National Collaborating Centre for Environmental Health

Centre de collaboration nationale en santé environnementale

Overview of Shale Gas and Hydraulic Fracturing in Canada

Background

Given declining supplies of conventional natural gas and the development of techniques to release gas from previously inaccessible geologic formations, shale gas will play an increasingly important role in Canadian energy production.[1] Shale gas extraction, similar to other oil and gas production activities, has the potential to impact public health through physical (accidents, malfunctions), environmental (air quality, greenhouse gas emissions), and socioeconomic factors, but can also have additional adverse effects on water quality and promote seismic activity.

Natural gas in Canada

Natural gas is a fossil fuel made up of a mixture of hydrocarbons including methane, ethane, propane, pentane, and butane and can include other impurities such as sulphur, CO_2 and nitrogen. Natural gas is considered a better form of energy source than other fossil fuels because it burns more cleanly, thereby reducing emissions.[2] In 2010, Canada was the third largest producer of natural gas in the world and exported $15.6 billion worth of natural gas. From this pool of natural gas reserves, two thirds were exported to the United States and the remainder to Canadian consumers.[3]

What is the difference between conventional and unconventional natural gas?

Natural gas is found in rock formations (known as reservoirs) beneath the earth's surface and can be extracted by conventional and unconventional processes. The natural gas produced from both methods is the same; however, conventional and unconventional processes draw from different geological formations and employ different extraction techniques. Typically, conventional sources are less abundant but easier to extract, whereas unconventional sources are harder to extract but more abundant.

Conventional natural gas is trapped in porous and permeable geological formations such as sandstone, siltstone, and carbonates. Natural gas was not created in the rock formations but has migrated and become stored there. Conventional natural gas extraction does not require specialized technology and can be accessed from a single vertical well. It is relatively easy and cheap to produce as the natural gas flows to the surface unaided by pumps or compressors. In Canada, conventional natural gas has been extracted since the early 1900s.

Unconventional natural gas is contained in geological formations with low permeability, making it challenging to extract. In non-conventional deposits, natural gas is situated in layers, which reflect the strata in which it was created. Its extraction requires complex stimulation treatments or recovery processes, such as horizontal or s-shaped drilling, and hydraulic fracturing (also known

as fracking). Unconventional reservoirs include tight gas, shale gas, and coalbed methane.

- *Coalbed methane* is found in coal seams. The coal acts as a storage vessel, in which most of the coal seam gas is adsorbed.
- *Tight gas* is found mostly in sandstone and in low-permeability silt and sand and limestone.
- *Shale gas* is found in sedimentary rock composed of many tiny layers (laminated rock). Because shale rock is less porous and permeable than tight gas deposits, the production of shale gas is much more complicated, involving more procedures to create the channels for gas to flow through and higher volumes of fluids. Gas extraction and reclamation (capping the well and deconstructing the well pad) can take decades.

Based on 2012 statistics, 15% of total dry natural gas production came from shale gas.[4] Projections done by the Canadian National Energy Board in their "Energy Supply and Demand Projections to 2035" indicate that natural gas generated from unconventional processes, particularly shale gas and tight gas will far outproduce conventional gas extraction over the next few years.[5]

What is hydraulic fracturing (also known as fracking)?

The purpose of hydraulic fracturing is to create fractures in relatively impermeable rock that allow gas to flow back up to a well head.[6]

- Drilling extends the wellbore (hole) vertically downwards and horizontally for 1.0 to 3.0 km within the rock layer containing the gas.
- Hydraulic fracturing forces large volumes of fracturing fluid mixture (described below) under high pressure down a drilled well into the rock.
- The high-pressure stimulation creates additional permeability by forming an array of cracks (fractures) in the rock, which allows the gas to flow more readily back to the wellbore.
- Multi-stage hydraulic fracturing creates small fractures that extend vertically between 100 and 200 meters.
- About one quarter to one-half of the fluid mixture returns up the well to the surface (flowback), along with produced water found in shale, which contains high levels of total dissolved solids and naturally occurring radioactive materials (NORM).[6]

Figure 1 illustrates the basic fracking process for extraction of unconventional gas using horizontal drilling, in comparison to conventional gas extraction, which uses only vertical drilling.

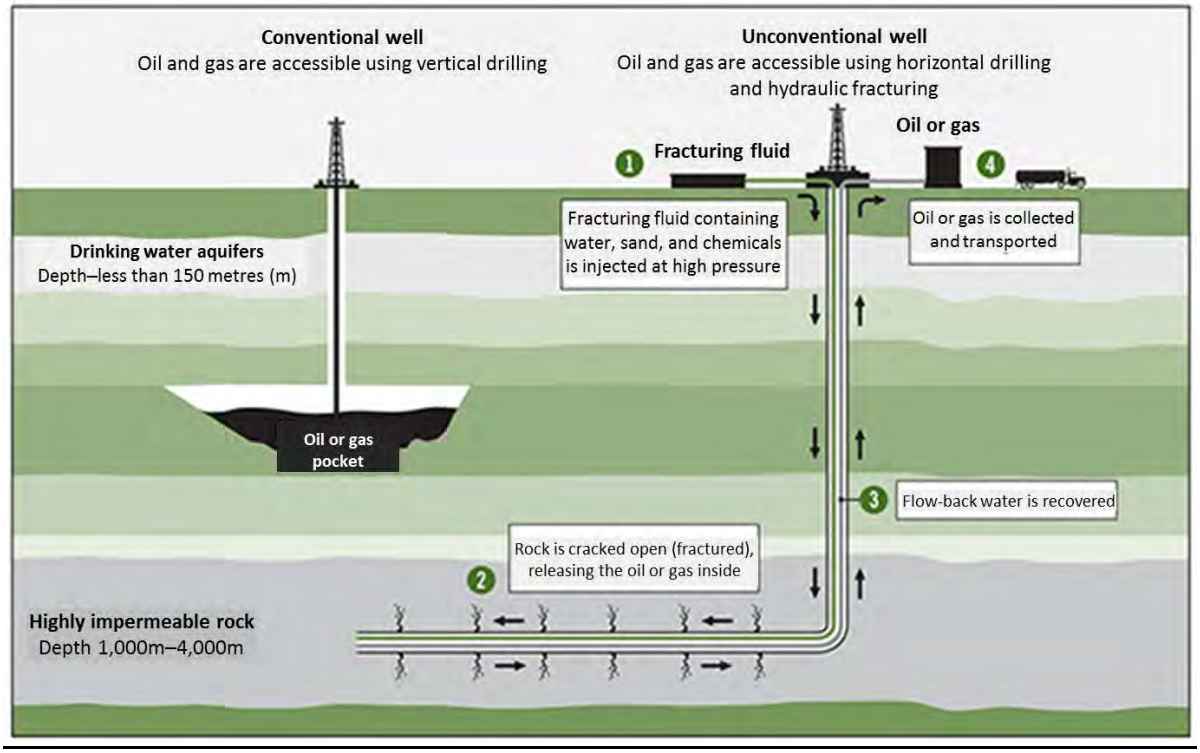

Figure 1: Comparison of Extraction Methods for Conventional and Unconventional Natural Gas (with hydraulic fracturing)[7]

What does the fracturing fluid contain?

"Slick water" is generally used as the base fluid (water combined with a viscosity-reducing agent allowing fluids to travel further into rock fractures with less pressure losses) to which "proppants" (e.g., crystalline silica, ceramic beads) are added to hold the newly created fractures open. The further addition of a variety of chemicals serves to limit the growth of bacteria in order to prevent corrosion of the well casing and to ensure that the fracturing process is efficient and effective. According to the US EPA more than 1000 chemicals have been used in fracking fluid including corrosion and scale inhibitors, friction reducers, gellants, biocides, and acids.[8] Chemicals used in mixtures for hydraulic fracturing in Canada include hydrochloric acid, ammonium chloride, glutaraldehyde, xylene, benzene, naphthalene, and many others, although only some are used at any one time. Current disclosure regulations are complicated by proprietary considerations, making it difficult to determine the proportion and type of compounds present in the fluid.[9] However, BC and Alberta have recently enacted provisions for public access to well-specific summary hydraulic fracturing information on the fracfocus website (www.fracfocus.ca).

What is shale gas composed of?

Shale gas is extracted from tight reserves stored 1–3 km below the earth's surface. It is a form of natural gas primarily composed of methane (90%) and contains small amounts of other gases such as ethane, butane, pentane, nitrogen, helium, and carbon dioxide.[6] If shale gas contains some natural gas liquids such as ethane and butane, it is known as a wet gas, whereas if it contains little or no natural gas liquids it is known as dry gas.[6] The sulphur content of natural gas determines whether it is classified as "sweet" or "sour" gas. Gas containing as little as a few parts per million hydrogen sulphide (H_2S) is considered sour gas.

Where are shale gas deposits located in Canada?

The production of shale gas in Canada primarily occurs in British Columbia and Alberta. Productive drilled wells are located in the shale basins or plays (defined geographic area containing sedimentary rock) including those of the Liard and Horn River Basins and the Montney Play, mostly found in northeast BC or in northwest Alberta. The less-extensive shale plays found in parts of Ontario, Quebec, New Brunswick, and Nova Scotia are underdeveloped or marginal. Currently, Quebec, Nova Scotia, and Newfoundland have enacted moratoriums on shale gas exploration involving hydraulic fracturing.[6] Figure 2 shows the locations of major shale gas basins in Canada.

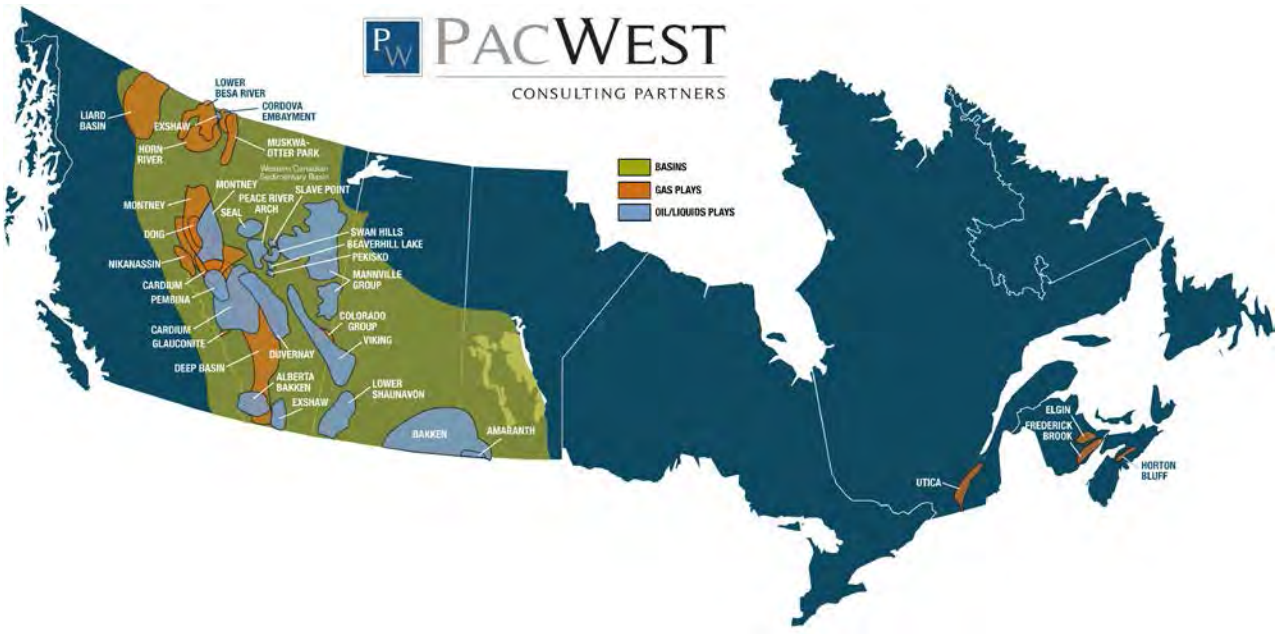

Figure 2: Major shale gas basins and plays in Canada[10]

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An accompanying document will provide an overview of environmental public health issues associated with hydraulic fracturing for shale gas that relate to air pollution, groundwater contamination, seismic activities, and other concerns, primarily based on a recent comprehensive Canadian review commissioned by Environment Canada.[6]

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