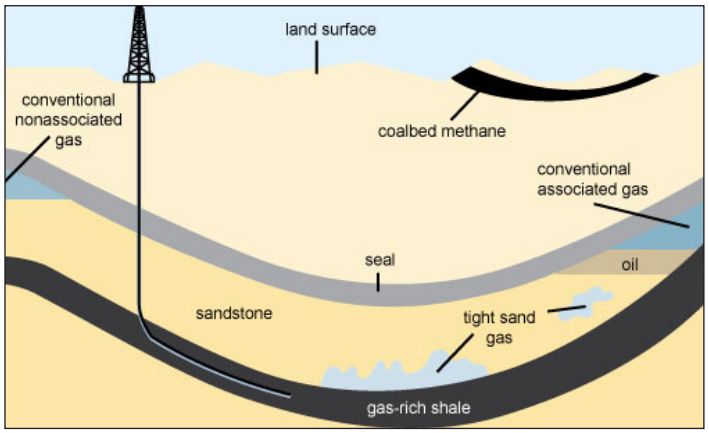
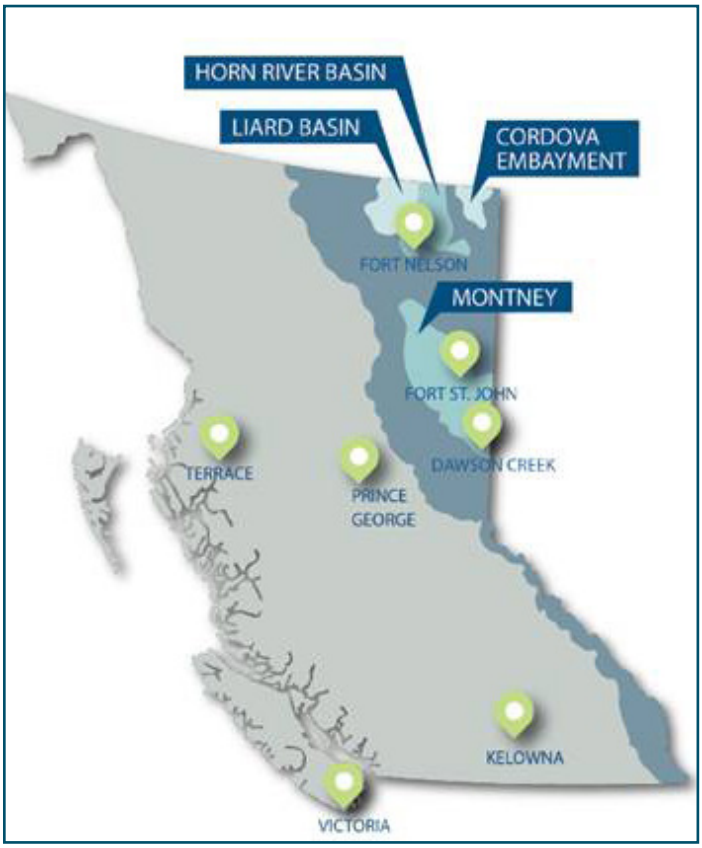
NATURAL GAS

FIRST NATIONS
LNG ALLIANCE

Schematic geology for natural gas resources



Source: USEIA/USGS



Source: BCOGC

What is natural gas?

Natural gas is mostly methane, with some additional natural substances that are removed before the gas is delivered to customers. Around the world natural gas is used mostly for heating and generating electricity.

Natural gas

Natural gas, coal and petroleum oil are fossil fuels. Together they provide about 85% of the world's energy supply. Natural gas is an important fuel for heating, cooking and power production.

There are different theories about how natural gas was created, but it is widely accepted that it began forming hundreds of millions of years ago when the remains of marine organisms (small plants and animals) settled on ocean floors or lake beds, forming a sludge which was later buried by layers of sand and silt. Land plants may also have contributed to the organic material.

The pressure and heat created by the enormous weight of many layers of sediment eventually transformed these layers into sedimentary rock.

When temperatures got warm enough in the layers, the organic materials were transformed into oil, and with even higher temperatures the oil was transformed into natural gas. Natural gas in these cases is referred to as being ***associated*** with petroleum deposits. In some places natural gas is formed independantly of oil.

Natural gas is sometimes found in large spaces or cracks between rock layers. This is referred to as conventional natural gas because it flows freely from the ground and is relatively easy to extract using conventional technology.

In other cases natural gas is located in small spaces (pores) in sedimentary rocks including sandstone, shale, carbonate and coal. This is referred to as **shale gas** or **tight gas**.

This type of natural gas is called **unconventional** because it is more difficult to extract from the ground. Getting to unconventional gas requires more complex technology like hydraulic fracturing, which is commonly called **fracking**. Another source for natural gas is from deposits of coal. This is **coalbed methane** or **sweet natural gas**.

Places where natural gas is found are referred to as reservoirs, fields, or pools. Some of these reservoirs, or pools, are still found in marine environments, such as offshore oil and gas deposits, but in many cases these ancient seas or lakebeds are now found inland such as in Alberta or northeastern BC.

Natural gas ingredients

Raw natural gas is what gas is called before it is processed to remove **impurities**. Raw gas is a naturally occurring organic compound composed of 90% to 95% methane. In this form it may contain smaller amounts of flammable components including ethane, propane, butane, and pentane.

The non-energy-producing components of raw natural gas include nitrogen, carbon dioxide, hydrogen sulphide and water. Coalbed methane is almost pure methane and contains very few impurities.

Once natural gas has been processed for commercial use it is made almost entirely of methane, with only very small amounts of other substances.

Natural gas is colorless, odorless, and tasteless, making it very difficult to detect. For this reason companies that sell and distribute natural gas add a chemical called **mercaptan**, which smells like sulphur or rotten eggs. This smell makes it easier to detect a gas leak.

Energy density of natural gas and other fuels

Energy density refers to the amount of energy stored in a specific amount of fuel. Another way to think about this is to consider how far one gallon of a fuel, such as diesel or gasoline, will move a car down the road. One unit of a higher-energy-density fuel will move the car further down the road than one unit of a lower-density fuel. Natural gas has a lower energy density than gasoline, but a higher one than coal.

But not all fuels are used for the same purpose. For example coal is not directly used to power cars. But we can show energy density in terms of an amount of energy (watt-hours or Megajoules) that is stored per unit (such as a litre or kilogram) of fuel. This allows a comparison of energy densities for a wide range of fuel types regardless of what we use them for. We can compare wood, coal, diesel, natural gas and even uranium. If we compare wood, coal, diesel and natural gas, natural gas has the highest energy density. But Uranium has an even higher energy density, though it is only used to generate electricity.

How far will a fuel take you?

It can be hard to compare energy sources. To provide a rough comparison lets look at how far a kilogram (kg) of different fuel types might move an electric car? As a starting point, we can use a brown coal called lignite. A kg of lignite might produce about 5 kWh. Assuming that for every 1 kWh we can move an electric car 5 km, the brown coal would take us about 25 km.

What about the other fuels?


Coal - 25 km


Fire wood - 22 km


Natural gas - 55 km

Gasoline - 60 km


Uranium - 5,416,665 km

See notes on page 9

What is a kWh?

A kilowatt hour (kWh) is a measure of energy. It is commonly used on electricity bills to measure energy delivered to customers. For example, if you had an appliance that consumed 1000 watts in one hour then you have used 1 KWh.

Natural gas reserves

Natural gas and other fossil fuel reserves are areas of known (discovered) fossil fuels that are believed to be commercially feasible to recover. The phrase **marketable and technically recoverable** means that the resources are recoverable using existing technologies, the supply estimate is based on geological information, but there may have been little drilling done yet (a definition from Natural Resources Canada, *Natural Gas Facts,* 2018).

Natural gas reserves worldwide are estimated to be 27,581 trillion cubic feet (TCF) of marketable and technically recoverable resources. Most of this is located in the Russia, the Middle East, and former Soviet states. About 55% is conventional, and 45% is unconventional.

In Canada, marketable and technically recoverable natural gas reserves are estimated between 864 and 1,773 TCF, with about 20% of this being conventional gas, and the rest is unconventional (coal-bed methane, shale and tight gas). Canada's gas reserves are largely located in unconventional sources.

About 97% Canada's natural gas reserves and production are located in the western provinces. The British Columbia Oil and Gas Commission estimates that there are 3,337 TCF of unconventional natural gas resources in BC. But only about 532 TCF of this is viewed as being marketable and technically recoverable. About 47 TCF is estimated to be currently recoverable, and about 7.33 TCF of this had been extracted as of 2016.

Since 2010 conventional gas production has been declining in BC, while unconventional production (from fracking) has increased. The discovery of unconventional reserves has also grown. There has also been a 45% increase in natural gas production since 2010.

Ian King/photo

A natural gas well pad which targets the Montney formation.

The price of natural gas and other fossil fuels

Natural gas is sold in international markets based on a price per unit (or quantity) of energy produced. Canada uses the Alberta Gas Reference Price, which is listed in Canadian dollars per gigajoule. Different units of measurement are used to sell and price natural gas around the world.

A gigajoule is a metric measure of energy content. One gigajoule of natural gas has about the same amount of energy as 27 litres of fuel oil, 26 litres of gasoline or 277 kWh of electricity. It takes approximately 100 gigajoules to heat an average house in Canada for one year.

In the United States, natural gas prices are based on US dollars per million British Thermal Units (BTU). A BTU is the amount of heat needed to raise the temperature of one pound of water by one degree Fahrenheit.

Natural gas prices are determined by supply and demand. Supply is affected by the amount of production around North America at a given time, by pipeline capacity, and global competition. Demand is affected by factors such as cold winter temperatures when more gas is needed to keep homes warm.

The rise and fall of natural gas prices usually reflects trends in the price of crude oil. From the year 2000 to early 2018 the Alberta Gas Reference Price has ranged from about $1 per gigajoule to about $11 per gigajoule.

In 2017 it ranged between $2 and $3. At the beginning of 2018, the price stood at about $1.82. Efforts to forecast the future prices of natural gas are made by various government and industry organizations worldwide, but it is tough to predict with accuracy.

Natural gas has been a relatively low-cost source of energy compared to heating oil, and it is often less expensive than electricity produced by hydro or other sources.

A LIQUEFIED natural gas carrier

What is the difference between natural gas and LNG?

In British Columbia, the natural gas used in homes and businesses is delivered in vapour form by pipelines. Sometimes the gas is delivered by truck and stored in tanks.

Liquefied Natural Gas (LNG) is natural gas that has been cooled to a very low temperature (-160°C) until it turns from a gas (its vapour form) to a liquid. This is done to allow natural gas to be stored in a much smaller space when it is being exported by tanker ship (shown on this page) for sale to overseas markets. **After it becomes LNG, the gas takes up only about 1/600th of its original space.**

Natural gas turns from gas to liquid at much colder temperatures than other substances, such as water, and has to be cooled to about 162 degrees below zero Celsius (the freezing point of water).

Before cooling the gas, impurities such as water are removed. After cooling is done, the resulting liquid is clear, colourless, and odourless. It is not corrosive or toxic.

LNG storage tanks on tankers are refrigerated to maintain the low temperatures, and LNG is converted from liquid back to gas (regasified) before delivery to end-users.

The energy required to cool natural gas to a liquid state is equal to about 10% of the total energy contained in the LNG product. Because conversion to LNG for shipping requires more energy than leaving it in a vapour form, the overall energy efficiency of natural gas is higher when it is kept in vapour form and produced for local use.

NATURAL GAS

How do we use natural gas?

In Canada, natural gas is used in homes and businesses for space heating, hot-water tanks, clothes dryers, cooking and even power generators. In 2011, natural gas accounted for about 45% of total home energy use in Canada. Natural gas accounts for about 54% of home energy use in BC and 72% in Alberta.

Natural gas is used to power industrial processes (such as making steam), as a raw material input for making fertilizer and petrochemicals, to produce the energy needed to run natural gas processing facilities, and to run the large pumps that push natural gas through pipelines. Natural gas is also used to produce electricity.

In some countries natural gas is increasingly used to power passenger vehicles and public transportation. The number of LNG-powered ships is growing, including some small BC Ferries.

The global use of natural gas doubled from 1980 to 2010 and is expected to almost double again through 2040. Natural gas use is greatest in North America, Europe, Russia, Asia and the Middle East. There is less use in Africa, South and Central America, and Oceania (the South Pacific nations).

Natural gas supplies about 25% of energy used in the United States for producing electricity, heating homes, for industry and commercial use, and transportation

Information links

BC Ministry of Energy, Mines and Petroleum Resources https://lnginbc.gov.bc.ca/

Natural Resources Canada
Liquefied Natural Gas http://www.nrcan.gc.ca/energy/natural-gas/5679

Natural Resources Canada, Natural Gas Facts, 2018 https://www.nrcan.gc.ca/energy/facts/natural-gas/20067

US Energy Information Administration
Natural Gas Explained
https://www.eia.gov/energyexplained/index. cfm?page=natural_gas_lng

First Nations LNG Alliance
https://www.fnlngalliance.com/

BC LNG Alliance
http://bclnga.ca/home/lng-in-bc/

Canadian Association of Petroleum Producers, Natural Gas https://www.capp.ca/canadian-oil-and-natural-gas/natural-gas

CLIMATE CHANGE

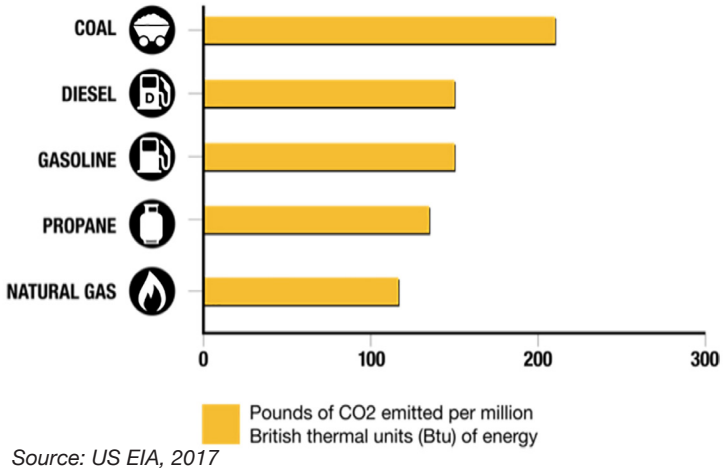
Source:Kevin Hanna

Salish Sea near Vancouver

Climate change is the most significant challenge facing humanity. The scientific community has reached a consensus that climate change is increasingly caused by human activities. Carbon dioxide (CO2) emissions from the burning of fossil fuels are the main contributors to human-produced **greenhouse gasses (GHG)** that contribute to climate change.

The amount of CO2 that is emitted to the atmosphere is different for different fuels. Natural gas has a low CO2-to-energy content. This means that to produce a given amount of energy natural gas produces less CO2 than other fossil fuels; including gasoline, diesel and coal. The low levels of impurities, such as water and sulphur, also contribute to natural gas being a relatively clean and efficiently burning fuel compared to other fossil fuels.

LNG and other fossil fuels



Source: US EIA, 2017

EMISSIONS

Emissions from natural gas production:

Venting

This is the release of CO2 and methane directly to the atmosphere from activities like well completion, or maintenance of wells pipelines or tanks.

Fugitive gas

These are unintentional leaks.

Flaring

This is the burning off of gas that is unprofitable, or gases that would present a safety problem. BC has limited the routine and economic flaring of gas.

Burning natural gas to produce power for industry activities

This is done for gas processing, such as generating power for cooling to produce LNG.

Source:Kitimat LNG

A shoreline in Kitimaat Village, BC

GHG emissions from the production of natural gas

While it is relatively easy to estimate greenhouse gases (GHG) emissions from burning natural gas to heat homes or generate electricity, there is uncertainty and debate about the amount of other emissions produced during the extraction, processing and transportation of natural gas.

Uncertainty about the extent of emissions from different sources is due largely to challenges with measuring the amount of fugitive gas and venting, and uncertainty about how to estimate the impacts of methane on global warming. The short and longer-term impacts of methane on global warming are estimated to be from 21 to 86 times greater than CO2.

Some estimates put GHG emissions from the production process as being almost as much as emissions from the actual end-use of natural gas. Combining production emissions with end-use emissions then almost doubles the lifecycle GHG emissions for natural gas. However, a 2015 analysis by the US Department of Energy of GHG emissions from the natural gas lifecycle puts natural gas emissions at roughly half of those from using coal and oil (see Skone 2015).

Despite the advantages of natural gas, there is disagreement about how effective it is to use more natural gas to help combat climate change. Given the need to reduce fossil fuel use to maintain global temperatures within acceptable limits, the positive contribution of natural gas is when it is used in place of more GHG-intensive fuels.

What are GHGs?

Gases that trap heat in the atmosphere are called greenhouse gases (GHGs). The most significant ones are carbon dioxide (CO2), methane, and nitrous oxide. Some gases are more effective than others at trapping heat. GHGs occur naturally and help keep the earth warm, but when human activities add more GHs than occur naturally, then warming can exceed natural limits. This can contribute to climate change.

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Schematic geology of natural gas resource adapted from United States Geological Survey fact sheet 0113-01

Notes

Calculations are based on the table of **Heat Values of Various Fuels (page 2),** available from the World Nuclear Association website, Information Library, Facts and Figures. Available at http://www.world-nuclear.org/information-library/facts-and-figures/heat-values-of-various-fuels.aspx. In practice the numbers would be less because we lose energy in each stage of conversion to electricity. Uranium is based on enriched U in a light water reactor.

Cover photo source: LNG Canada.

Author

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The Information Series is produced by the First Nations LNG Alliance in collaboration with the Centre for Environmental Assessment Research at UBC. The series provides information for individuals and communities interested in learning about the nature, structure, operation and impacts of the LNG industry and natural gas resource development in British Columbia. Where possible the information sheets are developed using sources available online. This is so readers can more easily access the sources used by the author. Information sheets may be updated periodically. Please check the date of issue for the most current version.

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