Northern Indigenous Peoples & The Prospects for Nuclear Energy

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INDIGENOUS PERSPECTIVES ON NUCLEAR ENERGY PRODUCTION AND SMALL NUCLEAR ALTERNATIVES: A PRELIMINARY INTRODUCTION

INTRODUCTION

Northern and remote Indigenous communities face formidable infrastructure challenges, ranging from problems with water quality and housing to high costs of energy. In the latter instance, the difficulties involved with delivering fuel are further complicated by the need to maintain and operate the electrical systems under often-difficult conditions. Families devote a much higher than average percentage of their total income to domestic energy use. Furthermore, the prohibitive cost, uncertain supply and often unreliable energy systems makes it difficult to capitalize on emerging technologies that could make substantial contributions to improving the quality of life at the community level.

With significant improvements in nuclear technologies, the possibility has emerged that "small nuclear" power plants could address the energy needs of remote communities in a cost effective fashion. If, as proponents suggest, small nuclear is safe, easily maintained, cost effective and capable of reliably producing large supplies of electricity, the new system could allow communities to introduce significant services such as food factories, greatly expanded use of digital technologies, and other energy intensive installations.

Any proposed implementation of small nuclear plants would, of course, require the support of the local population, which is largely Indigenous in northern regions. Most government or power utilities are unable to feasibly institute small nuclear power plants without the full understanding and concurrence of the local communities involved. As a preliminary in the long-term evaluation of the potential adoption of small nuclear in remote communities in Canada, this project assesses northern Indigenous attitudes toward nuclear energy (not including the mining of uranium). It includes outreach to selected Indigenous community leaders to get a preliminary sense of how Indigenous organizations and Indigenous peoples might respond to a formal proposal to develop a small nuclear strategy.

This work, undertaken by the International Centre for Northern Governance and Development and the Fedoruk Centre, both at the University of Saskatchewan, is used as background to a more specific analysis of the attitudes of northern Indigenous and non-Indigenous peoples to alternative energy sources, including small nuclear. The following is a preliminary research report exploring Indigenous attitudes about and relationships with the nuclear energy industry as a whole. The first part consists of a jurisdictional review of select international and domestic Indigenous perspectives on nuclear energy and uranium mining. Government reports, submissions to environmental review processes, news articles, blog posts and scholarly research

were among the primary data sources used. In particular, the sentiments of Indigenous peoples in Finland, Sweden, Norway, Russia, Greenland, Australia, the United States and Canada were reviewed. The second part consists of a much shorter review on energy consumption and energy costs in Canada's Far North to further understand the pressures they face with electricity production. Finally, The third part, which is a summary of discussions with community members, community leaders and energy stakeholders in various communities in Northern Saskatchewan, Northwest Territories and the Yukon.

NUCLEAR POWER AND INDIGENOUS RESPONSES: A GLOBAL OVERVIEW REVIEW

At present, international research on the receptiveness of northern and Indigenous communities to nuclear power in general and small nuclear systems in particular is extremely limited. Indigenous peoples have long been at the entry point (mining uranium) of the nuclear industry and not at the exit point (power consumption) or the storage of nuclear residues. As a consequence, Indigenous commentaries on and engagement with the uranium industry serves as a stand-in for the more specific questions that will be the focus for a longer-term project on the attitudes toward small nuclear industry in northern and Indigenous populations.

The following section describes, on a country by country basis, the situation in selected countries. For each nation, the following overview is provided:

- Nuclear Energy
- Uranium Mining
- Indigenous Perspectives

These brief descriptions document the extensive use of nuclear power, offset by considerable national and regional and Indigenous concerns about nuclear energy. There is insufficient information about global attitudes toward small nuclear energy; the literature on alternate energy systems focuses overwhelmingly on renewable energy, a field that has a great deal of societal appeal but more limited commercial or technical viability at present.

FINLAND

Nuclear Energy

Finland currently has four nuclear reactors that account for 30% of its overall electricity supply. Given their increasing demand for electricity and efforts to meet greenhouse gas reduction targets under the Kyoto Protocol, they are expanding their nuclear power program (Talus, 2013). A fifth nuclear reactor has been under construction since 2005. Unfortunately, after significant delays and cost over-runs it is not anticipated to be supplying electricity commercially until 2018

(World Nuclear Association, 2015e). In addition, the Finnish parliament has also provided approval for the construction of two further nuclear power plants (Talus, 2013).

Uranium Mining

No commercial uranium mining currently occurs in Finland despite active exploration. Known uranium deposits are low-grade and considered economically unfeasible for extraction (Geological Survey of Finland, 2014). Nevertheless, Talvivaara Mining Company in Sotkamo, Finland, developed plans in 2008 to recover uranium from Nickel and Zinc pond tailings using a "solvent extraction process" (Geological Survey of Finland, 2014). Despite this, the government licensing process is ongoing and no uranium has been recovered to date using this new process (Geological Survey of Finland, 2014).

Indigenous Perspectives

The Sami are transnational Indigenous inhabitants of Finland, Sweden, Norway, and Russia's Kola Peninsula. Despite their wide geographical spread, their rights as Indigenous peoples are recognized differently, varying country to country. In 1995, Finland formally recognized Sami Indigenous status in the country's constitution (Samediggi - Saamelaiskäräjät, 2014). The following year, they were devolved select self-government responsibilities for their language and culture that are managed through their own independent Sami Parliament (Samediggi - Saamelaiskäräjät, 2014).

The jurisdiction of Sami legal rights beyond their culture and language has been a sore spot between the Sami and Finnish governments (Modeer, 2015). In particular, Finland is not a signatory to the 1989 UN Convention on Indigenous and Tribal Peoples Convention (ILO 169), which would require them to recognize Sami ownership over their traditional homeland and associated rights (Amatulli, 2015). As a result, tensions persist regarding government approved natural resource management activities near their territory. For example, a 2014 article in The Guardian references conflicting Sami perspectives to mining exploration. While some communities see an urgent need for financial investment to spur economic growth, many others oppose all such forms of investment (Vidal, 2014).

Approximately 10% of the Sami in Finland continue their culturally distinct practice of reindeer herding (Koivurova, Masloboev, & Petre, 2015) and fears exist that mining—including uranium—could negatively impact this practice. Finland has made efforts to respond to these fears by creating several legislative protections for the Sami's traditional homeland in the country's recently overhauled 2011 Mining Act. Unfortunately, despite some progress, the legislation has been criticized from both mining industry leaders and the Sami Parliament for using vague language in describing required protection measures (Koivurova et al., 2015).

Some research has been done to better understand the perspectives of the Sami and industry stakeholders towards increased mining prospects in Finland. However, the researchers in question were unsuccessful at securing interviews with representatives from Finland's Sami Parliament. Instead, reviewing their public statements, researchers found that they oppose all mining activity except for gold panning (Koivurova et al., 2015 p. 24). Of the mining industry representatives interviewed, all agreed a disproportionate amount of negative information toward the industry has been perpetuated by the media, fuelling anti-mining sentiments among the Sami and the general public (Koivurova et al., 2015 p. 26). Furthermore, researchers found that breaking the barrier of conflicting information regarding the environmental and social impacts of mining will be key to new projects moving forward. They note, "the interviewed [mining] representatives think that if the Sami were properly informed about the real effects of mining activities, they would probably be more co-operative and willing to allow mining to take place" (Koivurova et al., 2015 p.26). In their interviews, mining representatives did note, interestingly enough, it is relatively easy for them to apply for an exploration permit in Sami homelands, and there exist few mechanisms for the Sami to appeal (Koivurova et al., 2015).

No direct evidence was found to indicate outright Sami opposition further developing nuclear power in Finland. However, one should reasonably expect Sami opposition to uranium mining should future mining proposals arise.

SWEDEN

Nuclear Energy

Nuclear energy currently accounts for nearly 40% of Sweden's power supply provided by 9 reactors (International Atomic Energy Association, 2014b; World Nuclear Association, 2015d). Despite its significant contribution to meeting the country's energy needs, public opinion toward nuclear power has been inconsistent over the last few decades.

As public acceptance of nuclear energy lessened after the Three Mile Island and Chernobyl nuclear power incidents, government actions were taken to phase-out nuclear power altogether—with mixed results (International Atomic Energy Association, 2014b; Wikdahl, 1991). Moreover, a nuclear energy capacity tax was imposed on the industry in the early 1990's and has since been raised multiple times (World Nuclear Association, 2015d).

As time went on, favourable public opinion towards nuclear energy increased in Sweden, despite the recent Fukishima incident in Japan. This led to legislative changes (and reversals) to previous nuclear policies resulting in the permanent shutdown of only 3 reactors and approval to replace the remaining 9 (International Atomic Energy Association, 2014b; World Nuclear Association, 2015d).

Uranium Mining

There are currently no active commercial uranium mines in Sweden; however, exploration is very active and future increase could be reasonably expected. At present, uranium exploration is focused on two projects in particular: the Kallsedet project and the Haggan project (Mining Technology, n.d.; World Nuclear News, 2012). Drilling samples from 2012 led to significantly increased revised estimates regarding the size of the uranium field at the Haggan deposit (World Nuclear News, 2012). According to Aura Energy, the proponent for the Haggan project, the Haggen field "is one of the largest undeveloped uranium projects in the world" (Aura Energy, n.d.).

Indigenous Perspectives

The Sami of Sweden share similar legal and political histories to their Finnish and Norwegian counterparts. The Swedish parliament recognized their rights as Indigenous peoples in 1977, and the official Sami Parliament was established in 1993 (Sametinget, 2014). The Swedish Sami Parliament has autonomous power over select areas of Sami life, particularly language and culture as is this case with Finland. However, the Swedish government only recognizes the Sami Parliament as a state administrative agency that reports to the government as opposed to an independent representative body (Sametinget, 2014; Sweden, 2015). This relationship has fueled some frustrations among Swedish Sami representatives, claiming they are unable to adequately represent and manage the interests of the their people (Sweden, 2015).

In 2014, the Swedish Sami Parliament developed a strategy regarding natural resource exploration activities in their traditional homeland. The strategy states their desire for a full moratorium on natural resource activities in their territory until the Swedish government signs the 1989 UN Convention on Indigenous and Tribal Peoples (ILO 169) and the Sami Nordic Covenant (Sametinget, 2015). However, the desired moratorium does not necessarily signify outright opposition to natural resource management under all circumstances. In fact, their opposition is far more focused at their lack of legal authority to decide how natural resources are managed in their territory than being levelled against the industry as a whole. For example, their strategy outlines circumstances in which they would agree to certain activities. One such requirement for a permit is described below:

> The prospector must consult the Sami Parliament, concerned Sami and concerned Sami reindeer-herding and economic districts. Prior to the consultation, the prospector shall draw up a report on the planned operations and in what way they shall affect reindeer husbandry and Sami interests as well as land and landscape impacts, impacts on the cultural environment, hunting and fishing" (Sametinget, 2015).

As was the case with Finland, no literature was discovered that demonstrates specific, outright opposition to nuclear energy development in Sweden broadly speaking. Similarly, Swedish Sami opposition is more focused on the mining industry particularly the expansion of an iron-ore mine in their territory. According to a 2013 article in IC Magazine (a self-described online publication of the centre for world Indigenous studies), they quoted the Swedish Sami as saying, "In contrast to what Beowulf [the proponent mining company] has reported to its shareholders, the company has not shown any willingness to cooperate with Saami communities, as required by international conventions. This is demonstrated by the company's refusal to assist the communities' participation in impact assessments, which are necessary to obtain knowledge of how the proposed mining would impact upon the Saami communities and their land uses" (Schertow, 2013).

NORWAY

Nuclear Energy

Unlike the energy markets of Sweden and Finland, Norway never developed nuclear power on a commercial scale—the vast majority of its energy is produced through hydroelectricity (World Nuclear Association, 2015c). Norway is currently exploring the use of thorium as an alternative to uranium for nuclear reactor fuel (Rhodes, 2012; World Nuclear Association, 2015c; World Nuclear News, 2013b).

Uranium Mining

Norway does not currently commercially mine thorium (or uranium) despite significant available deposits (Rhodes, 2012; World Nuclear News, 2013b). Depending on the results of ongoing thorium testing as an alternative nuclear fuel source, thorium mining is a future possibility.

Indigenous Perspectives

The Norwegian government recognizes the Sami as distinct Indigenous peoples and a Norwegian Sami Parliament was established in 1989 (Sámediggi Sametinget, n.d.). However, the specific division of powers is less obvious compared to other Sami parliaments.

Little directly sourced evidence was found to suggest the Norwegian Sami oppose or favour future nuclear energy development in the country (excluding the impacts of Chernobyl). Moreover, it appears they have stronger decision making rights for natural resource management projects compared to their Swedish and Finnish neighbours. According to the United Nations Regional Information Centre for Western Europe (UNRIC):

> Norway was the first country to ratify the protection of land rights pursuant to ILO Convention No. 169 concerning Indigenous and Tribal Peoples in Independent Countries in 1990. However, they have interpreted the phrase "ownership and possession" narrowly, and concluded that a "protected right to

> use" was also covered by the phrase. As a result of increased Sami activism, the controversial Finnmark Act of 2005 gave Sami and the population in Finnmark [Area in Northern Finland, large part of which are Sami territory] rights to the land and water in Finnmark when about 95% (about 46,000 km2) of the area in the Finnmark county was transferred to the inhabitants of the county (United Nations Regional Information Centre for Western Europe, 2015).

The Norwegian government and the Sami Parliament have an agreement outlined in the Finnmark Act that stipulates how consultation will occur for any "legislative or administrative" issue that affects the Sami and their territory (Sámediggi Sametinget, n.d.). This consultation requirement somewhat resembles Canada's duty to consult and accommodate. A background document produced by the Norwegian Sami Parliament states, "Consultations are not to be concluded until the Sámediggi and the Norwegian State agree that it will be possible to reach an agreement. As part of the agreement, a semi-annual consultation meeting is held between the cabinet minister in charge of Sami affairs and the president of the Sámediggi" (Sámediggi Sametinget, n.d. p. 2). Despite relatively stronger rights to natural resource management in Norwegian Sami territory, it appears they have less authority over matters concerning mining, oil and gas (Koivurova et al., 2015).

Thorium mining could be a reality in the coming years (or decades) due to promising research advancements into its use as an alternative nuclear fuel (Rhodes, 2012). While no Sami perspectives specific toward Thorium mining were found during this review, there are objections regarding other mining activities in and around their territory. In a few studied cases, as noted by Koivurova et al., there are doubts as to whether Sami land rights were respected as required under international and national law, adding fuel to their anti-mining sentiments (Koivurova et al., 2015).

RUSSIA

Nuclear Energy

Russia currently has 34 operational nuclear reactors that comprise approximately 18% of the country's total electricity production (Atomenergoprom, n.d.; International Atomic Energy Association, 2014a; World Nuclear Association, 2015f). They are currently undertaking an aggressive campaign to significantly increase its nuclear power capacity: 8 new reactors are presently under construction, 25 are in the planning stages, and a further 23 reactors have been proposed (World Nuclear Association, 2015f). Russia's markedly ambitious goal is to increase nuclear production to roughly 45-50% of overall electricity production by 2050 with further increases to 70-80% of total production by the end of the century (World Nuclear Association, 2015f).

Uranium Mining

Russia's uranium deposits account for approximately 9% of the world's known uranium reserves. State expenditures for uranium exploration have jumped in recent years—with a total budget of $450 million earmarked from 2013 to 2020 (World Nuclear Association, 2015f). Furthermore, geological surveys reveal potentially significant uranium deposits in the country's far North West in the Murmansk region (the Kola Peninsula), the traditional territory of Russia's Sami population. Increases in uranium exploration are expected to continue as the country shifts to increased nuclear energy production.

Indigenous Perspectives

Multiple Indigenous groups exist in the Russian Federation; however, Sami perspectives were the only reviewed. Current Russian legislation recognizes a group as Indigenous if their numbers do not exceed 50,000 members, a traditional way of life is maintained, certain remote regions are inhabited, and they identify as part of a "distinct ethnic community" (International Work Group for Indigenous Affairs, 2015).

Sami communities in Russia's Kola Peninsula (the Kola Sami) do not retain the same level of cultural recognition (and associated rights) that their Scandinavian neighbours. While some Indigenous rights are enshrined in the Russian Federation's constitution, they are considered weak, vaguely defined and often ignored (Koivurova et al., 2015).

The Kola Sami were subject to multiple periods of colonization that significantly impacted their traditional practices and livelihood, the most notable of which was the commercialization of reindeer herding and the environmental impacts associate with nuclear armament during the Cold War (Hakala, Mickelson, & Lakiasuo, 2007). The process of commercializing reindeer herding saw the creation of two reindeer farm cooperatives to replace traditional herding practices. As a result, Sami reindeer herding transformed from a cultural livelihood to a more businesslike approach where herders became employees of collective farms rather than independent agents (Hakala et al., 2007; Vladimirova, 2011).

It is well documented that the Kola Peninsula bore significant negative environmental impacts from nuclear armament during the Cold War era. According to Lassi Heininen, Professor of Arctic Studies at Lapland University, the Barrents Sea Region (the ocean bordering the Kola Peninsula) has the "largest concentration of nuclear weapons, reactors, and military facilities and industrial activities in the Russian Federation, and the whole Circumpolar North". Heininen further notes, "among the risky hotspots of the region are storehouses of highly active spent fuel, old storage vessels and a big number of submarines with nuclear reactors waiting for decommissioning. Severe socioeconomic and environmental influences are there and people face them" (Heininen, 2004 p.9).

The Murmansk region on the Kola Peninsula is also a highly developed mining area that serves as a major economic driver for North West Russia (Koivurova et al., 2015). State mining legislation does not include any requirement to consult or inform local Sami peoples of nearby mining activities (Koivurova et al., 2015). According to Tim Koivurova and his research team, "there are apprehensions among the Sami and local authorities that the development of new deposits can have major consequences. However, from the mining and geologist perspective, the prospects for any development of new fields in Lovozero district in the near future is quite low for economic reasons" (Koivurova et al., 2015 p.40). He and his team further note, "Both Sami and authorities believe that the development of new mining projects will include the discussion of Sami interests, and there is positive experience to be seen in the Fedorovo Resources and Stockman developments. In general though, Sami people suppose that such discussion will be formal and the interest of mining will prevail" (Koivurova et al., 2015 p.40).

It can be reasonably inferred that the Kola Sami and other local populations have some reservations toward further nuclear energy development and potential uranium mining in the region due to ongoing environmental impacts from the Cold War era. Potential exists for Sami opposition to mining projects if efforts are not taken to genuinely listen to their perspectives.

Impact of Chernobyl Radiation on Sami Reindeer Herding in Russia and Scandinavia

As a standalone event, the Chernobyl nuclear disaster in 1986 had a significant impact on the attitudes of the Sami toward nuclear energy development. The nuclear fallout from the disaster led to elevated radioactive contamination of Sami reindeer herding pasture resulting in restrictions placed on the amount of reindeer meat individuals could consume (Jakobsen, 2014; Stephens, 1987, 1995). Other reindeer meat was deemed unfit for human consumption altogether, and, in some instances, entire herds were slaughtered (Stephens, 1987). Increasing concern with nuclear development after Chernobyl led the Sami Nordic Council (a collective body that represents Sami interests in all four countries) to release a statement expressing concern with nuclear power and the environmental and health risks it poses (Avenhaus, Kremeńiuk, & Sjöstedt, 2002; Heininen, 2004). Elevated radioactivity is still found in reindeer 30 years on but at significantly decreased levels compared to those measured in the late 80's and early 90's. Interestingly enough, however, 2014 measurements indicate radiation levels found in deer herds can fluctuate by wide margins depending on the season and the reindeers' diet, creating ongoing uncertainty for harvesting timelines each year (Jakobsen, 2014). All told, the short and long term impact from Chernobyl dealt a devastating blow to the Sami livelihood, and, in certain areas, resulted in increased reliance on state welfare systems (Stephens, 1987)

GREENLAND

Nuclear Energy

Nuclear power does not currently comprise part of Greenland's energy makeup. Current electricity production largely consists of community based diesel generators and several hydroelectric stations (Statistics Greenland, 2015).

Uranium Mining

Greenland is home to sizable uranium reserves. In 2013, their parliament voted in favour (15-14) of removing the country's zero tolerance policy (established in 1988 by Denmark) on uranium mining and other radioactive elements (World Nuclear News, 2013a). As an aside, Greenland was under direct Danish rule until "home rule" was granted in 1979 followed by a more comprehensive self-government act in 2009. The act allows Greenland to manage all areas of government except monetary and defence which remain under the authority of Denmark (Library of Congress, 2013; Statsministeriet, n.d.). Uranium exploration has been ongoing since 2009 and as of late January, 2016, the Government of Denmark and Greenland reached a final agreement regarding the "export control" of uranium and other radioactive elements to ensure international nuclear non-proliferation commitments are met (Greenland Minerals and Energy Ltd, 2016; World Nuclear News, 2016).

Indigenous Perspectives

Greenland's near complete independence from Denmark as a self-governing Inuit nation makes for a unique case study when it comes to assessing Indigenous perspectives on uranium mining. All cases until now have reviewed the perspectives and rights of Indigenous peoples within the context of the broader non-Indigenous society and state. In Greenland, however, this is not the case as the vast majority (85%) of local voices are Inuit (Naalakkersuisut, n.d.).

The Greenland Parliament's narrow passing of the vote to remove its zero-tolerance policy on uranium mining is an indicator of the issue's obvious contentiousness. While some celebrate the significant economic benefits the Kvanefjeld mining project could provide, there are equally (if not greater) criticisms levelled against it (Bennett, 2013; Fletcher, 2014; Loewenstein, 2014; Nuttall, 2013; Ren, Bjorst, & Dredge, 2016). Several Greenlandic and international bodies have expressed serious concern with the rigour and depth of Greenland's consultation processes for natural resource projects. Organizations such as the Inuit Circumpolar Council (ICC), The Employer's Association of Greenland, Transparency Greenland, and the World Wildlife Fund of Denmark have each voiced their desire for increased "public debates about the nature of consultation and decision-making processes" for large- scale natural resource developments (Nuttall, 2013 p.376). Mark Nuttall, Professor of Anthropology at the University of Alberta, notes:

> When Inatsisartut began debating lifting the zero-tolerance policy on the first days of its autumn session on Friday 13 September 2013, Naamik Qujaanaarpunga ("No Thank You"), a coalition of groups opposed to its repeal organised a silent protest outside the parliament building, expressing concern over the potential environmental and social impacts and health consequences of uranium extraction. As a prelude, an event had been organised two days before in Nuuk's city centre where traditional drum dancers had sung songs about how minerals were the veins of the earth and had expressed concern over uranium extraction and the commodification of nature. Over the next month, support for Naamik Qujaanaarpunga grew and more protests were held in Nuuk, while Inatsisartut was sitting and debating, drawing large crowds and calling attention to what appeared to be a majority feeling in Greenland that the zero-tolerance policy should remain in place (Nuttall, 2013 p. 378).

In addition to public protests, there have been increased calls for a public referendum on the removal of the zero-tolerance policy on uranium mining (Nuttall, 2013) which have not occurred. As a result, one can expect that uranium mining—and natural resource management in general— will remain a highly charged and contentious issue in Greenland and increased conflict between the mining industry and local communities is likely inevitable.

AUSTRALIA

Nuclear Energy

Australia's energy production does not currently include nuclear power despite significant uranium resources and a well-established uranium mining industry. However, achieving greenhouse gas emission reduction targets make nuclear power development an increasingly appealing alternative in the coming years—particularly because of the country's heavy reliance on fossil fuels for electricity production (World Nuclear Association, 2015a, 2015b). In fact, in 2013-14, coal fired energy production accounted for nearly 65% of Australia's electricity generation, natural gas accounted for 21.3%, hydro was 7.2% and wind power was 4.4% (Department of Industry and Science, 2013; World Nuclear Association, 2015a).

Uranium Mining

Uranium mining has occurred in Australia since 1954 and current estimates indicate the country's uranium reserves account for 31% of the world's total (World Nuclear Association, 2015b). The uranium industry is a considerable component of Australia's economy as it accounts for 35 % of their energy exports in thermal terms and 12% of the world's current uranium supply (World Nuclear Association, 2015b). Moreover, uranium mining generates approximately $21 million in government royalties each year (World Nuclear Association, 2015b).

Indigenous Perspectives

Australia's uranium mining history is a particular sore point with its Indigenous peoples. Most of its uranium mining sites are located adjacent to Indigenous territory (Graetz, 2014). Geordan Graetz and Haydon Manning (2011) note that such close proximity has likely contributed to negative Indigenous attitudes toward the uranium industry. Furthermore, the forced relocation of some communities for nuclear tests in the 1950's and 60's resulted in significant negative social impacts (Graetz, 2014).

Another example includes the Mirarr Indigenous people from Northern Australia who opposed the proposed development of the Jabiluka uranium deposit. As noted by Graetz (2014):

> The Mirarr claim that they have experienced severe negative social and cultural impacts as a consequence of the Ranger mine, and the community's campaign against Ranger and the proposed development of the adjacent Jabiluka uranium deposit in the mid-1990s became a focal point for national and international anti-uranium and anti-nuclear activism p. 343). As a result of increased Indigenous opposition, the development plan was scrapped and a "Long-Term Care and Maintenance Agreement" was created in 2005 that ensures the Jabiluka deposit will not be mined "without the free, prior and informed consent of the Mirarr (p.343).

The ability of Indigenous peoples to halt potential uranium mining on their lands using the legal system is particularly difficult given their land title rights do not confer veto power for mining projects (Göcke, 2014 p.210). Nonetheless, Australia's uranium industry has taken select actions to improve their relationship with Indigenous peoples and promote economic development in their communities. For example, the Australian Uranium Association established Indigenous Dialogue Groups in 2009 to discuss ways to improve Indigenous economic outcomes from uranium mining (Australian Uranium Association, 2012).

Overall, Indigenous perspectives toward uranium mining appear largely negative in Australia; the perspectives on two Wongatha individuals demonstrate this point well. Geoffrey Stokes says, "We have sun, we've got wind, we've got people. Why should we pollute our country for money?" and Kade Muir, a Wongatha anthropologist, stated "We don't want this product disturbed from the ground. We don't want to bequeath a legacy for future generations of a toxic environment" (Boylan, 2010).

THE UNITED STATES

Nuclear Energy

The United States produces 30% of the world's total nuclear power generation—currently the largest single global producer (World Nuclear Association, 2016b). As of February 2016, it had

99 operational nuclear reactors, five more under construction, a further five with firm plans in place, and several proposals for more (World Nuclear Association, 2016b).

Uranium Mining

Present day uranium mining in the United States is a shadow of its former self. At peak production in the 1970's, hundreds of mines were operational at once—today there are less than 10 (World Nuclear Association, 2016b). As a result of significant decreases in output, current domestic uranium production contributes to only 10% of fuel required for the country's reactors, the rest is largely imported from Canada (World Nuclear Association, 2016d).

Indigenous Perspectives

The United States' uranium industry has a less than sterling record with Indigenous peoples, particularly the Navajo (Graetz, 2014). Despite the short lived economic benefits the uranium mines provided them through employment during the mid-late 20th century, their long-term health, environmental and social consequences on the Navajo were significant and are well-documented (Brugge, Benally, & Yazzie-Lewis, 2005; Brugge & Goble, 2002; Gilliland, Hunt, Pardilla, & Key, 2000; Graetz, 2014). For example, several studies found a strong positive correlation between uranium mining and lung cancer rates in Navajo men and increased cases of other diseases were also found (e.g. thyroid cancers and birth defects) (Gilliland et al., 2000; Graetz, 2014). More importantly, however, the Navajo were never informed of the negative consequences associated with uranium mining, despite full government and industry knowledge of present dangers. Doug Brugge, Timothy Benally and Esther Yazzie-Lewis (2005) note,

> The federal government and the mining companies knew of the hazards of uranium mining, and the Public Health Service even conducted a study to document the development of illnesses that they expected. The miners and the widows, however, were never informed, and had to find out about the danger on their own, from witnessing and experiencing the sicknesses that developed in the wake of working in the mines. The stories that they tell are very sad. They say that they tried every kind of medicine. When they tried Western medicine, the doctors didn't know what was wrong with their husbands until they were diagnosed with lung cancer. They were told simply that they were dying (p. xvii).

Political organization among the Navajo resulted in increased pressure on the American government to compensate those who suffered from the government and industry disregard for Navajo wellbeing. As a result, congressional hearings into the impact of uranium mining began in 1979. However, significant politicking among congressmen delayed action on compensation by nearly 20 years. When compensation was finally awarded, it was done in a "grudging and capricious fashion" (Brugge & Goble, 2002 p.1418).

The Navajo remain steadfast in their opposition to the uranium industry. In 2006, they hosted the Indigenous World Uranium Summit to increase awareness on the hazards they associate with nuclear proliferation (Navajo Nation, 2006). In his opening address to attendees, Navajo Nation President Jo Shirley said, "It is an almost impossible task to try to save the world from nuclear proliferation, but in the Diné way of life, we believe that there are no impossibilities" (Navajo Nation, 2006 p.1) he further notes "As Diné people, we're also looking for friends to help us defend ourselves against those who would break our laws to get at the uranium ore underneath our lands. At the same time, they [uranium mining industry] will contaminate our lands, our water and our people. It seems like some people out there, all they care about is money" (Navajo Nation, 2006 p. 2).

CANADA

Nuclear Energy

Nuclear power currently comprises 15% of Canada's total electricity production (World Nuclear Association, 2016a). While Canada has significantly fewer nuclear reactors (only 19) compared to its American neighbours, it has made considerable advancements to international nuclear research and technology (World Nuclear Association, 2016a). For instance, The Chalk River facility in Ontario is considered a major hub for international research into peaceful nuclear proliferation and a leader (and majority supplier) of medical isotopes (World Nuclear Association, 2016a).

Uranium Mining

Canada is also a major player in the global uranium market; until 2009, it was the world's largest supplier (World Nuclear Association, 2015g). Canada's uranium production is largely focused in Saskatchewan at the McArthur River and Cigar Lake mines in the province's northern region; however, early operations were focused in Port Radium, Northwest Territories and scattered pockets throughout Ontario (World Nuclear Association, 2015g). Exploration in Labrador, Nova Scotia , Quebec, Nunavut and Northern Ontario hold promise for continued production in the future (World Nuclear Association, 2015g).

Indigenous Perspectives

The relationship between Canada's uranium industry and Indigenous peoples is not without controversy. Similar to Australia, many uranium developments are located in close proximity to Indigenous lands, resulting in some historical negative environmental, social and health consequences for some communities (Graetz, 2014). However, uranium developments in recent years are alleged to be viewed more positively by certain Indigenous groups as well as provide increased economic development opportunities.

Canada's indigenous perspectives on the nuclear industry are exceptionally diverse and difficult to fully capture within the scope of this review. As a result, only some high-profile historic and present day cases were examined. In particular, select Dene, Metis and Inuit attitudes toward the nuclear industry comprise the following cursory overview of indigenous perspectives in Canada's far north.

Dene Voices

The Dene are exceptionally diverse indigenous peoples as evidenced by their significant geographic spread across Canada's north and multiple linguistic dialects (Dene Nation, n.d.). Sub- groups of the Dene Nation include the " Denesoline (Chipewyan), Tlicho (Dogrib), Deh Gah Got'ine (Slavey), K'ashot'ine (Hareskin) and the Dinku Zhuh (Gwich'in) (Dene Nation, n.d.).

In Mining Denendeh: A Dene Nation Perspection on Community Health Impacts of Mining, Noeline Villbrun, Dene National Chief, and Chris Paci from the Dene Nation's Lands and Environment Department give a good description of Dene diversity toward resource extraction. They say, "There is no single Dene perspective on mining: some call for greater involvement of Dene mine development; some for a greater share in the resource royalties and other benefits; some could be characterized as preservationists (of both lands and cultures) (Paci & Villebrun, 2005 p.72).

Northwest Territories Dene

Canada's first large scale uranium mine was located at Port Radium in the Northwest Territories which supplied the majority of uranium to the United States for the Manhattan Project (World Nuclear Association, 2016c). Not long after it's creation, the Canadian government took control of the private operation and turned it into a crown corporation—Eldorado Nuclear Ltd. The mine was closed in the late 1960's (World Nuclear Association, 2016c).

Uranium mining at Port Radium has a troubling past with local Dene communities. A Canada-Deline uranium roundtable was established in the late 1990's to examine the environmental, health and social impacts of mining activities at Port Radium on neigbouring Dene communities (Deline First Nation & Indian Affairs and Northern Development Canada, 2005). As part of the roundtable process, an analysis of Dene oral histories was conducted which found that nearby Dene communities felt that mining activities negatively harmed the environment, disrupted their familial and social patterns, and seriously jeopardized their health (Deline First Nation & Indian Affairs and Northern Development Canada, 2005). The results of the oral history analysis were also largely corroborated through further field examination in an around the mining site, including the surrounding shoreline where significant uranium mining tailings were dumped. These studies found that the the mining site and area immediately adjacent remain contaminated

from the operation—albeit in contained and isolated areas (Deline First Nation & Indian Affairs and Northern Development Canada, 2005).

Some reports found during this review indicate similarities between the experiences of the Navajo in the United States and the Dene near the Port Radium mine. According to Ronald Barbour (1998) a member of First Nations Drum, a Canadian Indigenous Newspaper:

> Throughout the 1950s, the American government began studies on cancers linked with uranium mining. Victor E. Archer, an American epidemiologist, who started the first cancer studies on miners in 1954, had stated that the American reports on these studies and updates were forwarded regularly to the Eldorado mine management, as well as to the Canadian government. Although the Canadian government knew there were significant dangers in working with radioactive material, the decision was made to continue mining the ore without adequate safe-guards to miners and laborers or even without informing their workers of the inherent dangers.

The Canada-Deline roundtable final report also acknowledges the lack of safeguards for Dene workers involved in the Port Radium uranium mining operations, particularly during the transportation of ore (Deline First Nation & Indian Affairs and Northern Development Canada, 2005 p. 88). The report did note, however, that overall causality between Dene involvement in Port Radium operations and incidences of cancer were difficult to link. The report states:

> The causes of a specific cancer in an individual can be difficult, and in some cases impossible to pinpoint, because of the numerous factors that could determine whether someone gets cancer. The three most common types of cancer in Déline are lung, kidney/bladder and colorectal; these could be related to uranium exposure, but are also known to be caused by other factors such as smoking and poor diet. It is not possible to know for certain if the illness or death of any individual ore carrier was directly caused by radiation exposure. However, studies predicted that some ore transport workers had a higher cancer risk due to their exposure to radioactive ore. Radiation doses to family members who lived at the mine or transportation route sites were estimated to be quite small and therefore not likely to increase cancer risk (p.89).

Nevertheless, despite difficulties associated with determining the exact causes of cancer incidences among Dene men near the mine, the report found the mining operations left a largely negative psychological impression on the nearby communities (Deline First Nation & Indian Affairs and Northern Development Canada, 2005).

Saskatchewan Dene

Approximately 85% of Northern Saskatchewan's population is considered Indigenous, many of which are Dene communities (Cameco, 2014e). Cameco, one of the world's largest uranium producers, has a significant presence in the province's north and goes to great lengths to engage Indigenous communities near their mines. For example, they have entered into three formal agreements with communities near their mining sites. According to Cameco, "all of these agreements provide Indigenous communities with the workforce and business development programs, dedicated community engagement programs, community investment monies, and mechanisms to collaborate around environmental stewardship"(Cameco, 2014d). Cameco maintains that 80% of their operating sites adjacent to Indigenous lands falls under formal agreements with the relevant Indigenous community (Cameco, 2014d). Cameco's website maintains they take efforts to consult community elders. It notes, "We regularly consult with and employ Elders at our mine sites, to create mutual understanding, build trust and strengthen our community relationships "(Cameco, 2014a)

Dene perspectives on uranium mining appear to vary: some reports suggest widespread support for uranium mining while other reports indicate opposition. For instance, an article by Red Power Media, a blog on Indigenous issues and resistance, speaks to the more negative perspectives on uranium mining in Northern Saskatchewan (Toledano, 2015). The article describes the perspectives of Don Montgrand, a Dene man who was part of a small group of Dene trappers, who formed a blockade on Saskatchewan's Highway 955 in November 2014. Montgrand says, "We want the industry to get the hell out of here and stop this killing. We want this industry to get the hell out before we lose any more people here. We lose kids, adults, teenagers" (Toledano, 2015). Another Dene trapper, Candyce Paul states, "We don't want our people to be engaged in only mining ever. When it's done, when it's over, you're going to have a whole generation of people that have nothing"(Toledano, 2015).

Conversely, Cameco states it has significant support for their operations among Saskatchewan's northern residents (the vast majority are Indigenous) (Cameco, 2014c). Their website states that for their Saskatchewan operations they had 81% public support in 2009, 86% public support in 2010, 79% in 2011, 81% in 2012, and 79% in 2013(Cameco, 2014c). However, it should be noted that no data collection or sampling methods were provided on their website to support how these polls were conducted.

In addition to Cameco's claims of strong public support, one of their Indigenous board members, Don Deranger, responded to a previously posted article on Nunatsiaq Online (Inuit news site) countering what he believes to be misleading negative perspectives on Canada's uranium industry. It should also be noted that Deranger while a Cameco board member is also the Athabasca vice-chief of the Prince Albert Grand Council. In his rebuttal, he states,

> The environmental effects of all our uranium operations on land, water and air are well below the limits set by Canada's federal and provincial regulators. Independent monitoring shows it is safe to consume the fish in nearby watersheds. While the Nunavummiut Makitagunarningit appears to be impressed by the negative view of uranium mining held by the City of Ottawa's chief medical officer, this is not the view held by the Canadian Nuclear Safety Commission. The CNSC is the chief federal regulator, responsible for ensuring the health and safety of those working in the uranium industry. It has many experts on staff and has undertaken scientific studies and reviewed the literature from other studies (Deranger, 2010).

He further notes,

> Externally, the well-being of the stakeholders who live closest to our uranium mines is important to utilities around the world that buy their uranium from Cameco and use it to generate clean electricity. These utilities have conducted sustainable development audits of our operations and have also looked at our commitment to social responsibility.
>
> The industry in Saskatchewan does many things to make sure that northern people benefit most from the development of Saskatchewan's uranium. To name a few: we have a flexible work schedule that allows our northern employees to pursue traditional hunting and fishing activities if they choose; we fly workers into our sites from the widely dispersed communities of the region; we employ aboriginal elders as cultural counselors at our operations; we support schools across the region and provide scholarships and other initiatives to encourage northern people to attend universities; we work with northerners on business development to ensure a high percentage of our good and services are purchased from northern-owned businesses; we support trades and apprenticeship training to help northern people advance to higher paying, higher skilled jobs; we fund charitable initiatives that improve quality of life across the region.
>
> Northern Saskatchewan is my home, so it is not my place to tell the residents of Nunavut what approaches they should take. However, they should know the facts about the uranium mining industry (Deranger, 2010).
>
> It is clear that dueling perspectives exist regarding uranium mining among Dene people in Northern Saskatchewan. However, the positive economic benefits to Indigenous communities near the mines, as touted by Deranger, are difficult to dispute. In 2013, Cameco alone spent $451,619,700 on local service

> procurement—67% of their total contracted services for their Saskatchewan operations. Previous years' percentages were even higher: 73% in 2012, 74% in 2011, 78% in 2010, and 71% in 2009 (Cameco, 2014b).

Inuit Voices

Perspectives on uranium mining in Nunavut are also controversial. Areva Resources Canada has proposed to build a uranium mine (known as the Kiggavik project) near Baker Lake. However, local Inuit perspectives to the proposed Kiggavik project have been nothing short of contentious. In fact, a 1990 plebiscite was held in Baker Lake regarding a similar proposed project in the same area and Baker Lake residents voted 90.2% against the project (Bernauer, 2012).

As part of the regulatory process established under Nunavut's 1993 Land Claim Agreement (NLCA), resource management and development proposals need to be screened by the Nunavut's Impact Review Board (NIRB). The screening is required to determine if further extensive review, involving multiple rounds of public consultations, is needed (Nunavut Impact Review Board, n.d.). The board's composition is noteworthy here, given its decision on the more recently proposed Kiggavik project. The board consists of a chairperson appointed by the Government of Canada; 4 members appointed by the Government of Canada on the advice of Nunavut Tunngavik Inc.; 2 Board Members appointed directly by the Government of Nunavut; 2 Board Members appointed directly by the Government of Canada; and 2 alternate Board Members appointed by the Government of Canada on nomination by Makivik Corporation, the designated Inuit organization for Northern Quebec.

The NIRB's review process for the Kiggavik project was extensive. The perspectives of hunters, trappers, elders, and community members from the region were solicited. In many of the submitted documents, locals expressed uneasiness with the lack of independently verified information provided to residents about the mine and the proposal's fluid project timelines (Kneen, 2011; Nunavut Impact Review Board, 2015). In the end, the NIRB decided against the project (Nunavut Impact Review Board, 2015).

In the final report, the sentiment of the Baker Lake Hunters and Trappers Organization provides a good summary of most perspectives received during the review process. They state,

> The Baker Lake Hunters and Trappers Organization is not necessarily against Kiggavik. We just want to make sure that we have the best possible protection for our caribou and that mining is done responsibly … we do not want this proposal approved but still hanging over our heads for decades to come, not knowing what the future of our community will be. We would be sitting and waiting for decades totally powerless to control our own future. This would not be right….The company can return when they have a start date, when they are serious about

> getting this project off the ground. Then we can talk about it (as cited in Nunavut Impact Review Board, 2015 p. xiii).

In particular, residents felt Areva provided insufficient information regarding their proposed environmental mitigation measures, which had a major influence on the NIRB's decision. As the final report states,

> While the Board has decided that the Project should not proceed at this time, this does not mean that this Project should not proceed at any time. The Board intends that the Kiggavik Project may be resubmitted for consideration at such future time when increased certainty regarding the start date for the project can be provided, and so enable the Board to make more definite and confident assessments having regard to the enduring significance of caribou, fish and marine wildlife for Nunavummiut, especially the beneficiaries of the Nunavut Land Claims Agreement (Nunavut Impact Review Board, 2015 p.xiv).

This is where increased controversy arises. Even though the NIRB rejected AREVA's application for the Kiggavik project, they do not have final authority. In fact, as stated in the NLCA, rejected applicants can appeal to Canada's Minister of Indigenous and Northern Affairs Canada (formerly Aboriginal Affairs and Northern Development Canada) (Martin, 2015). Vincent Martin, Areva Resources' President and CEO, appealed to then former Minister Bernard Valcourt in July, 2015. However, publicly available correspondence in the NIRB's project registry indicates Minister Valcourt did not make a decision. As a new government was elected in October, 2015, the decision now rests with Carolyn Bennett, the newly elected Liberal Government's Minister of Indigenous Affairs and Northern Development Canada. The final decision still awaits.

In a research report he prepared for the Centre for the Study of Co-operatives, Warren Bernauer noted that Baker Lake residents desire increased economic development opportunities but in a manner consistent with Inuit environmental protection values (Bernauer, 2011). Compared to other smaller mining operations in the region, residents were particularly concerned that the proposed Kiggavik mega-uranium mine would be too much for the local environment to support (Bernauer, 2011). In his two month stay in Baker Lake, he found that the town's residents, including several Elders, felt insufficiently knowledgeable of nuclear processes to fully understand the uranium mining process. Combined with perceived one sided evidence by Areva scientists, many residents were simply not comfortable enough to support the project (Bernauer, 2011).

With the concerns of Baker Lake residents in hand, it needs to be noted that Nunavut Tunnigavik Inc., (the body responsible for managing transferred land and natural resources under the NLCA)

and the Government of Nunavut, each developed policies in support of uranium mining in 2007 (Bernauer, 2012). However, several Inuit organizations and residents expressed concern that these policies did not involve sufficient public consultation as required under government land use strategies and the NLCA (Bernauer, 2012).

A wealth of literature exists on the controversy surrounding the Kiggavik project and it is nearly impossible to capture all perspectives involved. Nevertheless, as has been demonstrated above, the sentiments toward uranium mining in Nunavut—particularly Baker Lake— are far from straightforward, cohesive and positive.

INTERNATIONAL SYMPOSIUMS ON NUCLEAR ENERGY

In addition to the individual cases examined above, three notable international events regarding uranium mining shed further light on Indigenous perspectives toward nuclear energy. They also reflected the strong and often divergent views of the industry, for anti-nuclear sentiment could be see in several of these high profile settings.

The first event was the 1992 World Uranium Hearing in Salzburg, Austria; the second was the 2006 Indigenous World Uranium Summit in Window Rock Navajo Nation, USA; and the third was the recent 2015 World Uranium Symposium in Quebec City, Canada.

At the 1992 World Uranium Hearing, 80 Indigenous representatives from 23 countries (and a further 30 non-Indigenous representatives) shared their perspectives on the environmental and health related consequences of uranium mining and the nuclear industry (Göcke, 2014). In their final declaration, the "World Uranium Hearing called upon government, corporations, organisations, communities and individuals to ensure that radioactive minerals are no longer exploited" (Göcke, 2014p.204). A supporting statement to the declaration further demanded that uranium mining on Indigenous territory cease and global efforts to advance renewable energy should increase (Göcke, 2014). The 2006 Uranium Summit in Window Rock, Arizona, USA, saw a re-affirmation of the 1992 declaration and its supporting statement. The summit was well attended with over 300 Indigenous and non-Indigenous representatives from 14 countries (Göcke, 2014).

The recent 2015 World Uranium Symposium in Quebec City, Canada, which had an anti-nuclear emphasis from the outset, continued in the same vein as the previous two symposiums. Nearly 900 people attended the event, who heard from over 100 experts in the uranium and nuclear industries and Indigenous representatives from around the world. The final declaration from the event bears close resemblance to the other two declarations and calls for abandoning nuclear power as an alternative energy source in reducing reliance on fossil fuels.

ANALYSIS

To a greater extent, Indigenous perspectives investigated in this report appear to focus their attention on uranium mining rather than the implementation and development of nuclear power facilities in general. This comes as no surprise given most of the literature reviewed suggests many Indigenous communities do not see uranium mining and nuclear power development as mutually exclusive—the latter being the inherent and assumed development stemming from the former.

Admittedly, the majority of the perspectives encountered were less than favourable. Nonetheless, it cannot go unnoticed that there is significant interplay between the level of autonomous rights Indigenous peoples have secured (including their maturity as a self-governing nation) and their future willingness to consider uranium mining (Göcke, 2014). The importance of this cannot be understated. For example, as Nunavut and Greenland actions both demonstrate, their respective governments removed their restrictions on uranium mining in favour of increased economic development as they matured as self-governing nations. As Katja Göcke observes,

> Yet, there is also a recent trend in the opposite direction. For example, in 2007, Nunavut Tunngavik Inc., the representative organisation of the Inuit of Nunavut, (Canada), adopted a policy that supports 'sustainable' uranium mining on Inuit lands, in 2010 the Government of Greenland—a de facto Inuit-governed autonomous territory within the Danish Realm—relaxed its zero-tolerance on uranium mining and allowed mining companies to explore uranium deposits in Greenland, and in March 2012 the Nunatsiavut government, a regional Inuit government within the Province of Newfoundland and Labrador (Canada), lifted its three-year moratorium on uranium mining on Labrador Inuit lands. These institutions argue that Indigenous peoples are nowadays in a much stronger position to negotiate fair terms and conditions and to supervise the exploration projects (Göcke, 2014 p. 205).

INITIAL TEST OF NORTHERN AND INDIGENOUS RESPONES: NORTHERN SASKATCHEWAN

As a preliminary test of northern and Indigenous responses, ICNGD arranged to speak to New North, an association comprised of representatives of communities and villages through northern Saskatchewan. At the February 18th meeting, ICNGD representatives outlined the project and explained the interest in alternate energy sources, including small nuclear. Importantly, residents of northern Saskatchewan have considerable familiarity with uranium mining and nuclear energy issues, in large measure because of the fact that northern Saskatchewan has several of the richest uranium deposit in the world and because CAMECO and AREVA, two mining companies active in Saskatchewan, have extensive relations with Indigenous and non-Indigenous peoples across Northern Saskatchewan. As a result, this group has been more sensitized to nuclear issues than other regions of the Canadian North. The results are summarized below.

New North Summary of Responses

Previous Knowledge

Have you ever heard of Small Nuclear?

Figure 1: Summary of Previous Knowledge Results.

Response	# of Respondents
Yes	8
No	7
No Response	
Total	15

(New North Meeting, Prince Albert, Feb 18th, 2016).

If so, how did you hear about it and what do you know?

- Responses: News, word of mouth, U of S has one, Government of Saskatchewan, reactors used in poor regions of the world.

How do you feel about it?

- "I feel worried on the security of the nuclear capabilities. Is it healthy or not? It can't just be buried anywhere."
- "Negative."
- "Why not explain potential?"
- "Interested."
- "Sounds interesting, considering Saskatchewan produces raw uranium in Northern SK."
- "I support small nuclear under CNSC regulations and consultation."
- "How small is small? How dangerous is it? How much power output does it have?"

- "Safe and clean."

Renewable Energy
Is your community thinking about renewable energy options?

Figure 2: Summary of Renewable Energy Results.

Response	# of Respondents
Yes	8
No	6
No Response	1
Total	15

(New North Meeting, Prince Albert, Feb 18th, 2016).

If yes, what are those options? And why?

- "Never heard of it."
- "No idea on the details, recycling and reducing."
- "Investigation of geo-thermal. Did not progress beyond initial conversation."
- "Geo-thermal."
- "We have hydro power in our area, so how about small hydro run the mill plants in the Churchill River system."
- "Solar and wind, but cost prohibitive at this point in time."
- "Hydro/Biomass."
- "Solar/Wind and Biomass."
- "Solar power and wind-primarily for individual home and outlying; biomass district heating, Ile X BNS; generators."

Current Energy
Challenges of current power systems?

- "Provincial Utility-Occasionally unreliable. Aging infrastructure, very costly to upgrade."
- "High power bills-> no power but Saskpower."
- "We had a power line go through the community we were promised lower rates, we did not receive any benefits, power rates are higher than they were."
- "No challenges."
- "Not cost effective."
- "High cost of electricity, natural gas is unavailable.
- "There are no workers immediately available, the cost to operate and to the consumer; the short and long term effects on nuclear energy."
- "Cost and infrastructure."
- "Power outages."
- "Frequent outages, brown and black outs."
- "Power failures."

Benefits of current power systems?

- “Unknown.”
- “Installed and current.”
- “Cost and availability.”
- “None.”
- “Hard to evaluate the benefits when we only have one energy source”

Why are the current power systems hard to transition away from?

- “Cost of alternative-nuclear?”
- “Nothing else available.”

Small Nuclear

When thinking of Saskatchewan’s future involvement in the nuclear sector, how would your community support such an initiative?

- “Do not know.”
- “Don’t know enough about it.”
- “Environmental are the issues of the day, sort of like "pipelines." Most people have no idea about how nuclear energy can change their lives. They hear about nuclear medicine but beyond that it is a complicated issue. “
- “I don’t know.”
- “Mixed response; community engagement would have to occur.”
- “No support.“
- “No support because of lack of information and protection of the environment.”
- “Strong support.”
- “Very carefully produced.”
- “Where? Not our beautiful north.”
- “Yes. It is a fresh solve to the issue.”

If your community was thinking about small nuclear systems, what information would you need to know? What questions would you ask?

- “Cost, reliability, safety of the public and environment.”
- “Cost? Safety? Longevity? How would it impact other services?”
- “Everything.”
- “How would it compare to the size of the one in ternoble <Chernobyl>.”
- “Is there other small nuclear plants anywhere in the world?”
- “Is there waste? If so, where is this going? Storage? Disposal?”
- “No idea.”
- “Not thinking of a small nuclear plant at this time.”

- “Safety to our environment, cost return, benefits to the community, highly skilled people to run it.”
- “We can’t ask questions if we don’t know what it is.”
- “What are the risks? Nuclear waste? Storage? How many watts/power?”
- “What is it? Risks? Benefits? Economic/Environmental analysis.”
- “What? How? Why? Cost? All benefits and risks.”

This initial survey and data collection opportunity revealed some significant (and anticipated) results:

- Strong interest in alternate energy sources;
- Little understanding of small nuclear options;
- Mixed attitudes to uranium-based energy sources;
- Strong recognition of the urgent need for sale, reliable and inexpensive sources of energy.

A follow-up meeting with the New North executive provided valuable insights into the survey responses. They revealed that New North members had extended conversations about small nuclear and alternate energy after the ICNGD team left. Some members expressed dismay about the prospect; others were much more open to the possibility. As an organization, they expressed a strong interest in learning more, in part because the development of new uses of uranium had the potential to improve the uranium-based economy in northern Saskatchewan.

Building off the meetings in Northern Saskatchewan, researchers then travelled to the Yukon and Northwest Territories to meeting community leaders. A series of interviews were help with individuals conversant with northern energy issues, with a view to ascertaining their general knowledge or and interest in small nuclear.

Yukon Territory

We were able to speak with a range of participants while in the Yukon. These participants had varied specialties that ranged from innovation and renewable energy to government and economic development. Despite the diversity of the participants, the results were quite similar. Although all the participants were located in Whitehorse, the interview focused on a territorial approach to energy. The Yukon Territory has a limited relationship with the nuclear sector, in the recent years, one Premier declared the Yukon to be a "nuclear free territory.' This declaration has contributed to the limited relationship.

Northwest Territories

In the Northwest Territories (NWT) we interviewed participants in both Yellowknife and Inuvik. In Yellowknife, the discussion again focused on a territorial approach, whereas Inuvik was community specific. We had the opportunity to meet with government officials, community members, Non-Government Organizations (NGO) and not for profits representatives in the energy sector. Despite a limited relationship with nuclear energy at the territorial level, the community of Inuvik has an increased comfort level with the nuclear sector, recognizing that nuclear energy could be a viable option for reducing energy costs in the community. Over the past few years, the community has been increasingly researching small nuclear and exploring the new technologies in the sector.

Results

Background Knowledge on Small Nuclear

Saskatchewan

Over half of the participants interviewed had hear of small nuclear reactors in some capacity. They were familiar with nuclear use in medicine and reactors around the world. Those who were not familiar were quite interested in it, but concerned about personal safety. When discussing participant's initial feelings towards small nuclear, they referred it as "safe and clean." One participant noted that they are fully supportive of small nuclear within the Canadian Nuclear Safety Commission's (CNSC) rules and regulations.

Yukon Territory

Every participant we spoke with in the Yukon had a very good understanding of small nuclear. The discussion ranged from lead-cooled to CANDU reactors. Almost all of the participants made note of the Galena Nuclear Power Plant example in Alaska.

Northwest Territories

Everyone with has some knowledge of small nuclear. Again, the interviewees made reference to the Galena Nuclear Power plant in Alaska. There has been some ongoing discussion in the Northwest Territories, but it has not amounted to much past initial discussions. Climate change specialists in NWT have been looking at this an option, but people are not taking it too seriously. They believe that he North is always a perfect pilot for new energy options, but it is also the place where these options are more likely to fail. One participant used the example of the wind turbines in Cambridge Bay, Arviat and Kugluktuk 15 years ago. The communities did not have anyone in the community who was able to service the equipment, which struggled as a result of extreme weather.

Inuvik

All of our participants had a very in depth knowledge of small nuclear technologies. The community has discussions that the town had to replace locally-supplied natural gas. During these discussions, members brought up the idea of small nuclear plants to create energy efficiency. Many were interested in because of the urgency of the current energy situation in Inuvik. There have been many discussions at all different levels. One participant attended a leadership meeting where the Inuvialuit leader was stressing nuclear power. A lot of people at this meeting apparently saw it as a viable option. This participant noted that it is a very viable source for the North. It can run for 20 years without refueling and the amount of fuel you need is very small. The general public, however, does not know about the potential. They do not know that it could provide the whole town with heat and power and a stable costs of fuel. From the community members' perspective, there is still a stigma around nuclear. One participant stated "nuclear doesn't have a good reputation but from a practical sense and especially in Canada our nuclear energy has been really safe". It would help if there was an example of one in operation and producing to show that it could be a viable source of energy for the North.

Renewable Energy Initiatives

Saskatchewan

Eight of the fifteen community representatives we spoke to have considered or are implementing some form of renewable energy initiative. One community leader had not heard of renewable energy. The current challenges with implementation is capital costs and familiarity.

Geothermal

Two of the communities have been investigating geothermal. However, there has been little done on the concept since the initial conversations.

Hydro

Two communities have looked into hydro as an option. One community has hydro power in the area. They would like to see a small hydro run the mill plants using the Churchill River system.

Solar and Wind

At least three of the communities in Northern Saskatchewan have explored solar and wind power. There have been individuals who use solar and/or wind for their homes and for operations in outlying areas. At this time, the communities feel it is cost prohibitive to implement any large scale solar or wind projects.

Biomass

Three communities have explored biomass as an option. Again there has been very little movement after the initial conversations. Once again capital costs are a major barrier. The Primrose Resources Corporation was formed representing the four Métis communities of Cole Bay, Jans Bay, Beauval and Ile a la Crosse. One of their mandates was to explore projects such as biomass. Little has been accomplished in this area at this time.

Yukon Territory

In the Yukon the Cold Climate Innovation (CCI) is leading the alternative energy discussions. Currently, 95% of the Yukon receives its electrical supplies from hydro dams. Almost the entire Yukon is on the grid. In 2011, the Yukon released an energy resource plan that included public engagement, looking into next generation hydro; and an energy and climate change strategy.

Wind

The community of Kluane First Nation falls outside of the grid system in the Yukon. Last year, the community erected three 100KW wind turbines. They have also partnered with Cold Climate Innovation (CCI) to also erect a wind monitoring system. In the future, Kluane First Nation plans to sell the wind energy to the nearby ATCO micro-grid.

Solar

The Yukon is also currently testing four different types of solar panels, including bi-facial panels designed to capture reflective energy in hopes of optimizing solar generation in the North. In addition to this initiative, NorthwesTel, a telecommunications provider, currently has 122 locations in the Nortn. Almost half of these sites are in remote locations ran on diesel. They are now using solar to reduce their reliance on diesel fuel. This system relies on cogeneration with a battery in which the battery is used first, then diesel while the battery recharges. They have about 10-12 sites running on this system, producing significant savings by reducing the need for maintenance trips.

Biomass

In February of 2016, the Yukon Government released a biomass strategy. Originally, the discussion was only for heat, not energy because they felt the word energy was too broad. That perception has changed. There are many advantages to adopting biomass energy systems in Yukon. There is biomass in two locations: Raven Recycling and the Whitehorse Correctional

Institute. They have been focusing on microchip units rather than pellets as the chips are accessible in the region.

Geothermal

Kluane First Nation is also using geothermal for district heating. It utilizes a fault line that runs under their land to provide heat for the local greenhouse and water treatment facilities.

Northwest Territories

Renewable energy is gaining traction more in the North than anywhere in Canada because of high energy costs. NWT still has 30 communities on diesel and the government subsidizes residential users. However, this approach increases the cost pressures on operators of commercial and government buildings in small communities.

Solar

In NWT, solar is gaining significant momentum for electricity, but it is still a fragmented and immature sector. There are barriers to entry into communities, including the lack of integration and capacity of micro grids to absorb the energy from solar. In Fort Simpson, a local co-operative installed 12 solar houses. Other individuals have used off grid solar for 10-15 years; about 100 of them are on the house boats. Solar gardening is also being pushed by individuals but resisted by utilities.

Biomass

The NWT is considered a leader in biomass strategy. The NWT Biomass Energy Association has published a discussion paper outlining the barriers to biomass in the region. The Government of NWT enabled bulk import by serving as an anchor client. There are now several commercial companies.

Inuvik

Renewable energy is a major topic in Inuvik, a medium-sized community in the Far Northwest in the Mackenzie River delta. The price of natural gas is very expensive (35.44 per gigajoule versus Alberta, where it is 2.20 per gigajoule. There has been a real struggle with using natural gas for heating after one of the wells became unusable. Currently the Government of the Northwest Territories is subsidizing the costs by about 50%. They are unsure about how long they will continue to do so as fluctuating fuel pries makes the cost of energy uneconomic. The cost of fuel is high because there is no competition and the very high cost of transportation from the South. The renewable energy discussions have focused on wind power, solar and fracking. They have installed a research turbine at the airport to collect baseline studies. They are also conducting feasibility studies of hydro and solar. In Inuvik, there will not be a single solution. They already have several different sources of energy. But many of participants feel that nuclear could be the single solution that provides both power and heat.

Biomass

A large percentage of residents has switched to pellets and wood stoves. The Artic Energy Alliance provides subsidies to support the switch to stove or pellets. There are currently about 60-70 private homes with woodstoves; many others with pellet stoves. There are also three business selling pellets in Inuvik. The owner of the Mackenzie Hotel installed large pellet boilers in two properties (the hotel and an apartment rental property), He brings in bulk pellets from Northern British Columbia, significantly reducing his energy costs.

Solar

The housing corporation in Inuvik has installed solar power and additional insulation. The Arctic Energy Alliance is working with the housing corporation to conduct an energy use study. The greenhouse uses a gas boiler for heat in April and May, but rest of the time they rely strictly on solar. Both the recreation centre and town office use solar. The issue with solar is that they need to figure out how to store it more effectively. It increased the costs of power. The community believes that solar is useful but is far from the total solution.

Liquid Natural Gas (LNG)

Inuvik has quite a history with natural gas. The region sits near a massive natural gas deposit. In 1999-200, they switched from diesel to natural gas. With incentives to do the conversions, all the properties were retrofitted for natural gas. Since then one of the wells has watered out and is almost unusable. Despite the large deposit, it would cost $70-100 million to bring a new well online. The Territorial government buildings have since switched to propane. The power corporation has diesel and natural gas engines. Initially they were going to change the engines to diesel but they developed an LNG supply. They currently have three natural gas turbines and three diesel turbines. Anything located outside the town is all still using diesel or fuel oil.

Wind

Inuvik is currently running a test pilot for wind at Aurora Research Institute. They previously had wind just south of town but it was not useful due to the distances involved and the capital investment. They are also doing some wind studies close to town and the airport and are considering a wind farm. A substantial amount of capital is required for such a project wind but there is potential. There is a micro-turbine at the Mackenzie Hotel and the recreation.

Current Energy Challenges

Saskatchewan

Reliability

Most communities agreed that the current sources were occasionally unreliable. Many communities noted frequent outages, both brownouts and blackouts. This can be quite frustrating for residents and puts excessive strain on local government, especially during the winter months.

Infrastructure

Numerous communities also noted infrastructure as a challenge. The current infrastructure is aging; much of it needs to be upgraded and replaced. The cost to complete these upgrades would be very high.

Cost

The capital cost to change or upgrade is too high. The communities feel they have few available options. Power is supplied through a provincial crown corporation, which leaves them with only the one option. One community noted that they had a power line go through the community and were promised lower rates. However, in the end they did not receive any benefits. In fact, the power rates increased.

No Challenges

One community in Northern Saskatchewan noted that they in fact did not have any challenges with the current energy systems. This is unique to this community. There were no other communities in Northern Saskatchewan, the Yukon Territory or the NWT that noted a similar experience.

Yukon Territory

Demand

The biggest challenge for the Yukon is forecasting future demand. Currently the vast majority of electrical power used last year was from hydro. The communities that burn diesel make up a small percentage of energy needs. Yukon electricity is provided through an isolated grid; only four communities (Old Crow, Burwash, Destruction Bay and Watson Lake) are off this grid. One concern was capacity for cold days.

Liquid Natural Gas (LNG)

Yukon Energy now has a LNG plant running. It was quite difficult to get the communities on board with LNG. The negative perceptions around fracking lead to communities initially choosing diesel over LNG.

Reliability

Another challenge of the current energy systems in the Yukon is reliability. Diesel is seen as a reliable option; renewable energy is not. Hydro-generation is relatively reliable. However, it is going to continue to become less reliable as the Yukon experiences drought. The Yukon may have to burn more diesel to offset the consumption. Big hydro also has substantial environmental impacts associated with large scale dams. The reliability during peak times has always been a challenge. Peak demand is opposite to peak supply; the water levels are lower in winter when demand is high.

Northwest Territories

Reliability

The main concern for the communities is reliability. Diesel is proven, tried and known. It would be hard to convince people to adopt a new, unproven technology. The communities like diesel because it is easy and they can have backups. However, one participant notes that diesel is not as reliable as everyone thinks. Behchoko had no power for 3 or 4 days; a few years ago, both the diesel and hydro failed in Yellowknife.

Environment

The communities are all very concerned for the environment. They want something different from diesel, and do not like the effects such as air and noise pollution. Canada's North is one of the cleanest environments in the world and the members acknowledge it is currently being polluting with diesel. Oil trucks have gone through the ice road and, due to climate change, the ice roads are becoming less reliable.

Inuvik

Reliability

Reliability is not a challenge for Inuvik. The current system is familiar and reliable. If something does go wrong, everyone knows how to fix it. It also has a distribution system that is reliable. Since the gas was introduced in 1999, Inuvik has not experienced an outage. If there are outages they are very brief. In Inuvik, the issues are with the engines, which can be fixed pretty quickly, whereas in the south the problems rest with distribution, which is much harder to address quickly.

Cost

The most obvious challenge to the town is cost. The price of natural gas has increased since the natural gas well was taken off the grid, which caused a spike in energy prices. The price of diesel is also a challenge. For both diesel and natural gas, the transportation costs lead to the increase in overall costs.

Technology

The challenge with implementing new technologies in the North is that they are rarely designed for the climate. Technology that works down south, such as a condensing boiler which needs to get rid of the water through exhausts, will freeze up in -30C temperatures and therefore cannot be used in Inuvik. Another challenge with any new technology is having the people to work on things they different systems. People are reluctant to try new things in case they have a problem that they do not know how to fix. In cases where they may not know to fix it, the parts are not

readily available in Inuvik. When it is -40C, there is no time to wait for parts to be shipped from the South.

Community Support for Small Nuclear

Saskatchewan

Public Perception

The communities believe the public perception would be mixed and community engagement would have to occur. Some believe there would be no support, possibly because of the lack of information combined with protection of the environment. Others believe that there would be strong support and feel it is a fresh idea to solve current energy issues.

Public Education

Many of the communities felt that they really just did not know enough, or in some cases, anything about nuclear energy. One participant noted that "most people have no idea about how nuclear energy can change their lives. They hear about nuclear medicine but beyond that it is a complicated issue".

Yukon Territory

Generally, all participants agreed that nuclear energy should be a consideration for energy and heating options. There was a general consensus that the perception of nuclear in the North is negative and there would need to be significant education in order to garner community buy-in. From a technical side, there was a general concern from all the participants about the safety of a buried reactor as a fault line runs through the territory. Given the small size of the communities, there is a concern for ramping up and overproduction.

Public Perception

Public perceptions of nuclear will be the biggest challenge. The participants noted that people have to be part of the equation and also the solution. The public perception of nuclear in the Yukon is nuanced. There is no experience in the North with it and the communities are very protective of their environment. Some would vehemently oppose the idea because of the environmental threats and the terrorist threat; supporters would draw attention to such issues as costs and reliability. Public consultation would likely produce negative responses, because these are the groups that would show up. Such consultations would need to balance environment, economy and the people. Public perception is highly based on education and the regulatory environment. The Yukon does not currently provide a regulatory environment for nuclear. It is imperative that the First Nations are behind it and there is not a great legacy of benefits coming to them from recent developments. One participant notes that "will take a lot of social licenses

and nuclear doesn't have it. It needs to be proven". Communities are reluctant to invest in something that has not been shown to work effectively and cheaply.

Potential Benefits

Cost will be the biggest benefit. The cost to fly diesel to remote communities is extremely high. One participant provides an example of the long term cost benefits Old Crow flies in diesel fuel. A small nuclear system that generates 10 megawatts when ran at maxium capacity will last 3 years. Run at 3 megawatts, it will last 30 years. A community like this could have this technology for 30-40 years, drastically reducing their fly-in fuel costs. In addition to the fuel cost, there is also infrastructure costs. Currently, 50% of diesel systems in the Yukon are past their life cycles. There will be significant costs involved to replace these systems.

There have been conversations around small nuclear in the past. Many of the participants have attended presentations or meetings on the subject. One of the potential benefits of such technology that was often overlooked during these presentations was the potential use for heating. The participants interviewed felt that by incorporating heat into the equation would be a major selling point.

Risks and Regulations

There was concern about whether or not the process could be regulated and risks mitigated effectively in a small jurisdiction. There are very few people trained in the areas necessary for this technology. There is concern that the people that do have these skills would be located quite far away if there ever was a crisis. The North has a track record of adopting energy options without having the skilled people needed to operate and maintain them, such as the gasifier in the past. The regulation side would need a significant amount of work to include nuclear and it would require federal support. That being said, most participants made it clear that they would be less concerned about the risks, if the proper regulations were in place.

Waste

All participants noted that the top concern for the communities will be waste. There is a need for greater understanding of how it is created, how it is stored or transported, and the environmental impacts of each option. One participant stressed how little waste is actually created, citing the example of how lead-cooled rods can be almost entirely recycled.

Small Nuclear as an Option

Everyone we spoke with believed that small nuclear should be considered. Almost all were at least open to discussion. One of the reasons it is not being pushed is because the initial cost is very high and the recent territorial budget has allowed for a next generation hydro project. Discussion progressed to likely sources of funding, and whether it would it be industry, government, the community, or a combination of the three. They also noted that there are issues

with every energy source, and the territory will never find one that everyone supports. It is important to have a good regime around the energy supply. Any new system needs to answer a lot of problems and address community reliance on diesel.

Questions

We asked Yukon participants what they thought would be some potential questions from communities. The responses are as follows:

- Waste, how much, where is it stored?
- Why do I want to have the risks in my backyard?
- What are the benefits for me?
- How is it going to be regulated?
- What are the risks?
- What are the worst case scenarios?
- How do we mitigate the risks?
- How's it presented and who's paying for it will be big questions; expensive and proprietary?

Northwest Territories

The situation in NWT is two-fold. The communities are reluctant to new technologies. In the past, they have experienced broken promises regarding the impacts of other developments. Second, the policy solutions need to be clearly seen as the best option for the place. All choices need to be on the table so that people are able to make informed decisions.

Public Perception

One participant, although personally in support of small nuclear, feels there is zero chance of it every becoming a solution, based solely on public perception. The participant feel that oil is demonizing the nuclear sector. Community perceptions are manipulated and influenced through marketing and stakeholders who have a vested interest.

Renewable Energy

The impacts of climate change are not being discussed enough. One participants felt that if people really knew the full impact of climate change they would be scared. This participant feels that nuclear is the only really serious way to tackle climate change. The participants all acknowledge that it is unlikely that there will be one-size-fits-all solutions but rather a combination, possibly of wind, solar and nuclear.

Questions

We asked participants what they thought would be some potential questions from communities. The responses are as follows:

- What about the waste?
- What about meltdowns?
- Who is going to maintain it?
- Where is the fuel coming from?
- Safety (terrorism) and security?
- Pollution, air land and water?

Inuvik

Public Perceptions

The community would have a lot of question. They would need to feel comfortable with the solution. There are currently fears over losing control of traditional land and lifestyle. This is not to say that they would not be open to open to the discussions since some of these conversations have already started. The community is always interested in solutions because of the costs of power. In the past, they invited Peter Lang to present to the community on small nuclear. The town was quite open to the idea.

Public Education

The public would need more education to increase the comfort level. One participant notes that a nuclear reactor is just a source of heat not unlike a boiler in the hous. People do not realize that. Until recently, the community has had no reason for get informed. There needs a public awareness campaign, specifically about nuclear safety in Canada. People hear a lot about the large reactors and the issues with cooling them, but are unaware that the reaction times on small reactors are slow and they have an emergency shut off systems. The people are very open to new ideas and are aware that technology offers a long-term solution to the need for a stable and reliable source of energy.

Permafrost

A major concern about burying a reactor is the permafrost. There needs to be a special design to prevent a literal melt-down and to protect the permafrost from the heat. There needs to be some separation to allow the ground to freeze back. One participant gave the example of the heated pool in town; it has been specially designed with this consideration in mind. One solution may be to keep it above ground with soil over it. They could capture the heat for buildings or the greenhouse.

Questions

We asked participants what they thought would be some potential questions from communities. The responses are as follows:

- Why would Inuvik be the guinea pig?

- If it is possible, why is nowhere using it?
- Safety? If we're going to make it work, people need to be better informed. They only know what they hear on the news with the disasters, especially now that it is the 30th anniversary of Chernobyl.
- Is there capacity in the communities of people who can use it and maintain it?
- Long-term effects?
- Where does the waste go?
- How do you transport it?
- How do you deal with spills?
- What will it cost?

ENERGY COSTS & CONSUMPTION PATTERNS

This section provides a brief overview of energy costs and consumption patterns in northern communities, provided a foundation for reviewing community responses to questions about alternate energy supplies. As with the previous discussion, the material is presented on a country by country basis.

CANADA'S ENERGY REALITIES

Energy Demand

The National Energy Board (NEB) publishes periodic energy market assessments that detail current, emerging and future trends within Canada's energy sector. Updated demand figures, among other data, are provided in the report. (National Energy Board of Canada, 2016a). The latest assessment was released in January, 2016 (the prior report was completed in 2013).

2014 figures reveal natural gas comprises the largest share of energy demand in Canada at 33.9% followed by oil at 34.5%; coal, coke and coke oven gas at 6.5%; hydro at 9.9%, nuclear at 8.7%; and other renewables and landfill gas at 6.5% (National Energy Board of Canada, 2016 p.46). However, in their 2040 energy forecast, natural gas's proportion of total energy demand is anticipated to increase to 44.2%; oil to decrease to 30.5%; coal, coke and coke oven gas to decrease to 3.2%; hydro to remain the same at 9.9%; nuclear to decrease to 5.9%; and other renewables and landfill gas to decrease slightly to 6.3% (National Energy Board of Canada, 2016 p.46). To avoid double counting, current and future energy demands were calculated by subtracting end-use energy production (e.g. electricity) as they are energy by-products (National Energy Board of Canada, 2016a).

Unsurprisingly, energy projections are subject to a great deal of uncertainty. For instance, technological advancements in the oil and gas industry could alter future production levels and the volatile and unpredictable oil market renders accurate predictions nearly impossible (National Energy Board of Canada, 2016a). Few industry players or government economists expected oil prices to crash as low and for as long as they have, resulting in markedly reduced royalty payments to provincial and federal coffers (National Energy Board of Canada, 2016a; Parkinson, 2016).

Indeed, Canada's oil market has taken a massive hit. The price of western Intermediate Crude (WTI) declined by 48% from 2014 to 2015 (National Energy Board of Canada, 2016b) and the cost of other industry products continue declining or remain flat. For instance, the average gas price in Canada was down 15% in 2015 from $1.28/L to $1.09/L. Moreover, the values of Canada's crude oil exports decreased by a massive 42% despite a 13% overall increase in export volume from 2014 to 2015 (National Energy Board of Canada, 2016b p. 2).

Electricity Demand

Canada's electricity generation system consists of a patchwork of provincial and territorial bodies. Typically, the industry is broken down into three key roles: generation, high-voltage transmission, and end-use distribution (Natural Resources Canada, 2016). However, generation in places like Canada's Far North can differ at a localized level where power production relies heavily on diesel generation produced locally within communities (Standing Senate Committee on Energy the Environment and Natural Resources, 2009, 2014).

Electricity Prices

Canadians' demand for electricity has increased at an average yearly rate of 1.2% since 1990 (Natural Resources Canada, 2016). Prices vary depending on region for a multiplicity of reasons, chief among them is regulation. Unlike the fully unregulated and remarkably well integrated markets observed in Scandinavian countries, Canada's is still dominated by provincial regulatory agencies with the exception of Alberta (full-unregulated) and Ontario (partially unregulated) (Natural Resources Canada, 2016). Furthermore, proximity to consistently low cost and reliable energy sources, such as hydro, allow for lower prices in places like Quebec (Natural Resources Canada, 2016). Nuclear power, on the other hand, is marginally more expensive given the upfront, fixed capital costs associated with facility construction. Despite this, however, low fuel and operating costs allow nuclear power to remain one of the cheapest forms of electricity in Canada (Natural Resources Canada, 2016).

Electricity Generation Makeup and National Energy Outlook

Canada's overall electricity supply consists of multiple sources. Hydroelectricity is the largest at 59%, fossil fuels combined at 22.4% (12.6% coal, 8.6% natural gas and 1.2% petroleum), 14.5% nuclear power, and just over 3% non-renewable sources—predominantly wind followed by solar (National Energy Board of Canada, 2016a, 2016b; Natural Resources Canada, 2016). The NEB expects oil production to lead growth in Canada's energy sector until 2040 despite current downward pressure on the global oil market; in fact, they anticipate a 56% increase from 2014 production levels. Natural gas follows suit with a projected 22% increase from 2014 levels. However, coal production is expected to steadily decline (National Energy Board of Canada, 2016a).

ENERGY COST AND CONSUMPTION IN THE FAR NORTH

Background

The energy markets of Canada's far north are vastly different than those in the south: they are isolated and unconnected to the national grid, per capita energy use is twice the national average, and even short-lived power outages (particularly in the winter) create far more imminent, widespread threats to public health and safety (Standing Senate Committee on Energy the Environment and Natural Resources, 2014). Furthermore, a total of 116,700 people (largely

Indigenous) inhabit the three territories —a combined area that comprises 40% of Canada's entire landmass. This alone makes it seemingly impossible to feasibly establish a fully interconnected northern electricity grid (Standing Senate Committee on Energy the Environment and Natural Resources, 2014 p.5).

Consumption

Diesel is the single largest energy source in the Arctic region followed by hydroelectricity. In fact, 53 of the territories' 80 communities rely entirely on local diesel generators to meet their electricity needs (Standing Senate Committee on Energy the Environment and Natural Resources, 2014 p.9). They remain one of the most attractive (and practical) electricity generation options due to their reduced cost, portability, and scalability. In addition, many of the generators can be converted to run on natural gas should it prove more economical—Norman Wells and Inuvik currently source their electricity from Liquefied Natural Gas (LNG) generation (Standing Senate Committee on Energy the Environment and Natural Resources, 2014).

Hydro generation currently provides electricity to 25 communities and one mining operation in the Yukon and NWT. However, current infrastructure is well over 60 years old and significant capital investment would be required for any new facilities (Standing Senate Committee on Energy the Environment and Natural Resources, 2014). While some renewable sources are used to supplement electricity generation, they are not particularly well suited to the north. Indeed, given the limited daylight available and the area's harsh conditions, renewable energy production currently serves more as supplement to diesel generation and unlikely to be a full replacement any time soon (Standing Senate Committee on Energy the Environment and Natural Resources, 2014).

2015 Electricity Prices in other Canadian Jurisdictions

The next sections provide electricity cost and consumption data for each northern territory. For the sake of comparison, the following table outlines electricity rates in other Canadian jurisdictions. The national average is approximately 12.3 ¢ per kWh (Standing Senate Committee on Energy the Environment and Natural Resources, 2014).

Figure 3: 2015 electricity prices in select Canadian jurisdictions with data from Manitoba's 2015 Hydro's jurisdictional scan

City	Rate ¢ per Kilowatt Hour at 1,000kWh
Kenora, ON	16.497
Halifax, NS	16.030
Regina, SK	14.372
Saskatoon, SK	14.367
St. John's NL	12.558
Moncton, NB	12.298

Calgary, AB	12.184
Edmonton, AB	11.888
Saint John, NB	10.986
Vancouver, BC	10.290
Winnipeg, MB	8.109
Montreal, QC	7.191

(Manitboa Hyrdo, 2015)

YUKON

The Yukon Energy Corporation (YEC) is one of two regulated power utilities in the territory—the second is ATCO Electric Yukon, a private electricity distributor. ATCO electric is responsible for diesel electricity generation and distribution in six communities (Standing Senate Committee on Energy the Environment and Natural Resources, 2014 p.15). The majority of the Yukon's electricity is produced through hydro generation, with support from diesel. Four facilities currently exist: the Aishikhik Hydro plant, the Mayo Hydro facility, the Whitehorse Hydro facility, and the Fish Lake Hydro facility (Standing Senate Committee on Energy the Environment and Natural Resources, 2014).

Cost

Yukon's electricity prices are the most reasonable out of the three territories. Price increases are commensurate with consumption. Yukon's residential rate for the first 1,000kWh consumed is ¢12.14. For usage between 1,001-2,500 kWh, price rises to ¢12.82 kWh, and for usage over 2,500 kWh the price is ¢13.99 kWh.

Consumption and Outlook

Yukon's current generation system is near full capacity. As a result, options are currently being investigated for increasing their energy capacity. For instance, Yukon Energy is considering partnering with the the Tinglit's Pine Creek Hydro facility at Taku River along with developing an additional two new facilities: the Moon Lake hydro project and the west creek hydro project(Yukon Energy, 2015a, 2015b, 2015c). No natural gas generators currently contribute to the Yukon's electricity supply. However, three LNG generators are expected to come online in the near future to replace some diesel generators(Standing Senate Committee on Energy the Environment and Natural Resources, 2014 p.26).

While some renewable energy is currently produced it is comparatively minimal. Two wind turbines produce a combined total output of 800 kilowatts (Standing Senate Committee on Energy the Environment and Natural Resources, 2014). Governmental efforts to study the feasibility of developing wind farms are currently underway.

NORTHWEST TERRITORIES

Cost

The majority of NWT's power is provided through hydro generation predominantly distributed through two independent transmission grids (Standing Senate Committee on Energy the Environment and Natural Resources, 2014).

The price of electricity is significantly higher in the NWT depending on the type of energy used for generation. The rate scale for hydroelectricity is 21 to 34 ¢ per kWh (Standing Senate Committee on Energy the Environment and Natural Resources, 2014 p.17). Diesel generation is generally more expensive; for the first 1,000 kWh during the winter, the price is 28.53 ¢ per kWh, anything above 1,000 kWh is 60.83 ¢ per kWh. During the summer months, the first 600 kWh of electricity costs 28.53¢ per kWh and anything above that costs 60.83 ¢ per kWh (Standing Senate Committee on Energy the Environment and Natural Resources, 2014 p. 17).

Supply

Similar to the Yukon, the NWT's power system is near or at capacity (their power outage rate is four times the national average). Consequently, they are looking at additional new generation projects to increase their output. However, one of the biggest barriers is the lack of connectivity between the two transmission grids which could allow for greater "on demand" electricity sharing and, ultimately, increased overall capacity (Standing Senate Committee on Energy the Environment and Natural Resources, 2009).

Renewable energy (particularly solar) is being strongly considered to supplement energy supplies during peak loads. There are a few small-scale operations, the largest of which is located at Colville Lake. The electricity supply this projects provides during the summer is enough to allow for the shutdown of nearly all diesel generation (Standing Senate Committee on Energy the Environment and Natural Resources, 2009 p.32). Wind power is also generated by four turbines at Diavik Diamond to supplement their electricity needs (it supplied 10.5% of their supply in 2014) (Standing Senate Committee on Energy the Environment and Natural Resources, 2009). However, wind power contributes very little to the NWT's overall electrical grid (Standing Senate Committee on Energy the Environment and Natural Resources, 2009). Biomass heating is also strongly supported in the NWT and is growing. Wood pellet heating systems (not electricity generation) were present in 14 communities by 2014 (Standing Senate Committee on Energy the Environment and Natural Resources, 2009).

NUNAVUT

Cost

Nunavut's electricity supply is entirely dependent on 26 diesel generation stations for its electricity needs in 25 communities. No transmission grid currently exists and many of the

current generators are passed their useful life (Standing Senate Committee on Energy the Environment and Natural Resources, 2014).

The Nunavut government heavily subsidizes electricity prices (30.15 ¢ per kWh). Two community rates were provided in the Senate's 2014 Standing Committee report: Iqaluit and Kugaaruk. For the first 1,000kWh during the winter months in Iqaluit and Kugaaruk, the cost of electricity is 30.15 ¢ per kWh. Anything over that amount in Iqaluit costs 60.29 ¢ per kWh and 114.16 ¢ per kWh in Kugaaruk. While price point remains the same in the summer months, the threshold for price changes is reduced to 700kWh during winter periods.

Supply

Nunavut's current electricity supply appears relatively desperate compared to the Yukon and the NWT particularly given its fleet of diesel generators that have exhausted their useful life. While hydro power is a possibility, no project has been formally implemented and further feasibility studies are required (Standing Senate Committee on Energy the Environment and Natural Resources, 2014).

ECONOMIC GROWTH FROM INCREASED ENERGY, AND ANALYSIS

By and large, electricity generation is near or at peak capacity in all three territories. The 2014 Senate Standing Committee Report on Energy, the Environment and Natural Resources primarily used for this section, found that limited electricity supply is constraining economic growth in some sectors, particularly mining (Standing Senate Committee on Energy the Environment and Natural Resources, 2014). As noted in the report, "In many communities energy costs are high and rising. There is heavy reliance on imported diesel and much of the territories' energy assets are at capacity, aging and underperforming, threatening the reliable supply of energy to northerners. These factors strain public resources and limit economic growth and prosperity"(Standing Senate Committee on Energy the Environment and Natural Resources, 2014 p.41)

The senate report noted multiple potential options for future electricity generation in the far north, including small nuclear reactors. Given recent government commitment at the Paris Climate Change summit, and expected increases in electricity demand across the territories, serious efforts need to be taken if sustainable environmental and energy security is to be achieved.

Complications in securing appropriate licenses for conducting interviews in the North delayed the interview processes. The license for the Northwest Territories was received and interviews have been arranged. Upon receipt of Scientific Licenses from the Yukon, interviews will be conducted with community leaders in the following places. This work will be completed by the end of May 2016. An expanded and more detailed report will be issued at that time.

Regions of Interest

- Yukon
- Northwest Territories
  - Inuvik and Tuktoyuktuk
  - Southern NWT
- Nunavut
- Northern Saskatchewan
- Northern British Columbia
- Northern Labrador

Figure 4: List of Communities

Province/Territory	Community Name	Type
Yukon	Ross River	Telephone interview
	Carcross	Telephone interview
	Burwash	Telephone interview
	Haines Junction	Telephone interview
	Teslin	Telephone interview
Northern Saskatchewan	New North*	In-person Focus Groups
NWT	Inuvik	In-person Interviews
	Tuktoyuktuk	In-person Interviews
	Fort Good Hope	Telephone interview
	Rae Ezo	Telephone interview
	Fort Resolution	Telephone interview
	Fort McPherson	Telephone interview
Nunavut	Rankin Inlet	Telephone interview
	Baker Lake	Telephone interview
	Pangnurtung	Telephone interview
	Igloolik	Telephone interview
Northern Labrador	Nain	Telephone interview
Northern BC	Prince George	Telephone Interview

SMALL NUCLEAR THE NORTH: KEY THEMES

Based on the work to date, several key themes have emerged:

- The high cost of energy is a severe limitation on northern life, adding to the individual cost of living and restricting economic opportunities in the region;
- Concern about climate change has changed public attitudes toward alternate energy systems, but with a strong current interest only in renewable resources;
- There is considerable Indigenous and northern resistance to uranium mining and nuclear energy, but it is not uniform;
- Actual knowledge of the impact of uranium mining and nuclear energy use have been created primarily by public debates about this topics and do not reflect well-informed perspectives and understanding;
- Small nuclear proponents have to overcome existing concerns about uranium mining and nuclear energy – even if these are based on different modes of production than small nuclear energy systems;
- Because of the high cost of energy and the desire for local control, there appears to be an openness to discuss new energy systems and to engage with new energy system proponents.

In summary, interviews with Northern leaders demonstrated surprising openness to the idea of small nuclear installations, driven in large measure by issues related to cost, reliability and safety of existing systems. Conversations with northerners revealed some real and substantial concerns, largely because of the general lack of information, although it must be noted that the small nuclear option has been explored in several regions. Northerners need new energy sources. The renewables, particularly solar and wind, that are attracting a great deal of international attention, are less useful or cost effective in northern, sub-Arctic and Arctic regions. While more research is required, particularly at the community level, there does appear to be considerable openness to further discussion about nuclear options in the North.

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