

Crude Oil and Natural Gas Resources

Abstract

Canada has significant proven reserves of crude oil (178 billion barrels), second only to those of Saudi Arabia. Canadian natural gas reserves were 58 trillion cubic feet as of year-end 2006. These resources are found in the country's seven major sedimentary basins. The primary petroleum-producing sedimentary basin is the Western Canada Sedimentary Basin (WCSB), which extends from the Canadian Shield to the Rocky Mountains through Manitoba, Saskatchewan, Alberta and northeastern British Columbia. There are also producing basins in southern Ontario, offshore Newfoundland, and the Scotian Shelf. Potential reserves are also found in Northern Canada, where an estimated 30 per cent of Canada's conventional oil resources are located. The map shows the major petroleum-producing fields (or pools) of conventional natural gas, crude oil and the oil sands, as well as the extensive pipeline network.

Oil is found in sedimentary basins, areas of the Earth's crust that subsided and were consequently filled with sediments that eventually turned to rock. The sediments in these basins can contain hydrocarbons, products of the decomposition of ancient plants and animals. Hydrocarbons are chemical compounds that consists only of the elements carbon (C) and hydrogen (H). These compounds have low entropy (meaning they hold a lot of energy potential). The energy can be released and harnessed through combustion. Liquid geological hydrocarbons are referred to as petroleum (literally meaning 'rock oil') or mineral oil, whereas gaseous geological hydrocarbons are referred to as natural gas. Hydrocarbons are of prime economic importance because they are the primary constituents of the major fossil fuels (coal, petroleum, natural gas). All are significant sources of fuel. Hydrocarbon reserves require upgrading to produce petroleum (from traditional deposits) and synthetic crude (from oil sands deposits). Oil reserves in sedimentary rocks are the principal source of hydrocarbons for energy.

There are seven regions in Canada where some of the sedimentary rocks laid down during the past 500 million years have generated crude oil and natural gas. These regions are often referred to as the seven hydrocarbon regions: Western Canada Sedimentary Basin, Atlantic Margin, Arctic Cratonic, Arctic Margin, Pacific Margin, Intermontane and Eastern Cratonic. In the hydrocarbon regions of the sedimentary basins, crude oil is derived from marine plants and animals, mainly algae that have been heated at temperatures between 50 and 150 degrees Celsius for at least one million years. Natural gas is formed from both marine and terrestrial organic material at varying temperatures and pressures.

Crude Oil

Crude oil is extracted from three principal sources: conventional light and heavy oil deposits located in underground pools or reservoirs, and nonconventional deposits of bitumen-rich sand. The Western Canadian Sedimentary Basin, underlying most of Alberta, parts of Saskatchewan and Manitoba, the northeast corner of British Columbia and the southwest corner of the Northwest Territories, has been the main source of conventional oil in Canada for the past fifty years.

As of January 2009, Canada had 178 billion barrels of proven oil reserves, second only to Saudi Arabia; 95% of these reserves are in Alberta, the majority in the oil sands of northern Alberta. The Jeanne d'Arc basin, in Newfoundland and Labrador, currently produces approximately 40% of Canada's conventional light crude oil.

Oil sands, or bituminous sands, are mix of bitumen, sand, water and clay. The bitumen, a heavy, asphalt-like form of crude oil, surrounds the water and sand, enveloping each grain of sand. The oil sands are spread across 77 000 square kilometres of northern Alberta in three major areas: Peace River in northwestern Alberta; Athabasca in northeastern Alberta; and Cold Lake, which is immediately southeast of the Athabasca area. The oil sands are estimated to have in-place reserves of between 1.7 and 2.5 trillion billion barrels of bitumen, of which 173 billion barrels can be recovered using current technology. Only about 20% of the nonconventional Alberta oil sands deposit can be extracted using surface-mining techniques. The remainder is buried too far beneath the surface for open-pit mining, so the oil must be recovered using in situ techniques. Using drilling technology, steam is typically injected into the deposit to heat the oil sand, thereby lowering the viscosity of the bitumen so it can be pumped to the surface.

Since 1964, there have been 90 major offshore oil and natural gas discoveries. The first offshore production was off the coast of Nova Scotia opposite Cohasset, Massachusetts in 1992. In November 1997, Hibernia production started at an oilfield located 315 kilometres from St. John's, Newfoundland and Labrador. The other two offshore projects in the Atlantic are Terra Nova and White Rose. On the Pacific Coast, experts believe that there are sizable oil and natural gas reserves. However, a moratorium currently exists on all offshore oil and gas activities.

Bitumen from the oil sands must either be upgraded to light crude or put through high-conversion facilities designed specifically for bitumen or conventional heavy oil. Most refineries find it difficult to process bitumen because it is too thick to flow through pipelines unless diluted with condensates. Bitumen from the oil sands is typically extracted and upgraded nearby (for example, within the Athabasca region), or it is diluted and shipped by pipeline to regional upgraders in Edmonton and Strathcona County, Alberta or to refineries in the northern and midwestern United States. Natural gas liquids (NGLs) are used to dilute the bitumen for pipeline shipment.



Classification of the various types of crude oil that are found and produced is based on the density or gravity of crude oil, measured as the proportion of large carbon-rich molecules present in the oil:

- light crude oil: liquid petroleum with an API* gravity of 28 degrees or higher
- heavy crude oil: liquid petroleum with a gravity below 28 degree API*
- bitumen: petroleum in semisolid or solid form found in bituminous sands with a gravity of less than 12 degrees API*, making it so heavy that it will not flow unless diluted or heated
- synthetic crude oil: similar to light crude oil, but made by refining or upgrading heavy crude oil and bitumen
- condensates: hydrocarbons recovered from a natural gas reservoir
- pentanes: hydrocarbons containing molecules of 5 carbon atoms and 12 hydrogen atoms

*API: American Petroleum Institute gravity scale, measured in degrees

Refineries are necessary to transform crude oil into a range of petroleum products. Refineries are designed according to the end products they are intended to provide, and the nature and quality of crude oil available for processing. In 2008, 16 Canadian refineries offered a full range of refined petroleum products. Refining light crude oil yields gasoline, diesel fuel, light fuel oil for home heating, heavy fuel oil for electric power generation and aviation jet fuel. Other products from light crude oil include asphalt, paving and roofing tar, motor oil and grease, waxes for candles and polishes, and petrochemicals.

Alberta has the highest production of crude oil, followed by Saskatchewan and Newfoundland and Labrador (Figure 1). These three provinces export most of their crude oil to the United States.

Source: National Energy Board. Statistics Canada. 2008 Energy Statistics. US Energy Information Administration.

Natural Gas

The main gas-producing area is the Western Canadian Sedimentary Basin, with Alberta, British Columbia and Saskatchewan accounting, respectively, for 83%, 13% and 4% of its production. Minor onshore established reserves exist in Ontario, the southern Yukon and the Northwest Territories. Offshore production at the Sable Offshore Energy Project (Sable Island, Nova Scotia) commenced in late 1999 and

has amounted to approximately 1.4 trillion cubic feet to date. The Hibernia Project (offshore Newfoundland and Labrador) also produces natural gas, which is used for on-site operations and reservoir injection. Additional frontier basins containing significant discovered resources include the Beaufort Sea, Mackenzie Delta, Arctic Islands, Labrador Basin and Grand Banks Basin. One small established reserve near Inuvik, Northwest Territories, the Ikhil reservoir, is producing and supplying Inuvik with natural gas.

Natural gas must be processed before it can be shipped on long-distance pipeline transmission systems or used by consumers. The processing sector of natural gas production is called the midstream sector. In Alberta and Saskatchewan, natural-gas producers have built pipelines to move raw natural gas to processing plants. In Alberta, most of the plants are close to major gas pools. In British Columbia, natural gas is processed by Westcoast Energy Inc. at one of their five large gas-processing plants. As of June 2007, there were 952 operating gas-processing plants in Canada: 889 in Alberta, 34 in British Columbia, 24 in Saskatchewan, 2 in Nova Scotia, 2 in the Northwest Territories and 1 in Ontario.

Gas-processing plants transform raw natural gas to 'pipeline quality gas', composed mainly of methane but usually combined with smaller amounts of ethane and other natural gas liquids. The latter are extracted from raw natural gas at so-called 'straddle plants', a type of a gas processing plant. Gas liquids, such as ethane, butane, propane and condensates are important by-products and are used primarily as a feedstock for Alberta's petrochemical industry. Straddle plants are primarily located near major export points in Alberta.

In 2007, Canadians consumed 3.1 trillion cubic feet of natural gas, which supplied 28% of our energy needs. Natural gas is used primarily in the residential and commercial sectors for heating, in the industrial sector for process heat in the production of chemicals, and for generation of electricity. Natural gas exports to the United States in 2007 were 294 million cubic metres per day (3.8 trillion cubic feet, or 10.4 billion cubic feet per day), representing revenues of \$24.3 billion. Most of our natural gas export markets in the United States (Figure 2) are in the Central, Midwest and Pacific Northwest regions. Canada also imports natural gas from the United States (for example, in Ontario) where and when it is cheaper to obtain than from Western Canada and to take advantage of existing pipeline infrastructure and storage facilities.

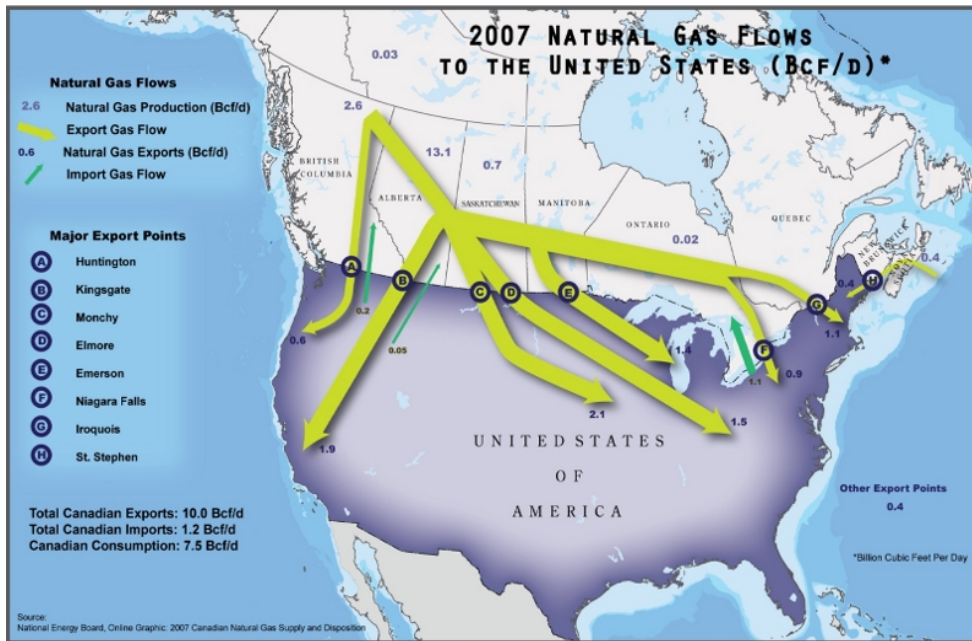


Figure 2. 2007 Natural Gas Flows to the United States (billion cubic feet per day)

Source: National Energy Board. Online Graphic: 2007 Canadian Natural Gas Supply and Disposition.

Natural gas liquids (NGLs) are the heavier hydrocarbons (ethane, propane, butane and pentane), removed from natural gas at processing plants in Fort Saskatchewan, Alberta and Sarnia, Ontario. However, not all NGLs are produced from natural gas, since 11% of propane and butane are produced as a by-product of the refinement of crude oil.

Canada also has reserves of unconventional natural gas from coal seams (coal bed methane), low permeability rocks (tight gas) and shale (shale gas). Unconventional natural gas production is in its early stages of development in Canada. The unconventional reserves of natural gas are not shown on the map.

For further information on refineries and other facilities associated with the production and transmission of natural gas refer to the Atlas of Canada's map text on pipelines.

Map Sources

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Sedimentary Basins

Not all of the sedimentary basins depicted on the map conform to the strict definition of the term 'basin'. A sedimentary basin is a geographical feature which exhibits subsidence and consequent infilling by sedimentation. Some of the basins on the map are erosional remnants or outliers and others are defined by their physiographic or bathymetric extent rather than by their surface geology. Map compiled by G.D. Mossop, K.E. Wallace-Dudley, G.G. Smith and J. C. Harrison. Geological Survey of Canada. 2004. Map: Sedimentary Basins of Canada. Open File 4673. Scale 1:5 000 000.

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