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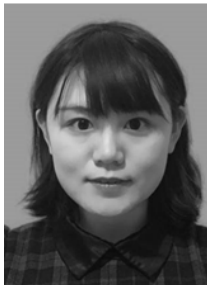
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Hydraulic Fracturing in Canada: Risk versus Reward

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Abstract

Hydraulic fracturing is a reservoir stimulation technique that increases the reservoir permeability and its connectivity with the producing wellbore by injecting a pressurized fracturing fluid mostly comprising water and sand. It has been implemented in the oil and gas industry since the 1940s and has undergone a constant evolution ever since, with a sharp increase during the last decade in areas of rich low-permeability hydrocarbon resources such as the central and eastern United States, and western Canada. This sharp increase has provided tangible economic benefits and a higher energy independence to both countries. However, multiple environmental and social concerns have also arisen in the process. In this paper, we review the risks and rewards of the implementation of hydraulic fracturing stimulations in Canadian provinces. Better understanding of the risks and rewards helps to effectively formulate appropriate policy and regulation.

1. Introduction

Hydraulic fracturing is one of the primary engineering techniques implemented to improve the productivity of a well by overcoming the wellbore damage caused by drilling and subsequent production, and to extend the conductivity channels (or fractures) deeper into the reservoir (Smith & Shlyapobersky, 2000). Its first commercial implementations in North American conventional reservoirs date back to 1947 in the Hugoton gas field in western Kansas (Howard & Fast, 1970), 1949 in Velma, Oklahoma (CSUR, 2010a), and 1953 in the Pembina Cardium field in Alberta (Ewart, 2014), where a gasoline-based napalm gel was used as fracturing fluid. This technology has been continuously evolving to reach the modern multi-stage hydraulic fracturing stimulations in multi-lateral horizontal wells based mostly on a water-sand mixture as a fracturing fluid, currently implemented in low-permeability shale gas and tight-oil reservoirs.

Canada has vast resources of low-permeability hydrocarbon reservoirs with an estimated Gas-In-Place (GIP) from shale gas resources of more than 1100 trillion cubic feet (Tcf), mostly concentrated in the Western Canada Sedimentary Basin (WCSB) and with the remaining resources distributed in north-western and eastern provinces (Figure 1). Hydraulic fracturing has been massively practiced in some WCSB formations, sustaining the country's natural gas production of approximately 15 billion cubic feet per day (Bcf/d) and exporting more than 50 percent of its production to Midwest and Western U.S. (NRCAN, 2018). This practice, together with all other industrial activities related to oil and gas developments, is tightly regulated at both federal and provincial levels (Green & Jackson, 2015).

However, the public concern regarding the environmental and public health impacts of large-scale hydraulic fracturing practices has also increased across the country to the point of forcing the establishment of moratoria by the provincial governments of Quebec, Nova Scotia, New Brunswick, and Newfoundland and Labrador (Winter, Dobson, & Lorefice, 2016), forcing the increase of imported natural gas from northeast U.S. to more than two Bcf/d in 2016 to cover the demand in these provinces (NRCAN, 2018). This has not been the case with local and First Nation communities located in the WCSB (i.e. eastern British Columbia, Alberta, and southern Saskatchewan and Manitoba), where public concerns have also arisen among them but have also been more receptive as they've cohabitated with the traditional oil and gas industry for decades. The major gaps between currently implemented hydraulic fracturing technologies, applicable federal and provincial regulations, and the negative public perception among some communities, represents a major challenge for the oil and gas industry, the government, and for academia. This requires a careful, updated, and unbiased review of the economic and environmental impacts of current hydraulic fracturing practices and its future implications.

2. Economic impacts

A recent report by the Natural Resource Canada estimates that a total of 7.8 percent of Canada's gross domestic product (GDP) was sourced from the oil and gas industry. This represents about 190,000 direct jobs and over roughly 190,000 construction jobs. The report estimates that the oil and gas industry represents a total of \$83 billion or 31 percent of total Canadian expenditures. Also, the industry accounted for \$137 billion in domestic exports (NRCAN, 2016). A significant portion of contributions to the annual budget of the federal and provincial or territorial and municipal governments are from the industry's taxes, royalties and land sales. Government revenues from the oil and gas industry averaged \$20.3 billion over the last five years (NRCAN, 2016). The proceeds are then used for meeting government priorities as well as to support programs, public services and infrastructure. The development of shale gas and tight resources potentially adds more jobs to Canadian labor forces. Also, shale gas production is expected to make a significant contribution to the Canadian economy in terms of lease and royalty payments as well as tax payments to municipal, provincial, territorial, and federal governments. From a macroeconomic point of view, the long term growth in shale gas production will make a stronger trade balance, reducing Canada's dependence on imported energy as well as increasing investment.

According to the 2012 U.S. Energy Information Administration assessment (Table 1), shale gas resources in Canada contributed to eight percent of world wide recoverable shale gas resources (NRCAN, 2016). British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, and Nova Scotia are provinces endowed with shale gas resources. In Canada, with recent advanced technological advancements in drilling and completions, including hydraulic fracturing, produced shale gas is fast commercialized. Hydraulic fracturing technology has been used in approximately half of Canada's natural gas and light oil production (Winter et al., 2016) and has positively transformed the Canadian energy market in last decade. Hydraulic fracturing has provided significant economic opportunities to improve the shale and tight resource production. However, at the same time the question of how to reduce the environmental footprint as well whether laws and regulations associated with the hydraulic fracturing activities are appropriate is the topic of significant discussion and debate in Canada.

3. Environmental Impacts

The chief environmental concerns associated with hydraulic fracturing are contamination of groundwater, deterioration of air quality, induced seismicity and land disturbance. "Leaky" wells can pose a threat to groundwater and air quality through the upward migration of fugitive gas (i.e. methane) along poorly cemented well casing to the Fresh Groundwater Zone (FGWZ) and/or atmosphere (e.g. Canadian Water Network 2015; Council of Canadian Academies 2014; R. B. Jackson et al. 2014). The construction of required well pads and access roads, and their associated industrial activities, including truckload traffic and noise from heavy machinery, can have a significant impact on the local communities and wildlife. Furthermore, recent seismic activity in western Canada has been closely linked with hydraulic fracturing stimulation. These environmental impacts are, in most cases, closely monitored and regulated by federal and/or provincial regulators. However, they still represent constant challenges for the industry, the regulators, and the local communities alike.

3.1 Groundwater

Arguably the greatest environmental concern associated with hydraulic fracturing is the potential negative impact on non-saline aquifers in the FGWZ. According to the Council of Canadian Academies (2014), the most likely source of groundwater contamination is the migration of fugitive gas from the target or intermediate zone along the annuli in wells with poorly cemented or deteriorating surface casing (“leaky” wells) or through natural and pre-existing fracture networks into the FGWZ. Dusseault and Jackson (2014) suggest almost five percent of the 316,439 total wells in Alberta in 2014 were leaky. Another study by Brufatto et al. (2003) reported a 50 percent probability of sustained casing pressure (SCP) resulting from fugitive gas migration in a well after 15 years (Figure 2). Although methane is neither toxic nor poisonous, it can pose an explosion risk if a large enough volume of gas accumulates in an unvented, enclosed area (AEP, 2006). Additionally, as a greenhouse gas (GHG), methane has the ability to contribute to global warming if released to atmosphere (discussed in follow section).

The Alberta Energy Regulator (AER) has developed several directives to prevent and manage fugitive gas migration in oil and gas wells. AER Directive 008: Surface Casing Depth Requirements (updated January 31, 2018) requires surface casing be cemented to the greatest of the following depths, to protect non-saline aquifers (AER, 2018):

- i) $TVD \times 0.1$
- ii) *deepest water well depth (within 200 m) + 25m*
- iii)
$$\frac{\text{max pressure gradient} \times TVD(m) \times (0.5 - 0.0000625 \times TVD(m))}{22 \text{ kPa} / m}$$

where TVD represents the total vertical depth of the wellbore.

Additionally, AER’s Directive 009: Casing Cementing Minimum Requirements (July 1, 1990) requires the entire length of the surface casing be cemented without the use of additives that compromise the compressive strength of the cement (AER, 1990). The British Columbia regulation equivalent for surface casing cementing and depth is the Oil and Gas Activities Act: Drilling and Production Regulation, Part 4 - Well Operations (BCOGC, 2017). Theoretically, if all shale gas wells were cased and cemented following the applicable and outlined regulations and the hydraulic stimulation was being conducted at great depths (e.g. > 2000 m below ground surface), there should be very little to nil concern for FGWZ contamination. Unfortunately, the severe lack of baseline monitoring makes it challenging to discern if groundwater has been impacted since the implementation of hydraulic fracturing in association with the shale gas boom.

3.2 Air Quality

Improperly cemented well casings provide conduits for fugitive gas (i.e. methane) to migrate along the well annulus, from high to low pressure, and vent to atmosphere. This is a concern as methane is a GHG with a global warming potential (GWP) of 84x that of an equivalent mass of carbon dioxide over 20 years (IPCC, 2013). Disregarding methane emissions from leaky wells, GHG emissions released throughout the

natural gas life cycle (or, “well-to-burner emissions” (CCA, 2014)) are significantly less than those emitted throughout the life cycle of oil or coal (Figure 3). Until recently, Canadian provinces such as Alberta, Saskatchewan, and Nova Scotia produced over half of their electricity from coal combustion whereas Ontario has already completely phased out coal-powered electricity (IAE, 2015). Switching from coal- to natural gas-powered electricity can reduce carbon dioxide emissions by ~50 percent and also decrease the amount of NO_x and SO_x emitted to atmosphere (CCA, 2014). In this respect, use of natural gas produced through shale gas development could provide an environmental benefit. Coal-reliant provinces should take the opportunity to implement natural gas-powered electricity to lower overall Canadian emissions.

Nonetheless, the benefit of lowering GHG emissions realized through the transition to lower-carbon natural gas will be negated if methane masses any greater than three percent of total production are emitted to the atmosphere by venting, flaring, or leaky wells (CCA, 2014). Considering the majority of methane emissions occur during the well completion stage (before pipeline tie-in), over 90 percent of shale gas operators now use reduced emissions completions (RECs) or “green completions”, which capture over 90 percent of initial gas flow, preventing their release to atmosphere (CCA, 2014; EPA, 2009). Industry also reports the usage of bi-fuel (i.e. natural gas and diesel) to power sand and water pumper trucks during fracture stimulation and proppant phase of hydraulic fracturing, decreasing emissions by minimizing diesel combustion (M. Gibson, personal communication, March 1, 2018). Although venting or flaring of natural gas is performed as an often-necessary safety precaution to bleed off higher-than-appropriate facility pressures, it also contributes GHGs to the atmosphere. The AER has implemented Directive 060: Upstream Petroleum Industry Flaring, Incinerating, and Venting (AER, 2016) towards reducing venting and flaring emissions. The BCOGC presents similar regulations in their Flaring and Venting Reduction Guideline (BCOGC, 2016). The AER reports an overall trend of decreasing volumes of solution gas flared or vented from crude oil or crude bitumen facilities between 1996 - 2016 but does not discuss changes in volumes vented specifically in gas batteries or gas gathering lines. However, in terms of volumes of solution gas flared, a 43.2 percent decrease is reported for gas batteries, a 19.3 percent decrease for gas plants, and 13.6 percent decrease for gas gathering systems between 2002 and 2016 (Figure 4). The decrease in flared and vented volumes has been linked to increased compliance of outlined regulations by energy companies (AER, 2016).

Similar to groundwater monitoring, there is a severe lack of baseline air quality data in regions of shale gas recovery, limiting the ability to evaluate the impact hydraulic fracturing has had on air quality. Additional challenges in determining potential impact to air quality include attempting to predict methane leakage rates or CO₂ emissions generated during the drilling, completion, production, and gas processing stage of resource exploitation and development (CCA, 2014).

3.3 Induced Seismicity

The increase in the development of unconventional oil and gas reservoirs in the past years has triggered an anomalously high seismic activity in several sedimentary basins around the world. This increased seismicity rate is mostly associated with fluid-injection practices implemented routinely in unconventional reservoirs, as wastewater injection and hydraulic fracturing. Figure 5a shows the

cumulative seismicity in two sedimentary basins in North America between 1985 and 2015, both of them with a similar increased pattern since 2009. The sharp seismicity increase in the central and eastern U.S. mid and eastern basins is mostly linked with massive wastewater injection (Keranen, et al., 2014), whereas the similar increase pattern in the Western Canada Sedimentary Basin (WCSB) is inferred to be triggered by hydraulic fracturing operations (Bao & Eaton, 2016). Most of the seismic events reported in this period for WCSB are closely located to hydraulic fracturing wells completed in western Alberta and northeast British Columbia (Figure 5b).

In response to this increased seismicity, in 2015 the AER released the Subsurface Order No. 2 that requires the implementation of a Traffic-Light Protocol (TLP) based on the local magnitude (M_L) of seismic events detected during the monitored operations (Alberta Energy Regulator, 2015). According to this TLP, the hydraulic fracturing operations can continue as planned when the M_L of the detected seismic events are below 2.0 (green light), must be modified and reported to the regulator when a seismic event of M_L between 2.0 and 4.0 is detected (amber light), and must be immediately ceased when a seismic event of $M_L \geq 4.0$ is detected within five kilometres of a hydraulic fracturing well (red light). The British Columbia Oil and Gas Commission (BCOGC) implemented a similar TLP where all injection operations must be suspended if a $M_L > 4.0$ is detected within three kilometres from the well. $M_L \geq 4.0$ has been chosen as a red-light threshold by both Alberta and British Columbia as a seismic event with a magnitude below 4.0 corresponds to a minor earthquake, whereas a seismic event with a magnitude above 4.0 can cause minor property damage. To date, six red-light seismic events have been reported, three of them located in the northern Montney play in British Columbia, and three in Fox Creek, Alberta (Figure 5b and Table 2). The increase of seismicity in these two areas has been attributed to hydraulic fracturing operations (see Farahbod et al. (2015) and Shultz et al. (2017) respectively).

3.4 Land Disturbance

The sharp increase of well drilling and hydraulic-fracturing stimulation (as shown in Figure 5b) entails a significant footprint on natural landscapes. Well drilling for development of a hydrocarbon reservoir (either conventional or unconventional) requires the construction of multiple well pads, access roads, pipelines, and processing plants. It also increases the noise levels, dust release, and damage to existing roads from traffic congestion and compressor stations, affecting the local wildlife and communities. This footprint, however, can be significantly reduced by implementing key environmental practices. Multiple deviated wells, and more commonly horizontal wells with typical lateral lengths greater than two kilometres for tight reservoirs, are commonly drilled from a single well pad. This reduces the required number of well pads and access roads to reach an equivalent drainage area and production volume when compared with conventional vertical wells (Spellman, 2013). Noise levels from well pads, access roads, and compressor stations can be minimized by installing noise absorbing panels and planting trees around these facilities. Finally, once the drilled wells surpass their economic production limit, the operator must cement the wells and return the altered area to its original condition (i.e. removing all the heavy machinery in place and replanting local vegetation to cover the built well pads and access roads). This land reclamation process is regulated by federal agencies (such as the Indian Oil and Gas Canada (IOGC) for affected areas located within First Nation protected regions), and in some provinces (as Alberta or

British Columbia) is also closely regulated by provincial regulators (Council of Canadian Academies, 2014).

3.5 Impact on First Nations Communities

Hydraulic fracturing takes place most often in remote, rural settings; regions of land frequently shared with the First Nations and other small communities. Because First Nation people have strong spiritual ties to their environment, their major concerns associated with hydraulic fracturing include impact to their land, water, and wildlife (Gale & Lowe, 2014). To First Nations people, “water is life” and as such, there is great concern around the potential impact of casing cement failure over the long-term (C. Brooks, personal communication, March 5, 2018), which could lead to upward migration of fugitive gas into the FGWZ. To ensure all parties have a voice in the conversation, energy companies have a duty to consult with impacted First Nations about any oil and gas exploration or development plans. The consultation process requires the energy company inform the First Nation of their development plans and respond to concerns the First Nation may have with regard to land or cultural implications (e.g. when planned development location infringes on their hunting land) (J. Armstrong & M. Gibson, personal communication, March 1, 2018).

Ultimately, in Canada it is the responsibility of the federal government to protect First Nations and treaty rights. A division of the Government of Canada, the Indian Oil and Gas Canada (IOGC) serves to manage and regulate oil and gas resources on First Nations reserves and negotiate agreements with energy companies according to the *Indian Oil and Gas Act* and *Indian Oil and Gas Regulations*. Revenues generated (e.g. rent, bonuses, royalties) through oil and gas exploitation on First Nations land are placed into regional trust funds; these funds can be accessed by First Nations by applying to the Aboriginal Affairs and Northern Development Canada (AANDC) (Government of Canada, 2013). Although First Nations have the opportunity to make a monetary profit from shale gas development, to most First Nations people, it is not about the money, it is about preserving their land and culture and as such, the environmental risk of hydraulic fracturing outweighs the benefit (C. Brooks, personal communication, March 5, 2018).

4. Background and Current Status

A continuation of growth in the unconventional gas industry in Canada, along with high profile regulatory decisions related to hydraulic fracturing in other countries, has resulted in concern about whether current regulations can provide a satisfactory level of protection from the risks associated with hydraulic fracturing. In the following section, we will conduct an assessment of the existing regulatory framework for hydraulic fracturing activities. The assessment will focus on the current Canadian legal framework, including legislation and regulations, to identify opportunities to improve the currently regulations.

4.1 Existing Regulatory Instruments

At the federal government level, the overall regulatory control of hydraulic fracturing is located in a suite of technical regulations issued under the authorities of the *Oil and Gas Activities Act*, the *Canada*

Petroleum Resources Act, the *Canadian Environmental Protection Act*, and the *Indian Oil and Gas Act*. Provincial jurisdiction governs the shale gas and oil extraction unless it takes place on federal lands or offshore. In some circumstances, the related jurisdiction falls within the federally mandated specific provisions under the *Canada Water Act*, the *Species at Risk Act*, the *Fisheries Act*, the *Migratory Birds Convention Act* or federal regulations pertaining to chemical substances (Winter et al, 2016). Although the acts and regulations include detailed requirements, many of the issues do not exclusively address hydraulic fracturing activities.

Given the diverse natures and activities involved, in Canada the elements of hydraulic fracturing are governed by a number of provincial acts and a suite of oil and gas regulations, including:

Provincial Acts:

- *The Oil and Gas Activities Act*
- *The Petroleum and Natural Gas Act*
- *The Environmental Management Act*
- *The Heritage Conservation Act*
- *The Land Act*
- *The Water Act*

Oil and Gas Regulations:

- *The Oil and Gas Activities Act General Regulation*
- *The Drilling and Production Regulation (DPR)*
- *The Environmental Protection and Management Regulation (EPMR)*
- *The Pipeline Regulation*
- *The Oil and Gas Waste Regulation*
- *The Oil and Gas Road Regulation*
- *The Consultation and Notification Regulation (CNR)*
- *The Emergency Management Regulation*

The acts and regulations work in combination in provide comprehensive regulatory oversight addressing hydraulic fracturing activities in Canada.

4.2 Key Considerations

Hydraulic fracturing activities in Canada are rapidly evolving and an effective regulatory regime is required. According to previous studies, in Canada, policy-makers and regulators are facing immense knowledge gaps on the risks, costs, and benefits of hydraulic fracturing (Winter et al, 2016). In addition, the economic benefits, environmental risks, and other costs are not fully understood; more research is required to fully understand the implications of hydraulic fracturing on a larger scale. In 2014, the Council of Canadian Academies (CCA) conducted an assessment of shale gas in Canada and identified many knowledge gaps that have yet to be filled. As stated in the report, a lack of baseline data, insufficient information on long-term cumulative effects, and a lack of region-specific information are identified as a knowledge gaps related to hydraulic fracturing activities in Canada.

Data collection and analysis capability are the most challenging issues to resolve the knowledge gap, however, currently there are no specific requirements regarding baseline testing, ongoing monitoring, or data submission. The collection of this data is hindered by the significant development and production that has already occurred (Winter et al, 2016). Given that large-scale hydraulic fracturing completions in shale gas reservoirs have been occurring for only a relatively short period of time, there is no formal study on its long-term cumulative effects. According to previous studies, long-term data collection, observation, and research will contribute to resolving the cumulative effect of hydraulic fracturing but the process is not expected to be fulfilled in the short term (Winter et al, 2016).

4.3 Policy Options

An effective regulatory framework for managing hydraulic fracturing activities would include four distinct elements:

(i) Data collection and monitoring. The lack of baseline groundwater and air quality data severely limits the ability to quantify the extent, if any, of environmental impact caused by hydraulic fracturing. We recommend enhancing existing data-collection and analysis capabilities by developing regulations and requirements regarding baseline testing, ongoing monitoring, and data submission. In addition, environmental data should be transparent and available to all stakeholders.

(ii) Effective regulatory authority and oversight. Rules to govern hydraulic fracturing activities must be effective, efficient, and also science - based. We recommend that the provision of related Acts and Regulations be flexible enough to respond to new information, research, and changes in technology through its continuous improvement process.

(iii) Stakeholder engagement. Engagement of the local communities, including the First Nations, impacted by hydraulic fracturing activities. Public engagement is necessary not only to inform local residents of development, but to receive their input on what values need to be protected. The public must be involved in the decision-making process to ensure their concerns are considered throughout project development.

(iv) Government collaboration. Collaboration with provincial and federal regulators and with industry stakeholders to promote broader continuous improvement efforts. Strengthen the federal-provincial relationship, and promote cooperation and communication with all orders of government, in all regions.

5. Conclusions

An activity is deemed efficient if the value society places on the activity exceeds the value of all economic resources allocated to performing the activity. Given that, the hydraulic fracturing activity in Canada has been economically efficient since it has provided positive effects on incomes, employment, and tax revenues. The abundance of natural gas produced from hydraulic fracturing stimulations has also shown some reductions on overall air pollution emissions. By switching the electricity generation from

traditional coal power plants to natural gas power plants, carbon dioxide emissions can be reduced by ~50 percent and the amount of NO_x and SO_x emitted to the atmosphere can also be significantly reduced. The environmental risks related with hydraulic fracturing processes, such as methane gas emissions, groundwater contamination, land disturbance, and induced seismicity, are all well identified. However, multiple knowledge gaps have also been reported due to the lack of availability of environmental baseline data - either because its acquisition was not mandatory, or because it is not accessible for the general public. These gaps must be managed and mitigated with appropriate regulations that require continuous monitoring, robust and accessible databases of the recorded environmental data, and ongoing technology developments. Finally, the public perception of hydraulic fracturing can also be managed by maintaining transparent and continuous communication between the government authorities (both federal and provincial), the industry, and local and First Nation communities regarding the development of unconventional reservoirs that require hydraulic fracturing stimulations.

6. Figures and Tables

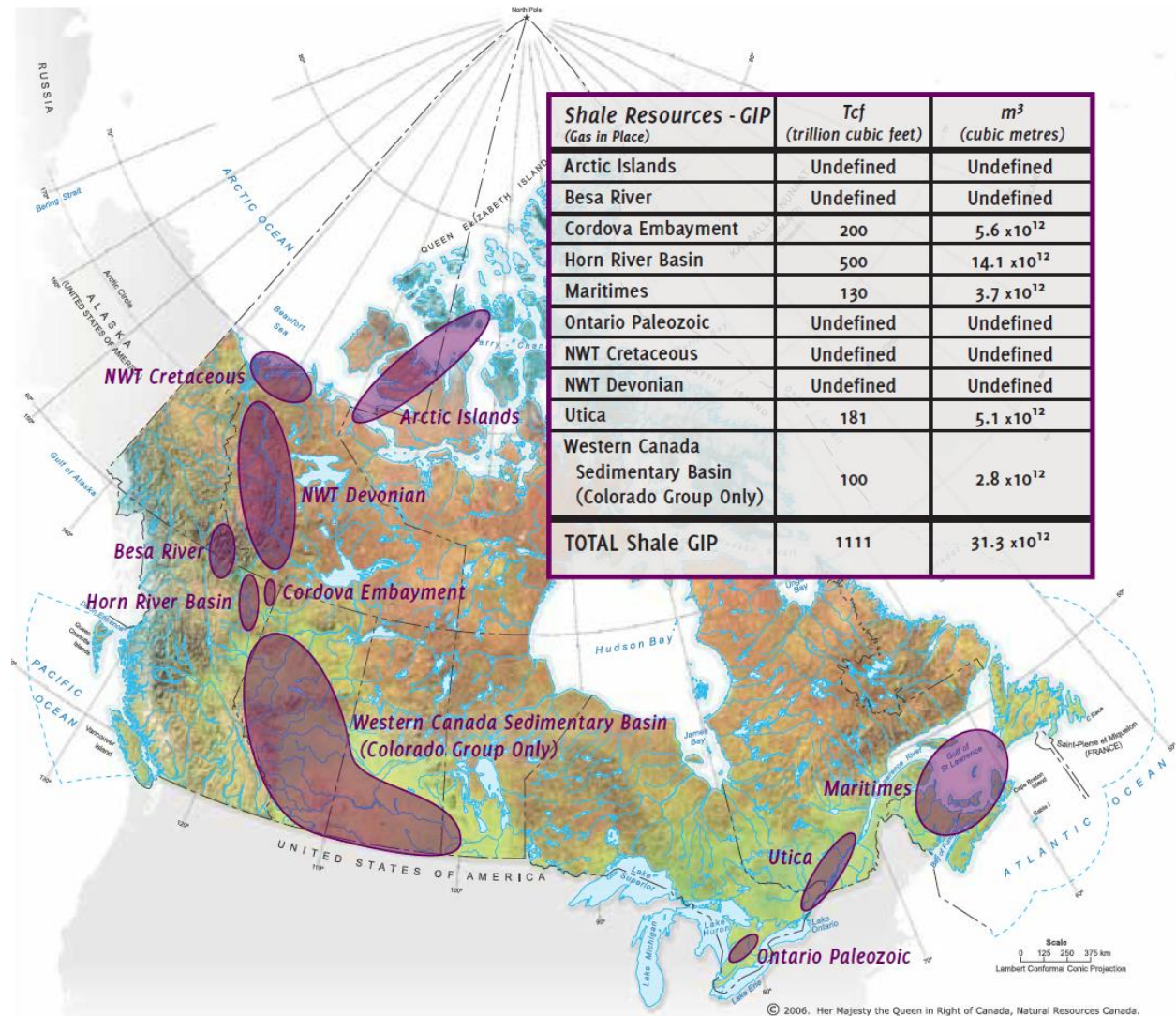


Figure 1. Distribution of major shale gas basins and estimated resources in Canada (CSUR, 2010b).

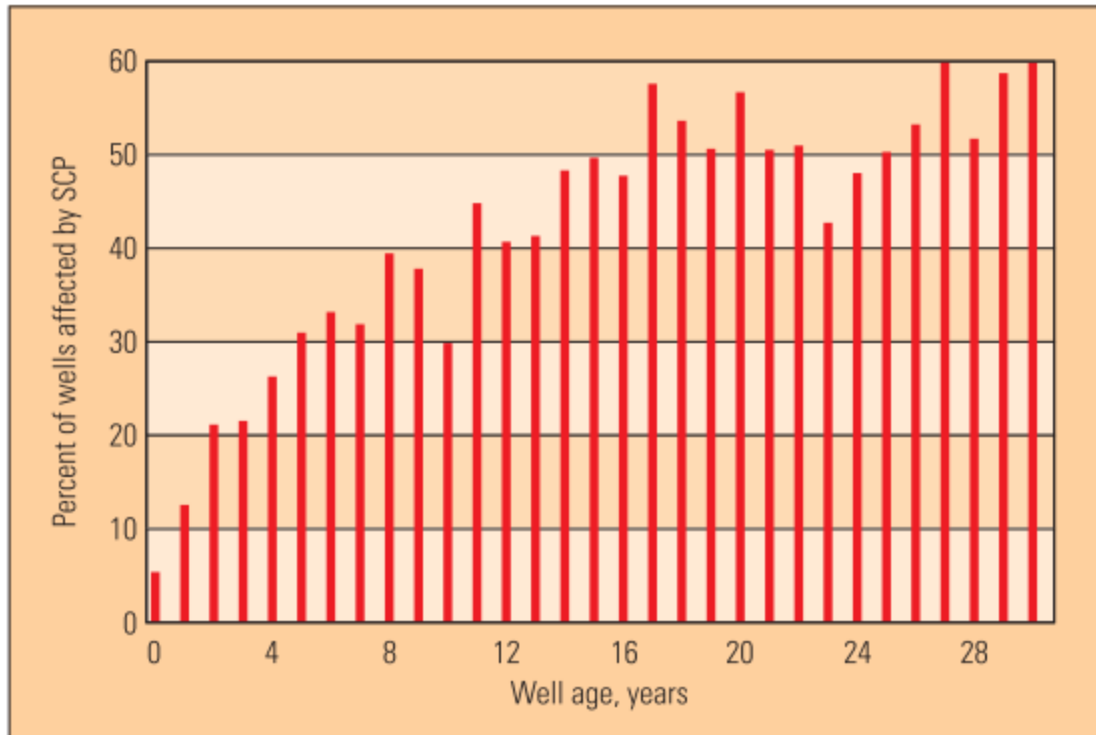


Figure 2. Percentage of wells affected by surface casing pressure (SCP) increases with well age. This data was collected from the 6,692 of 15,500 producing, shut in, or temporarily abandoned wells presenting SCP, located within the outer continental shelf portion of the Gulf of Mexico (Bruffato et al., 2003).

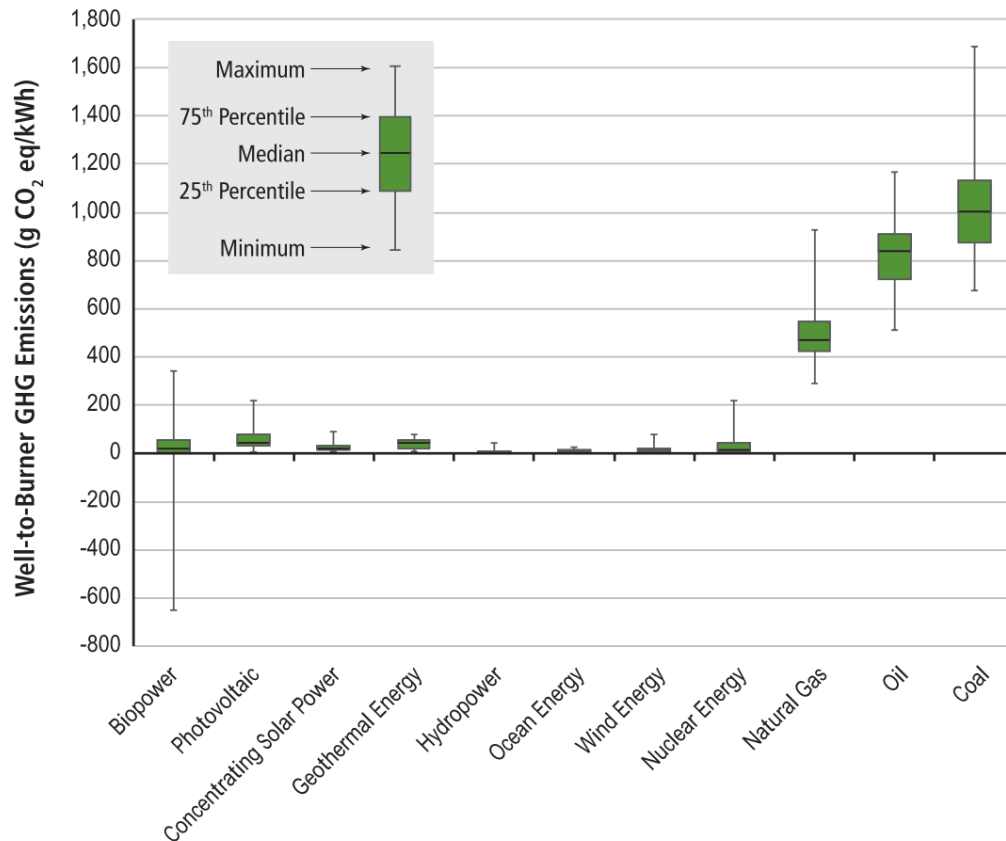


Figure 3. The life cycle (“well-to-burner”) greenhouse gas (GHG) emissions of oil and coal exceed that of natural gas, in terms of equivalent kilowatt hours. Non-fossil fuel energy sources produce significantly fewer GHG emissions than their fossil fuel counterparts (CCA, 2014).

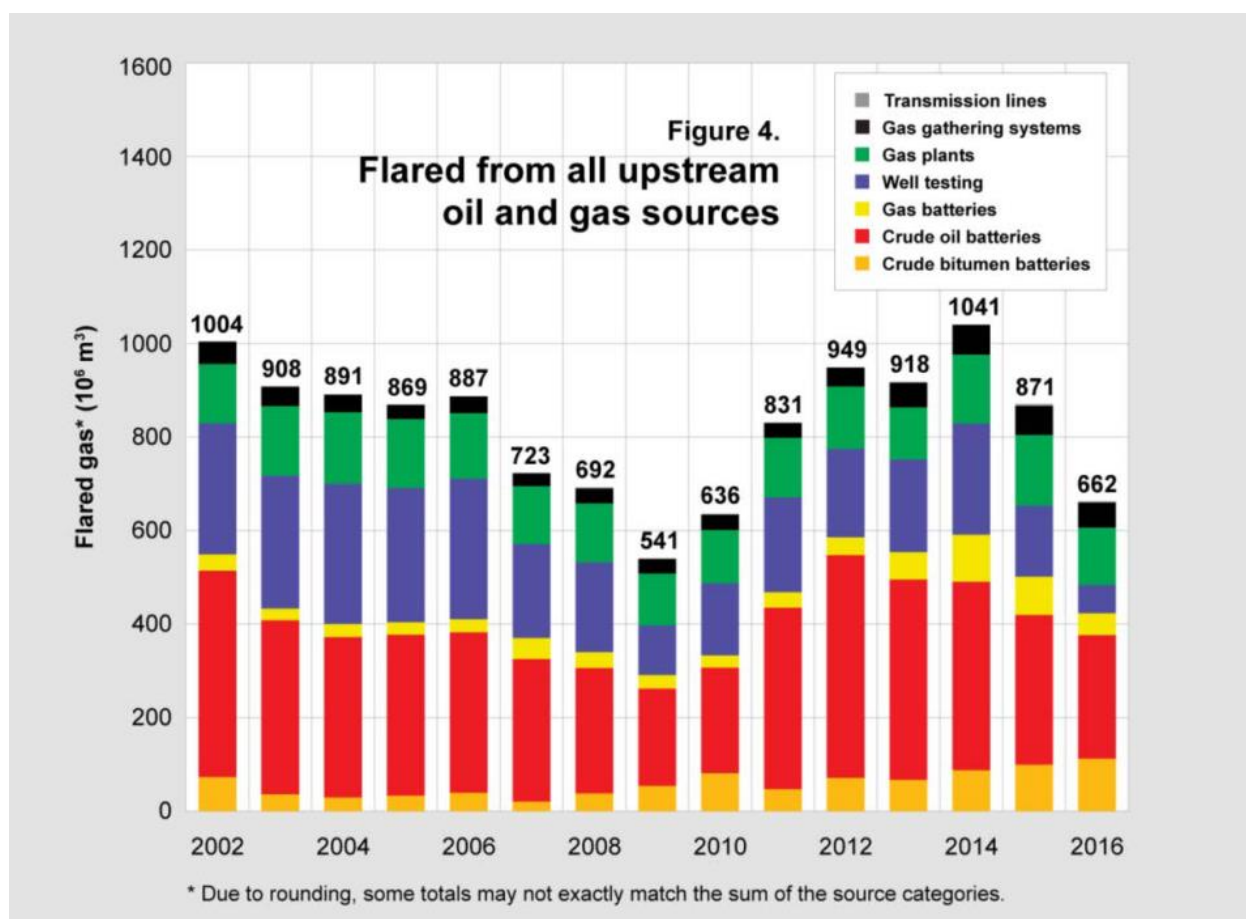


Figure 4. Volume of flared gas derived from all upstream oil and gas sources between 2002 and 2016 (AER, 2016).

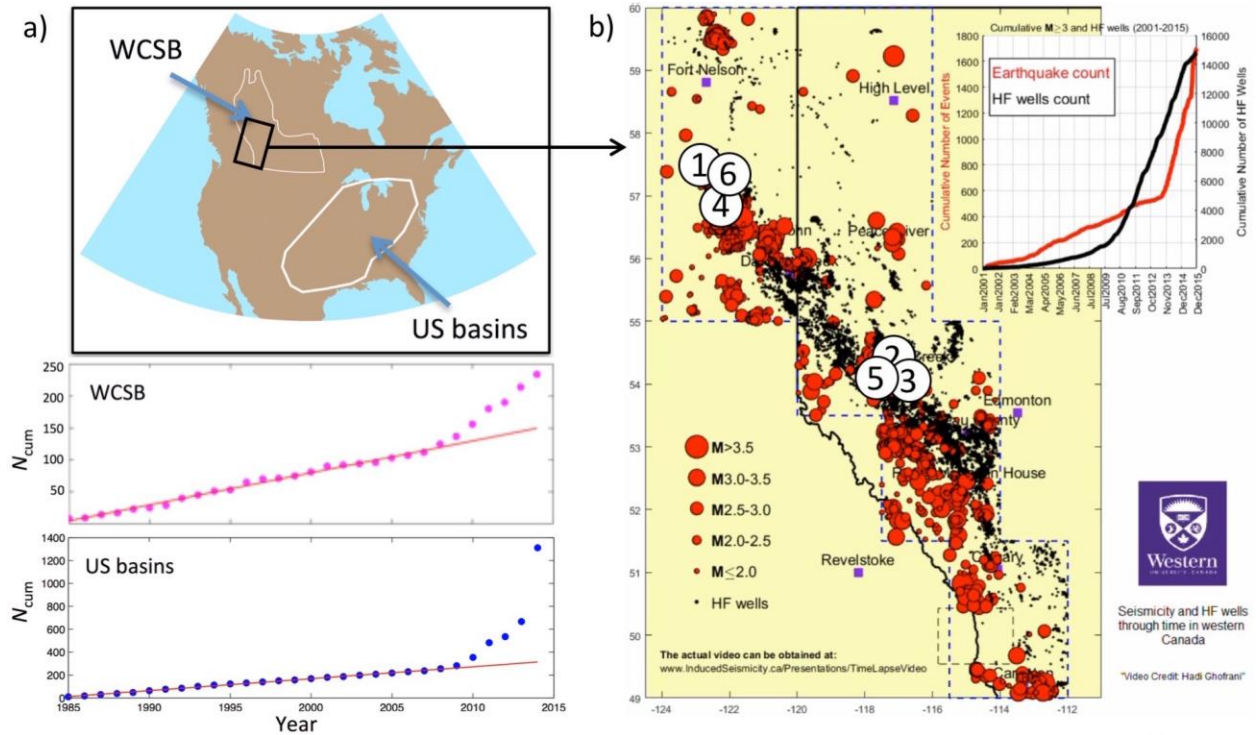


Figure 5. a) Reported seismicity in Western Canada Sedimentary Basin (WCSB) and in mid and eastern US basins between 1985 and 2015, with a similar increased pattern since 2009 (Eaton, 2016). b) Hydraulically fractured wells completed in Alberta and north-east British Columbia between 2001 and 2015, with the reported seismicity for the same period and red-light seismic events listed in Table 2. (source: <http://www.inducedseismicity.ca/presentations/>).

Table 1. Shale gas resources in Canada contributed to eight percent of world wide recoverable shale gas resources (modified from NRCAN, 2016).

**World technically recoverable shale resources –
7,299 Tcf (2012)**

1) China	15%
2) Argentina.....	11%
3) Algeria.....	10%
4) United States	9%
5) Canada	8%
6) Mexico.....	7%
7) Australia.....	6%

Table 2. List of seismic events of moment magnitude (M_w) > 4.0 detected in Alberta and British Columbia, Canada (Kao et al., 2018).

Event	Date	Time (UT)	Lat. (°N)	Long. (°W)	M_w	Source Area
1	2014-08-04	17:17:24.6	57.5688	122.9216	4.5	N. Montney, BC
2	2015-01-23	06:49:20.1	54.4263	117.3135	4.4	Fox Creek, AB
3	2015-06-13	23:57:54.0	54.1418	116.7985	4.6	Fox Creek, AB
4	2015-08-17	20:15:01.1	56.957	122.275	4.6	N. Montney, BC
5	2016-01-12	18:27:24.3	54.4136	117.3094	4.4	Fox Creek, AB
6	2016-07-12	21:08:39.4	57.3592	122.0119	3.9	N. Montney, BC

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