

IHS ENERGY

# The Two Pillars: The increasingly integrated US-Canadian oil trade

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## STRATEGIC REPORT

Canadian Oil Sands | Special Report

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## About this report

**Purpose.** The revival of North American crude oil production reduced offshore imports in North America and strengthened energy security. This Special Report compares the integrated oil markets of Canada and the United States and their reliance on offshore imports (or non-Canadian, non-US produced crude oil) over time (graphically by state and province and by heavy and light crudes). An analysis is provided of the contributions and implications of oil sands and tight oil growth to North American energy security.

**Context.** This is part of a series of reports from the IHS Canadian Oil Sands Dialogue. The dialogue convenes stakeholders in the oil sands to participate in an objective analysis of the benefits, costs, and impacts of various choices associated with Canadian oil sands development. Stakeholders include representatives from governments, regulators, oil companies, shipping companies, and nongovernmental organizations.

This report and past Oil Sands Dialogue reports can be downloaded at [www.ihs.com/oilsandsdialogue](http://www.ihs.com/oilsandsdialogue).

**Methodology.** IHS has full editorial control over this report and is solely responsible for its content. This report relies on data from the US Energy Information Administration, National Energy Board of Canada, and Statistics Canada, as well as IHS expertise and judgment. Although best efforts are made to align with various sources, some differences may exist which can result in minor variances between values in this report and those from other sources. This report also distinguishes between crude oil imports and crude oil processed by refiners. Imports may include crude oil delivered to the United States or Canada to be stored or reexported and may not be run by domestic refiners. In this report, *offshore imports* refers to non-Canadian and non-US produced crude oil.

**Structure.** This report has four sections.

- Introduction
- The Great Revival in North American oil production: 2009–15
- The increasingly integrated and self-sufficient Canadian and US energy market
- North America to be increasingly energy secure

## The Two Pillars: The increasingly integrated US-Canadian oil trade

### Key implications

The rise in Canadian and US domestic oil production has displaced offshore imports and made North America more self-sufficient and energy secure. In 2009, around the time US crude oil supply growth began to emerge, about half of the crude oil consumed in North America came from offshore sources. In 2015 this had decreased to less than 30%.

- **Oil sands and tight oil may compete for capital, but not markets; they serve distinctive refining sectors.** There have been two pillars of growth in North America—oil sands in Canada and tight oil in the United States. Oil sands production growth targets heavy, sour refineries while tight oil meets light, sweet crude oil demand.
- **The integrated North American oil trade allows Canada and the United States to collectively achieve greater energy security than each could achieve individually.** The US supply growth has come from light, sweet crude oil—a type of crude demanded by Canada's eastern refiners; while Canadian growth has come from heavier crudes—the type demanded by refiners in the US Midwest and US Gulf Coast. From 2009 to 2015, US light, sweet crude exports to Canada increased 400,000 b/d while US imports of Canadian heavy oil—primarily from the oil sands—increased 1.2 MMb/d.
- **Tight oil has displaced most offshore imports of light crude oil, but opportunities remain for greater use of Canadian heavy oil.** US offshore imports (excluding Canadian) of light oil have fallen nearly 75% since 2009—to around 700,000 b/d as of first quarter 2016. However, the United States continues to rely on 2 MMb/d of offshore heavy, sour crude imports of similar quality to the growing volumes from Canada.

# The Two Pillars: The increasingly integrated US-Canadian oil trade

## Introduction

The Great Revival in North American (Canadian and US) oil production has transformed both the continental and the global oil markets. US refining has expanded, Canadian and US oil trade has grown, offshore imports sourced from nations other than Canada and the United States have fallen, and North America has become more energy self-sufficient.

From 2009 to 2015, North American crude oil production increased by more than 5 MMb/d, to over 13 MMb/d. Individually the United States and Canada rank, respectively, as the third and sixth largest producers globally; collectively they would rank first.

Production is expected to decline, as lower prices have hampered investment in new production. IHS expects production volumes could bottom out toward the end of 2016 and early 2017 at around 12.5 MMb/d before beginning to recover with higher prices. This is a reduction from the 2015 high but still well in excess of levels in 2009.

Although there are various sources of supply growth, the two pillars have been the Canadian oil sands and US tight oil. Together they accounted for nearly 95% of the supply growth, with oil sands expanding about 1 MMb/d and US tight oil nearly 4 MMb/d.<sup>1</sup>

Together Canada and the United States consume about 18 MMb/d of crude oil and other liquid hydrocarbons. This demand is met by a combination of Canadian and US produced crude oil, delivered to refiners by pipeline, rail, and barge, and imports delivered by marine tanker from offshore markets.

The distinct nature of oil sands and tight oil growth has contributed to the further integration of the North American oil market and to a greater displacement of offshore imports than could have been achieved by either nation alone. Between 2009 and 2015, cross-border oil trade between Canada and the United States increased 80%—from about 2 MMb/d to nearly 3.6 MMb/d. In the same period, consumption of offshore imports fell by 3.4 MMb/d, displaced by domestic sources. The North American oil market has become increasingly self-reliant and energy secure. In 2009, about half of Canadian and US refinery demand was met by offshore imports. In 2015 nearly three-quarters of this supply was sourced from domestic (North American) sources.

In 2015, Canadian and US trade was worth over half a trillion dollars. Despite the low oil price, energy was worth over \$90 billion, with oil accounting for about 60% of this activity. Yet, the potential for even greater trade, integration, and self-sufficiency exists. This report explores the implication of the historic rise in North American crude oil production that has come about since 2009. Where has this growth emerged, what is the impact on oil trade between Canada and the United States, and what is the potential for even greater integration and energy security?

## The Great Revival in North American oil production: 2009–15

North America has undergone a renaissance in crude oil production. In 2009, years of historical decline reversed and growth began to reemerge. From 2009 to 2015, North American supply expanded by over 5 MMb/d—a rise unprecedented in the history of oil markets.

Although there are various contributors, the two pillars were the Canadian oil sands and US tight oil.

Growth in the Canadian oil sands has a long history stretching back nearly half a century. However, it wasn't until after 2001 that a combination of technological advances and an uptick in global oil prices led to an acceleration of growth.<sup>2</sup> Although oil sands extraction was historically dominated by mining operations, in more recent years increasing volumes have come from in-situ, steam assisted operations, which from a production standpoint have more in common with

1. Note that Canadian tight oil production, which is part of the remaining 5% of growth, grew about 200,000 b/d in 2009–15.

2. For more information see the IHS Canadian Oil Sands Dialogue Special Report *Why the Oil Sands? How a remote, complex resource became a pillar of global supply growth*.

conventional oil production. Between 2009 and 2015, Canadian production expanded over 1 MMb/d, with nearly all of this growth coming from the oil sands.<sup>3</sup>

The advent of tight oil is a new phenomenon, but the speed and scale of growth have had no equal in the history of the oil markets. Tight oil is produced from a variety of geological formations of low permeability and porosity (including shales, tight sands, and tight carbonates). These reservoirs were once considered uneconomic, but the advent of horizontal drilling and multistage completion techniques resulted in a dramatic turn in US oil production. After bottoming out in 2008, US crude oil production grew 4.7 MMb/d from 2008 to April 2015, nearly all attributable to tight oil.

Lower prices have reduced activity in new oil production in North America. The longer lead times associated with oil sands production mean that it will continue to grow through the worst of the low oil prices. US tight oil, however, is more price responsive, and production is declining. IHS expects US production may decline toward the end of 2016 into early 2017 around 8.5 MMb/d—back to the level of May 2014, yet still significantly above 2008 levels of around 5 MMb/d. As the market moves out of surplus, higher prices should eventually incentivize new investments in oil production, US supply growth is expected to reemerge, and Canada may maintain its long history of growth.

## Meeting refinery demand takes crude of different quality

Across the continent, refineries process a wide spectrum of crude oil. Neither crude oil nor the refineries that manufacture it into refined products are homogenous. Various crude oil properties affect the cost and refining equipment required to convert the oil into refined products, and subsequently the value and market available to crude oil producers. Facilities designed for one type of crude find it less profitable to process other grades of crude oil—mismatches exist between crudes available and various refining configurations. If a refinery processes a crude that is not optimal for its configuration, it will produce fewer high value refined products. Two key distinguishing traits of crude oils are density and impurities.

- **Density.** In a general sense, less dense or “lighter” crude oils are more easily converted into refined products such as gasoline and diesel. “Heavier” or higher density crudes are more costly to convert into refined products. To process heavier crudes, refiners must make large capital investments in specialized processing units. Additional energy and therefore cost is also required to aid in refining these crudes.
- **Impurities.** Impurities, such as sulfur, must be removed during the refining process to meet product specifications. The higher the content of sulfur (or other impurities), the greater the costs for a refiner to process the crude oil. Low-sulfur crudes (less than 1%) are called “sweet,” while high-sulfur crudes are “sour.” Sulfur is the most commonly cited impurity, but others exist, such as heavy metals or acids.

The physical characteristics of different crudes have resulted in an array of refineries with varying abilities to process different crude oils. Refineries will value crudes differently, depending on their configuration (their ability to efficiently process different crudes). No two refineries are the same. Heavier, sourer crudes are more costly to refine and as a result trade at a discount to lighter, sweeter crudes. Refiners that have made large capital investments into processing heavy crudes will continue to consume them, while less complex facilities, which are not equipped for handling heavier grades, will seek out lighter feedstock.

Throughout this report we refer to light, medium, and heavy grades of crude oil. Although there are generally held views as to which properties define these categories, there is no hard-and-fast rule. For the definitions used here, see the text box “Crude oil definitions used in this report.”

## Oil sands and tight oil are complementary sources of supply

Oil sands and tight oil have been complementary sources of supply. In 2015, North America consumed nearly 18 MMb/d of crude oil. This broke down roughly into 8 MMb/d of light crude and condensate (ultralight), about 5 MMb/d of heavy crudes, and about 4.4 MMb/d of medium grades (or everything in between).

3. Oil sands production includes bitumen upgraded into light synthetic crude oil, and raw bitumen. Diluent used for the creation of bitumen blends and dilbit is not included in the IHS definition of production.

## Crude oil definitions used in this report

There are general categories of crude oil—light, medium, and heavy—as well as key quality indicators, such as sweet or sour. When not expressly stated, such as in figures, the definitions used in this report are as follows:

- **Light crude oil includes low-sulfur (less than 1%) crudes with an American Petroleum Institute (API) gravity greater than 24 degrees (24° API).** These crudes are also often referred to as condensate; light, sweet; and medium, sweet crudes.
- **Medium crude oil is defined as higher-sulfur crudes (greater than 1%) with greater than 24° API.** These crudes are also often called light, sour and medium, sour crudes.
- **Heavy crude oil includes crude oil with higher sulfur content (greater than 1%) and less than 24° API.** Middle Eastern heavy crudes of less than 28° API were included in our definition of heavy crudes. Generally these crudes are referred to as heavy, sour crudes.

Although tight oil and oil sands may compete for capital investment, they are complementary from an oil market perspective. US tight oil, a light crude oil, has predominantly helped meet the demand of light crude oil refiners across North America, whereas oil sands have principally targeted more complex facilities configured toward heavier crude oils.<sup>4</sup>

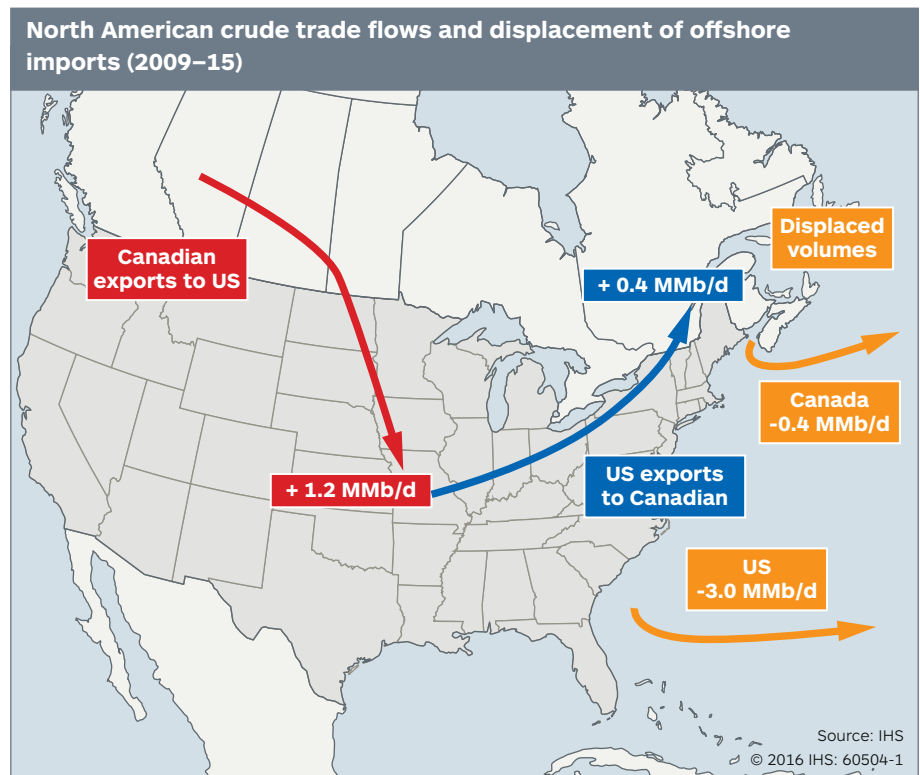
## The increasingly integrated and self-sufficient Canadian and US energy market

Nearly all of US tight oil and Canadian oil sands growth has found its way into North American refineries, where it has been converted into refined products such as gasoline and diesel.

From 2009 to 2015, the processing of North American sourced crudes expanded 64%—or nearly 5 MMb/d. In a system that consumed about 18 MMb/d in 2015, this is a significant increase. About 3.4 MMb/d of the increase came about as domestic supply displaced offshore imports. About 1.6 MMb/d was made possible from the increased trade of growing Canadian heavy crude supply into the US market and the flow of US light, sweet crude into Canada’s eastern regions (see Figure 1).

In 2015, the United States and Canada were each other’s single largest source of foreign oil. From 2009 to 2015, US imports of Canadian crude increased nearly 1.2 MMb/d, reaching a record level of 3.1 MMb/d in 2015. Conversely,

Figure 1



4. Canadian oil sands supply includes both heavy bitumen blends and bitumen upgraded into light synthetic crude oil similar to light, sweet crudes. However, the onslaught of US tight oil diminished the economic incentive to invest in the heavy oil upgrading capacity necessary to convert bitumen into synthetic crude, and growth has been dominated by heavier bitumen blends targeting heavy crude oil refiners.

US exports to Canada expanded 400,000 b/d and in 2015 were also at record levels exceeding 420,000 b/d on an annual average.

Oil trade has taken an increasingly important role in the Canada-US trade relationship, where trade tops half a trillion dollars per year. Energy alone was worth over US\$90 billion in 2015, of which oil made up the majority (even in 2015 at depressed oil prices), accounting for 60% of the total energy trade between the countries.<sup>5</sup>

### Traditional markets for Canadian heavy consumed more

Increasing volumes of Canadian imports into the United States have come in the form of growing heavy diluted bitumen blends from the Canadian oil sands. These imports have ended up principally in the US Midwest—the historical home for Canadian exports. In 2009, the Midwest consumed about 1.2 MMb/d of Canadian crude. In 2015 this had risen to over 1.8 MMb/d. States that had traditionally run Canadian heavy crude are running more of it. As Figure 2 shows, states such as Illinois, Indiana, and Minnesota still rely heavily on Canadian supply to fill their refineries. Increasing volumes of Canadian supply—all heavy, sour crudes—have continued to build into the Midwest regions, but volumes are reaching the Texas Gulf Coast region as a result of increased US pipeline connectivity. IHS estimates that deliveries into the Gulf Coast states may have approached 500,000 b/d in 2015, up nearly 400,000 b/d since 2009.

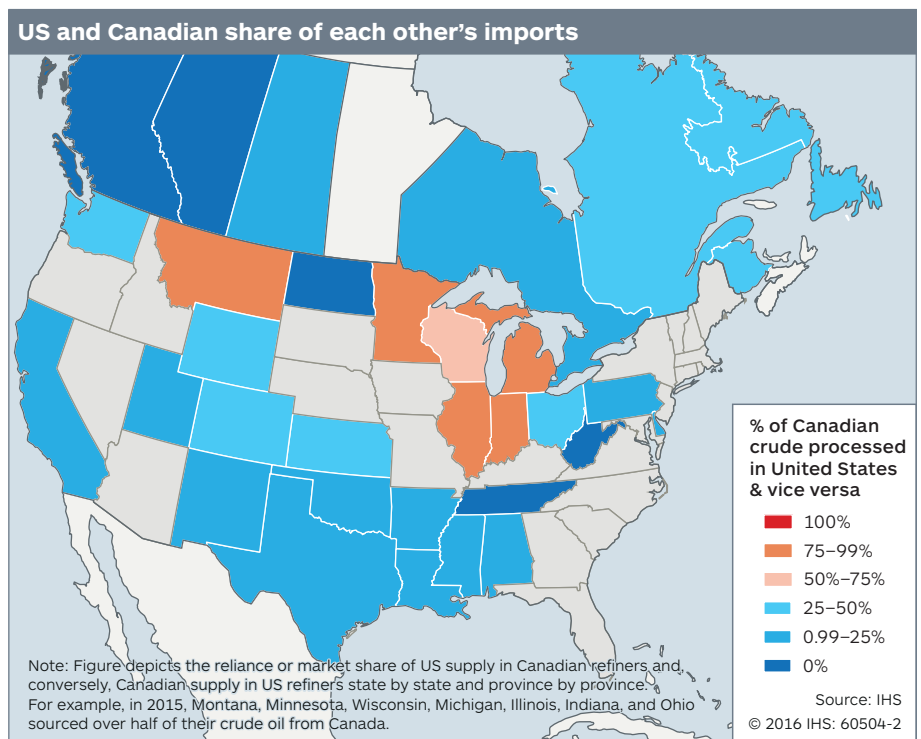
### Greater energy security potential remains from the Canadian oil sands

The Canadian oil sands still hold untapped potential to further increase North American energy self-sufficiency. Although tight oil has displaced significant volumes of offshore imports, the impact has been largely restricted to crude oil of similar quality. In 2015, North America still imported significant volumes from offshore sources, including about 2 MMb/d of heavy, sour crude oil of similar quality to the growing supply from the oil sands (see Figure 3). Nearly 90% of these imports arrived into the US Gulf Coast (USGC) region.

As Figure 4 shows, the states that have historically relied on offshore heavy, sour imports remain largely untouched by Canadian supply growth (the exception being Virginia, whose refinery shut down in 2010). Increasing volumes of Canadian crude have begun to move into the USGC, but since the cross-border pipelines are near their current capacity, pipeline flows to the Gulf may be constrained until new upstream capacity is built. A large viable market for Canadian heavy crude remains in the United States, particularly Texas, Louisiana, Mississippi, and Alabama (which together imported nearly 2 MMb/d of heavy crude in 2015, with actual processing capacity being even higher).

Moreover, US heavy oil refineries along the Gulf Coast face an uncertain future from their historical suppliers, Mexico and Venezuela. Mexican production has fallen by over 1 MMb/d over the past decade; and although the drop in

Figure 2



5. Source: U.S. Census.



Venezuela’s output has been a more modest 200,000 b/d, the country also faces significant economic challenges that may affect its ability to maintain production levels in the future. In 2015, the United States relied on 1.4 MMb/d in imports from these two nations. Because the USGC is the single largest heavy crude oil processing market in the world, the potential match between Canadian supply and USGC demand remains an attractive pairing—particularly in light of the prospect of reduced access to leading competitive sources of supply from Mexico and Venezuela.

**US tight oil has penetrated all regions, including Canada**

US light tight oil has overrun regional demand and displaced foreign imports in the Gulf Coast, Midwest, West Coast, and East Coast, as well as in Canada. Abundant cheap inland crude has also encouraged greater consumption of lighter crudes.

Combined refinery demand for offshore imports of light crude in Canada and the United States fell by around 2.5 MMb/d, from just under 3.2 MMb/d in 2009 to around 700,000 b/d in 2015. Lower prices are reducing US production, and some light barrels will flow back into the United States over the coming months. Light oil imports have already increased by 175,000 b/d since fourth quarter 2015. Yet US offshore imports (excluding Canadian) of light oil remain nearly 75% lower than 2009 levels, at 700,000 b/d as of first quarter 2016. As prices recover, growth will return, and with them US supply may rise again, displacing offshore imports.

Figure 3

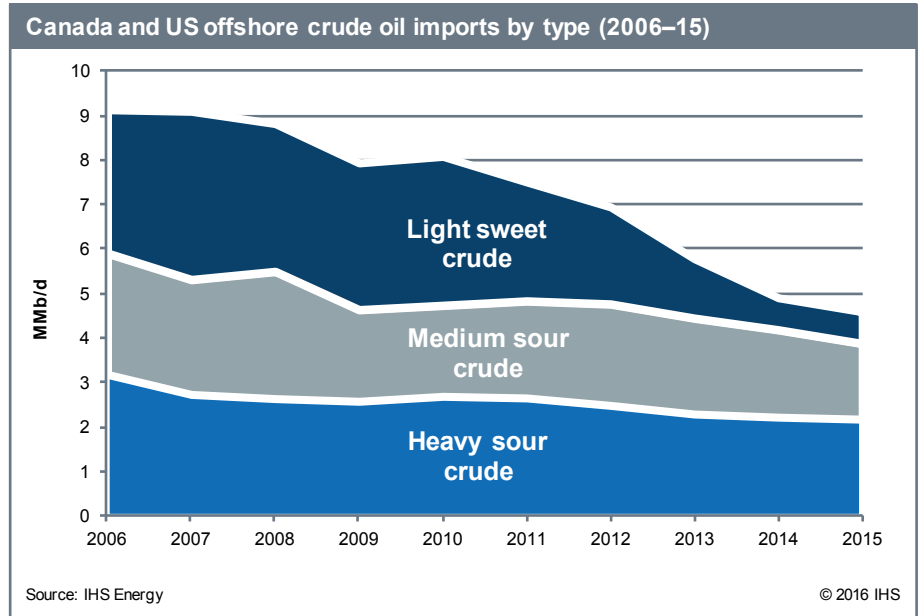
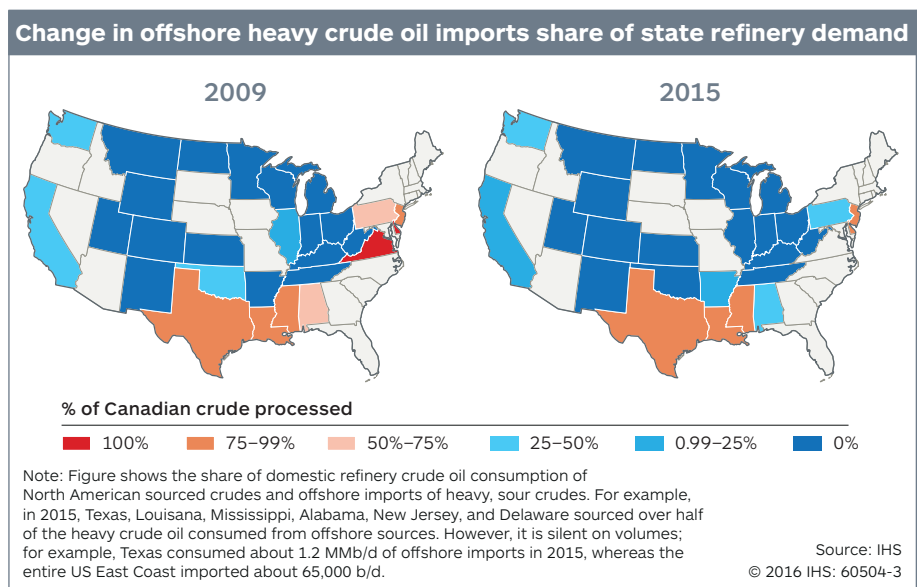


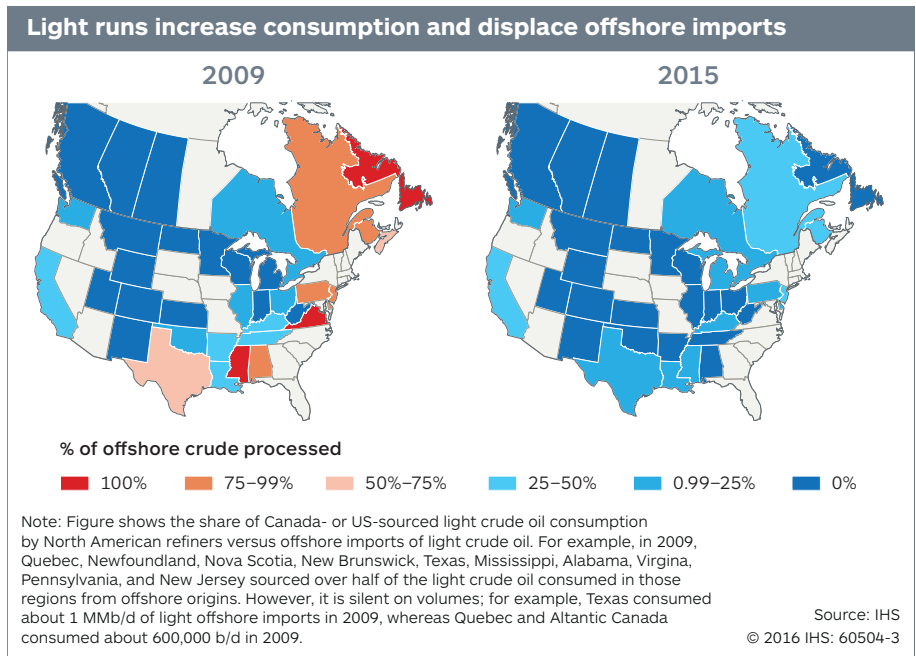
Figure 4



As shown in Figure 5, the impact on offshore imports across the United States and Canada has been more pronounced in coastal regions. In 2009, the US East Coast consumed 1.2 MMb/d of offshore imports—over 65% being light crude. Between 2009 and 2015, consumption of offshore imports of light crude oil on the East Coast fell 74%, from 700,000 b/d to about 180,000 b/d, with the greatest impact being felt in Pennsylvania, New Jersey, and Delaware. USGC consumption of domestically sourced light crudes increased from 1.1 MMb/d in 2009 to nearly 3.8 MMb/d in 2015. Stated another way, consumption of light crude oil imports sourced from offshore sources fell from over 1.5 MMb/d in 2009 to 130,000 b/d in 2015. The rise of crude-by-rail has given light, sweet crude from tight oil access to nearly all US markets and Canada’s eastern regions.

Canada’s refining sector illustrates the similar impact of increased supply, trade, and displacement of light, sweet crude oil imports from offshore sources. Canada’s eastern provinces, which are the farthest from the producing areas in western Canada, have historically consumed most of the country’s offshore imports. From 2009 to 2015, consumption of offshore imports into eastern Canada fell over 430,000 b/d as a direct result of increased tight oil deliveries (and also because of a reduction in regional refining capacity).<sup>6</sup> In 2009, Quebec and New Brunswick sourced nearly all (90%) of their refinery demand from offshore imports. By 2015 this had fallen to just over 40%—a reduction of nearly 500,000 b/d. In 2009, total US deliveries to all of Canada were a meager 45,000 b/d. In 2015, US volumes exceeded 420,000 b/d—a new record and nearly 30% of Canadian demand.<sup>7</sup> The vast majority of these deliveries were into Canada’s eastern regions. These volumes are expected to soften as a result of lower prices and further distance to US supply centers. However, the prospects of increased pipeline connectivity from the western producing regions in Canada and the upper Midwest (home to Bakken production, one of the key regions of US tight oil growth) could enable more economic movements of both Canadian supply and US production into this region.

Figure 5



## North America to be increasingly energy secure

The increase in supply of US tight oil and Canadian oil sands has proven complementary, and the North American energy market has become more integrated as a result. The trade of crude has expanded, enabling a greater displacement of offshore imports than could have been achieved by each nation alone. In 2015, the United States and Canada were each other’s largest source of oil imports, with Canada supplying about 20% of US oil demand and the United States supplying nearly 30% of Canadian crude oil consumption.

As supply from both production types—tight oil and oil sands—has increased, each has met the needs of different types of refineries. On the one hand, the enormity of the scale of US tight oil production has allowed it to reach every corner of North America by pipeline, rail, and marine transport, and offshore imports of light crude were decimated. However, the picture is very different for heavier grades of crude oil. Offshore imports of these grades—medium and heavy—are largely unchanged. The persistence of these imports highlights the scale of continental oil consumption as well as the mismatch of US tight oil and refiners’ capabilities.

Lower prices will reduce North American supply—predominantly from US tight oil—and some lighter barrels may flow back into the United States and Canada to offset these declines. However, with production declining globally, prices are expected to rise, and with them US production growth will reemerge and Canada may maintain its long history of growth.

6. Canada’s reduction in offshore imports was impacted by a reduction of East Coast refining capacity with the conversion of Shell’s 130,000 b/d Montreal East refinery to a terminal in 2010, and similarly the conversion of Imperial Oil’s 88,000 b/d Dartmouth refinery into a terminal in 2013.

7. In May 2015, US deliveries reached 524,000 b/d.

Growing volumes of Canadian heavy oil could increase North American energy security. IHS expects increasing volumes of Canadian heavy oil to be drawn to the USGC region, where the heavy, sour crudes from the oil sands represent an attractive substitute for declining offshore heavy crude supply from Latin America (primarily Mexico and Venezuela). As volumes increase, North American oil trade—and therefore energy security—could expand further.

## IHS team

**Aaron Brady**, Senior Director, IHS Energy Oil Market Services, has more than 15 years of experience in analysis and forecasting of global and North American oil markets. Mr. Brady has authored numerous IHS reports, including the role of biofuels, the economics of electric vehicles, and peak oil demand in the developed world, along with many regular Market Briefings and World Oil Watch reports. Previously, Mr. Brady was a consultant in the oil industry, focusing on downstream regulatory issues, including the transition to ethanol in the California gasoline market. Mr. Brady holds a Bachelor of Arts from Amherst College, Amherst, Massachusetts, and a master's degree from Johns Hopkins University's Paul H. Nitze School for Advanced International Studies, Washington, DC.

**Kevin Birn**, Director, IHS Energy, leads the IHS Oil Sands Dialogue. His expertise includes energy and climate policy, project economics, transportation logistics, and market fundamentals. His recent research includes analysis of the greenhouse gas intensity of oil sands, economic benefits of oil sands development, upgrading economics, and the future markets for oil sands. Prior to joining IHS, Mr. Birn worked for the Government of Canada as the senior oil sands economist at Natural Resources Canada, helping to inform early Canadian oil sands policy. He has contributed to numerous government and international collaborative research efforts, including the 2011 National Petroleum Council report *Prudent Development of Natural Gas & Oil Resources* for the US Secretary of Energy. Mr. Birn holds undergraduate and graduate degrees in business and economics from the University of Alberta.

**Peter Kucera**, Research Manager, IHS Energy, manages subscription services covering North American downstream companies and markets and contributes to IHS Energy's downstream and midstream consulting practice. He specializes in North American crude and product markets, midstream infrastructure, and competitive benchmarking. Proficient in French and literate in Russian, Mr. Kucera holds a BS from Georgetown University and a certificate in Russian Studies.

**Dominik Rozwadowski**, IHS Energy Market Research Analyst, North American Oil, supports research efforts for North American crude oil analytics. He contributes to the delivery of market research concerning crude oil supply and demand balances, transportation by pipeline and rail, price forecasts, and geopolitics. Prior to joining IHS, Mr. Rozwadowski worked at the Canadian Energy Pipeline Association, where he collaborated with North American pipeline companies on program development for operational issues related to regulatory reform, the environment, and pipeline safety. Earlier, at Nabors Drilling, he gained field experience at a number of oil and gas fields in northern Canada. Mr. Rozwadowski holds a Bachelor of Commerce degree and a Bachelor of Arts degree from the University of Calgary.