefineries in Canada

# Annual Canadian Petroleum Refining Emissions | 2005 to 2021



- The Canadian refining industry has steadily dropped its absolute emissions since the early 2000s by 27%. The reduction in emissions outpaced reduced refining runs which decreased 15% over the same period.

Source: Canadian National Greenhouse Gas Inventory, Canada Energy Regulator

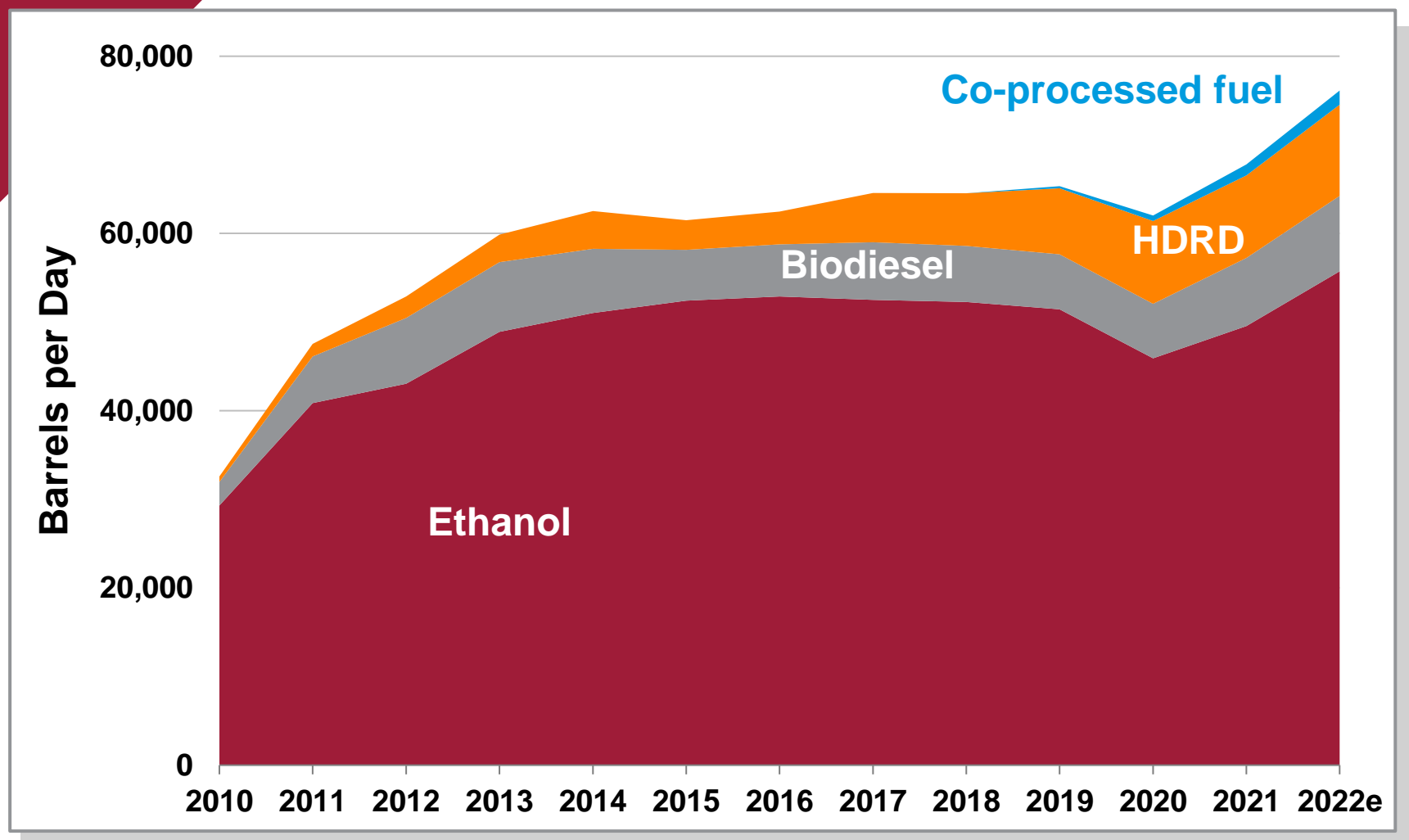
# Key Sustainability Policies Affecting Canadian Refineries

Clean Fuel Regulations	Large-emitter policies	Biofuel blending mandates	
<p>In summer 2023, the federal government enacted the Clean Fuel Regulations (CFR), rules that are meant to reduce the carbon intensity of fuels used in Canada.</p> <ul style="list-style-type: none"><li>▪ The policy requires that the GHG emissions for gasoline, diesel, aviation fuel, and heavy fuel oil are reduced by 12% between 2023 and 2030.</li><li>▪ To comply with the CFR, refiners have options for compliance including reducing GHG emissions in the refinery, blending biofuels, or buying credits from EV chargers, upstream oil and gas producers who decarbonize, and other low-carbon fuels producers. Biofuels are expected to play a significant role in compliance.</li><li>▪ The Parliamentary Budget Officer expects the CFR to increase the cost of gasoline by up to 17 cents per litre and diesel up to 16 cents per litre by 2030.</li></ul>	<p>In 2018, the federal government enacted the <i>Greenhouse Gas Pollution Price Act</i> (GGPPA), often referred to as the carbon tax.</p> <ul style="list-style-type: none"><li>▪ The GGPPA contains two parts: a retail fuel charge, and a large-emitter policy affecting industrial emissions, including refineries.</li><li>▪ The policy allows provinces to write and enact their own alternative policies, many of which have done so.</li><li>▪ The large-emitter policy is based on an Output Based Price System, where facilities have emissions limits based on their product output. The GHG intensity stringency is increased over time.</li><li>▪ For the retail fuel charge, by 2030, the carbon tax fuel charge will reach 37 cents per litre for gasoline and 45 cents per litre for diesel.</li></ul>	<p>Several provinces and the federal government have set biofuel blending mandates for both gasoline and diesel with the goal of reducing fuel emissions.</p> <ul style="list-style-type: none"><li>▪ The primary biofuel blended into gasoline is ethanol, while biodiesel is the predominant diesel replacement.</li><li>▪ Mandatory alternative fuel blends into gasoline across the country include British Columbia (5%), Alberta (5%), Saskatchewan (7.5%), Manitoba (10%), Ontario (10%)<sup>1</sup>, and Quebec (10%)<sup>1</sup>.</li><li>▪ For diesel, the alternative fuel blend rates for different provinces includes British Columbia (4%), Alberta (2%), Saskatchewan (2%), Manitoba (5%), Ontario (4%)<sup>1</sup>, and Quebec (3%)<sup>1</sup>.</li></ul>	<ul style="list-style-type: none"><li>• Some Canadian policies, including the biofuels blending mandates and CFR, help promote the development of biofuels and other low-carbon fuels for blending and replacement.</li><li>• The large-emitter GHG reduction policies and CFR encourage a reduction in direct emissions from refineries, through electrification, carbon capture and storage, or other means of reducing site emissions.</li><li>• The GGPPA and CFR are designed to ramp up in stringency over time for increasingly strict emission targets.</li></ul>

Source: Government of Canada, Canada Energy Regulator

<sup>1</sup> Ontario and Quebec both increase their blending requirements over time

# Annual Canada Biofuel Consumption | 2010 to 2022e<sup>1</sup>



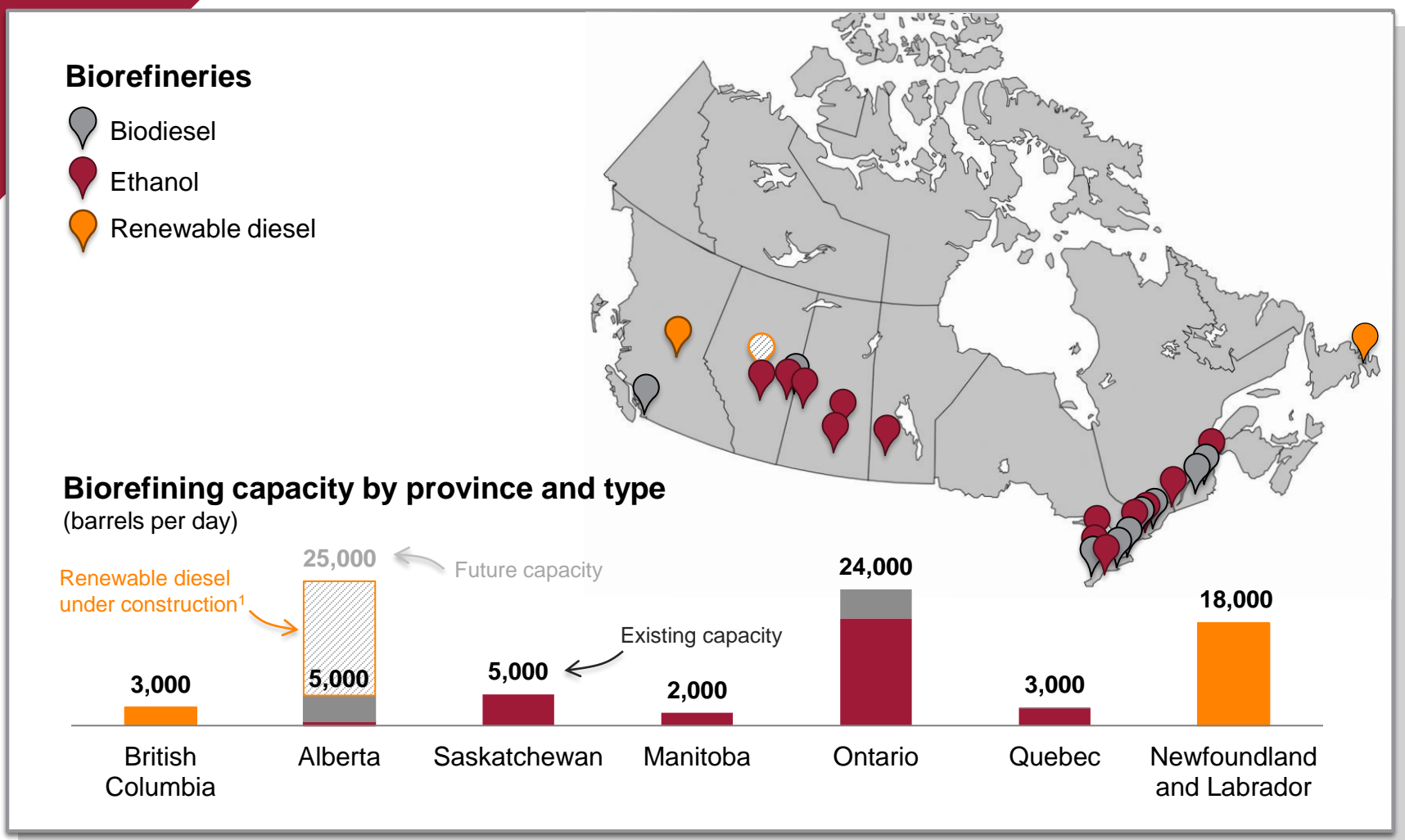
Source: Advanced Biofuels Canada

- Federal and provincial governments have enacted biofuel blending mandates.
- For gasoline, they range from 5% to 10% across the country. Ethanol is typically the fuel of choice for gasoline blending.
- For diesel, the mandates range from 2% to 5%. Biodiesel can be blended at lower rates, while hydrogenation-derived renewable diesel (HDRD) is chemically identical to diesel refined from crude oil and, as such, has no blending limit.
- The Clean Fuel Regulations (came into force in 2023) are expected to increase the consumption of biofuels in Canada.

<sup>1</sup> 2022 values are estimated



# Canadian Biorefineries and Capacities by Province | 2023 YTD



- Three major renewable diesel refineries are either recently completed (Prince George, BC) or under construction (Strathcona, AB; Come-by-Chance, NL) across the country. Combined, these would effectively double Canada’s total daily combined refining capacity among biodiesel, ethanol, and renewable diesel.
- Parkland also co-processes some bio-feedstock at its Burnaby refinery in BC.

Source: Renewable Industries Canada, USDA US Department of Agriculture, Canada Energy Regulator (1) HDRD facilities under construction: Strathcona, AB