Energy Resources in the Canadian Circumpolar North: A look at current and future resources and impacts on Northern communities

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Abstract

Although there is interest in renewable energy, current energy resources in the Canadian Circumpolar North (i.e., the Northwest Territories, Yukon, and Nunavut, with a focus on mid to high latitudes of the territories) are mainly non-renewable. The Canadian North struggles to become renewable because of the remoteness of communities, the harsh climate, and the amount of capital involved in these large projects. There are some current renewable energy projects, though most are concentrated in the southern half of the territories. Current and ongoing renewable energy projects include: a solar-diesel hybrid project in the hamlet of Kugluktuk; a biomass pilot project in Fort McPherson, which has led to proposed biomass projects in Inuvik and other northern communities; and the wind turbine project in Haeckel Hills, with new technology turbines. With each successful project, continued research, and the lowering costs of technology due to global demand, the Canadian Circumpolar North steps closer to a renewable future. Along with the environmental impacts of a transition from non-renewable to renewable energy, renewable energy projects can be a step towards reconciliation and Indigenous energy sovereignty. Though technology and infrastructure will need to continue to advance and become cost-efficient, renewable energy projects in the Canadian Circumpolar North have great potential to impact the environment and the communities they serve.

Keywords: Canada, renewable energy, non-renewable energy, circumpolar north

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Introduction

The United Nation's (UN) Sustainable Development Goal 7 seeks affordable, reliable, sustainable and modern energy for all by 2030 (Sustainable Energy for All, n.d.). There are three aims of the goal: ensure universal access to affordable, reliable and modern energy services; increase the portion of renewable energy across the globe; and double the global improvement rate in energy efficiency (Sustainable Energy for All, n.d.). Current energy resources that service the communities of the Canadian Circumpolar North are mainly non-renewable, for various reasons, but interest in renewable resources is prominent and growing. The development of renewable energy resources and the implementation of new energy systems in the Canadian North will positively impact communities overall by leading to energy sovereignty and reconciliation with Indigenous communities, as well as climate change mitigation. The following essay will investigate the current non-renewable dependence seen in the Canadian North and why there is that dependence; examine a few ongoing renewable energy projects and the potential for future projects; and finally, discuss how renewable energy can help lead to Indigenous energy sovereignty. For the purpose of this report, "Canadian Circumpolar North" refers to Yukon, Northwest Territories, and Nunavut, with a focus on areas above the Arctic Circle.

Non-renewables in the Canadian Circumpolar North

Current non-renewable energy resources

Many far north communities in Canada must rely on hydrocarbons for energy resources. Canada Energy Regulator (CER) states that Nunavut is the only Canadian territory or province with a significantly high reliance on petroleum for electricity generation, as seen in Figure 1 (CER, n.d.-a). All electricity generated in Nunavut is transmitted and distributed by the government-owned Qulliq Energy Corporation (QEC), which operates 25 diesel plants in 25 different communities, none of which are connected by roads or powerlines and have no backup grid (CER, n.d.-a). In the Northwest Territories, about 61% of electricity is generated from petroleum and natural gas (CER, n.d.-b). The rest of the electricity generated comes from hydro and wind resources, with a very small percentage from solar resources (CER, n.d.-b). Most of the renewable energy generation is in mid to lower latitudes of the province, such as the Taltson hydro system (located along the Northwest Territories and Alberta border) or the wind turbines at the Diavik Diamond Mine (CER, n.d.-b). The Northwest Territories has a fragmented power system, with eight communities using hydroelectricity and the remaining 25 communities relying on diesel-fired power plants (CER, n.d.-b). The Yukon is the outlier of the three territories, with 72% of its electricity generated from hydro, 0.7% from other renewable resources, and the remaining 27% from natural gas and petroleum (CER, n.d.-c). However, similar to the Northwest Territories, most of Yukon's renewable energy is generated in mid to lower latitudes, like the Whitehorse Hydro Facility (CER, n.d.-c). The Government of Canada has an interactive map, titled "The Atlas of Canada – Clean Energy Resources and Projects (CERP)," which provides a clear picture of the location and size of energy projects in Canada and may be of interest to the reader (Government of Canada, n.d.). The "Remote Communities Energy Database" may also be of interest and provides an idea of the potential for various energy projects (Government of Canada, n.d.). Recent data estimates that there are approximately 300 remote Indigenous communities in Canada and that nearly 83% of the communities are entirely reliant on their own micro-generation of electricity (Stefanelli, et al., 2019). Diesel generators are the most common systems of these micro-grids, causing environmental harm while often being costly, unreliable, and insecure sources of power (Stefanelli, et al., 2019).

Continued reliance on non-renewables & limitations to renewables

Communities in the Canadian Circumpolar North are small and spread over vast areas. The most common barriers to the development of renewable resources are technical, logistical, and regulatory problems

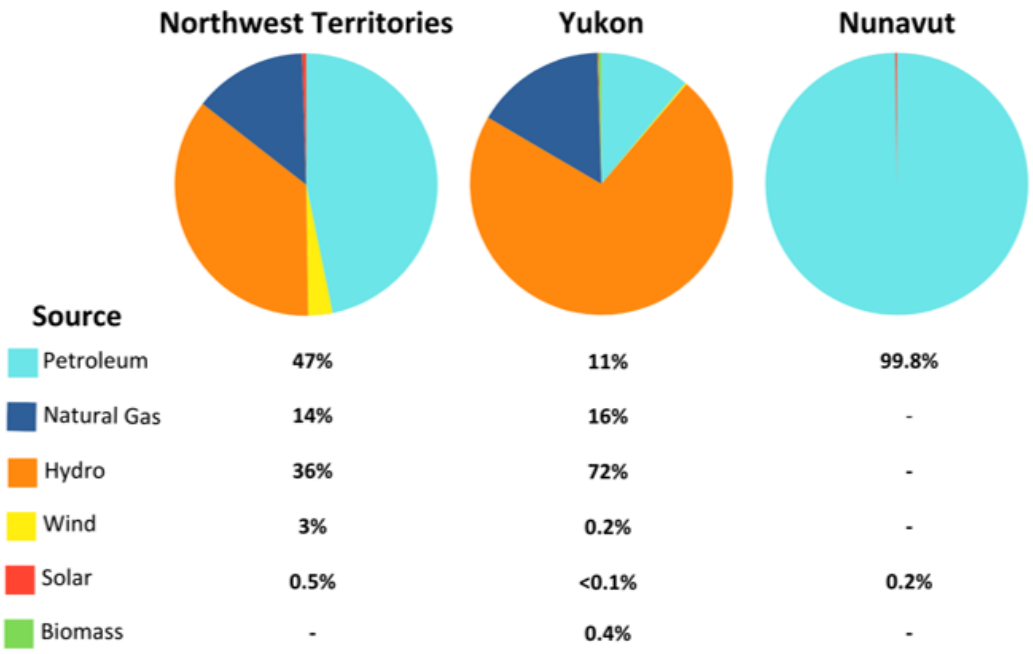

Figure 1. Electricity generation by source for three Canadian territories. Graphs are made with data found on CER Provincial & Territorial Energy Profiles (CER, n.d.-a, n.d.-b, & n.d.-c).

(Giordano & Raymond, 2019). For example, in Nunavut, potential sites for hydroelectric plants are usually far distances from communities and run-of-the-river projects need rivers deep enough to not freeze in the winter (Pinto & Gates, 2022). In this case, both remoteness and a cold climate impact if hydroelectric projects are possible. Similarly, most projects for wind turbines have not been successful in Nunavut due to intolerance of equipment to cold weather and challenges with location (Pinto & Gates, 2022). Krupa (2012) lists six barriers to renewable energy development, which tie in with Giordano & Raymond (2019). The first barrier Krupa (2012) discusses is "cash": Although there are some financial policies in place to help Indigenous communities, often there is simply not enough cash available to meet the day-to-day needs of the community and the strict financial requirements for new renewable energy generation. This idea is related to another barrier, "lack of equality", which is seen in the enormous economic gap that exists between many Indigenous peoples and Settler Canadians (Krupa, 2012). This lack of equality is seen at all levels, including representation in government, business and post-secondary education (Krupa, 2012). This barrier relates to another, "lack of legitimacy", which is the political hoops some Indigenous communities must jump through to ensure new developments do not interfere with ongoing treaty negotiations (Krupa, 2012). Krupa's (2012) other barriers include: "capacity," "clarity," and "circumstances". These barriers focus on the consultation, preliminary project preparation, and regulatory processes that require significant capital and expertise; the lack of clarity on how governments will be incentivizing additional long-term development; and the technical, financial, and societal resistance to the introduction of unknown renewable energy projects (Krupa, 2012).

The Cost of Energy

When discussing the energy industry, cost is often one of the first topics brought up, and as discussed above, many barriers are linked to economic factors. There are three types of costs which should be discussed. The **marginal cost** of energy is a combination of the most obvious costs: buying fuel, transporting that fuel, storing it, generating electricity, and the applicable taxes and associated handling and service charges (Lovekin & Heerema, 2019). When a renewable energy system replaces a diesel system or is integrated alongside an existing diesel system, there is

an **avoided cost** (Lovekin & Heerema, 2019). The avoided cost of energy refers to the financial savings gained when the diesel system operating time is reduced because the renewable energy system produces a portion of the energy required by community energy, and therefore, the diesel system uses less fuel and requires less maintenance and staff to operate (Lovekin & Heerema, 2019). The **true cost** of energy includes both non-economic and economic costs: Non-economic costs include health and societal costs related to pollution and climate change, and environmental costs due to diesel spills and contamination; whereas economic costs include diesel subsidies used to make energy more affordable in remote communities (Lovekin & Heerema, 2019). The UN states that there are 13 million deaths every year worldwide due to avoidable environmental issues such as air pollution. Transitioning to clean sources of energy can address such health problems (United Nations, n.d.). In parts of Nunavut, the marginal cost of energy can be up to $1.14/kWh, which is ten times higher than the rates the average Canadian pays, meaning subsidies must be added to reduce costs to a slightly more affordable, but still very high, $0.30/kWh (Lovekin & Heerema, 2019). Some of the current subsidy structures can make the transition from diesel to renewable energy more difficult, which means governments and utilities must consider how policies can be shifted to make renewable energy more affordable (Lovekin & Heerema, 2019). The report from Lovekin & Heerema (2019) includes figures which may help readers understand these costs.

A UN (n.d.) webpage discussing the future of renewable energy states that the cost of electricity from solar power fell 85% between 2010 and 2020, and the cost of onshore and offshore wind energy fell 56% and 48% respectively. The UN also stated that every dollar of investment into renewable energy creates three times more jobs than in the fossil fuel industry, and an estimated 14 million new jobs could be created by 2023 (United Nations, n.d.). In 2022, $7 trillion was spent on subsidizing the fossil fuel industry, including tax breaks and health and environmental damages not priced into the marginal cost of fossil fuels (United Nations, n.d.). To compare, about $4.5 trillion a year needs to be invested into renewable energy technology and infrastructure to allow for the UN net-zero emissions by 2050 goal to be reached (United Nations, n.d.). Even though marginal costs of non-renewable energy in the far north are high, growing interest in renewable energy technology means that renewable energy makes more economic sense and low-cost energy may soon be available to all Canadians.

Renewable Resources

Advancing technology and increasing economic support from local and federal governments means renewable energy can and will become more dominant in the far Canadian North. There are many instances where the Government of Canada recognizes the environmental, social, and economic issues that come from diesel dependence (Buss, Mansuy, Laganiere, & Persson, 2022). The following are examples of ongoing renewable projects, with many more listed on the CER website. These current projects can be used to identify any issues or concerns and will help make the next round of projects more successful.

In 2019, the federal government, QEG, and hamlet of Kugluktuk announced joint funding for Nunavut's first hybrid solar and diesel power plant (CER, n.d.-a). In 2022, Nunavut's diesel demand was 1056 litres per capita, which is a shocking 37% above the national average capita demand (CER, n.d.-a). The proposed project will replace the existing less efficient diesel facility and was expected to be completed in late 2023; no further updates have been provided (CER, n.d.-a). A solar/diesel hybrid system is an excellent start to bringing renewable energy to the North; due to low solar insolation during the winter season in northern communities, the diesel portion of the system will pick up the slack of the solar system (Pinto & Gates, 2022). In summer, solar photovoltaic panels can operate exceptionally well and often outperform their rated capacity at sub-zero temperatures due to lowered resistance in electrical components and snow reflection increasing solar intensity (A Northern Vision, 2011). A solar company based in Ontario states that solar panels in Canada can offer 25 to 30 years of energy production, with minimal maintenance due to simplistic designs: no moving

parts means that solar panels simply must be kept clean of debris and snow (Solar Direct Canada, 2024). Comparatively, another Canadian power company suggests a 20-item checklist for maintaining diesel systems, including regular oil and coolant level checks, frequent inspections for broken parts, and specific maintenance in cold weather (Trinity Power, 2014). While solar electricity is more expensive per watt to install than conventional diesel systems, prices are declining as global production increases and research continues (A Northern Vision, 2011). Combining existing diesel systems with solar into community grid systems is also being considered in Yukon and the Northwest Territories (A Northern Vision, 2011).

The use of community-based biomass energy systems in northern and Indigenous communities is relatively new (Buss, Mansuy, Laganiere, & Persson, 2022). In 2013, Fort McPherson received a boiler used to provide heat for two buildings during a pilot project (Buss et al., 2022). The pilot project investigated the use of local willow chips vs. imported wood pellets (Buss et al., 2022). The use of biomass can reduce greenhouse gas (GHG) (Buss et al., 2022). Communities in the Northwest Territories would have access to similar biomass sources. Unfortunately, Nunavut has little potential for biomass energy because it is entirely above the tree line, although waste wood from packaging and construction is used for heating to a limited extent (A Northern Vision, 2011).

The Haeckel Hill Wind Project, located outside of Whitehorse, is a $15.5 million wind turbine project (Infrastructure Canada, 2022). Funding for this project comes from the Canadian government, the Yukon Development Corporation, and the Eagle Hill Energy Limited Partnership (Infrastructure Canada, 2022). In March of 2024, commercial operations commenced, marking a historical accomplishment as the first 100% Indigenous-owned wind project in northern Canada (Chu Níikwän Limited Partnership, n.d.). The turbines will produce the clean energy needed to power over 650 homes for the next 25 years, which will offset an estimated 100,000 tonnes of GHG emissions or displace 40 million litres of diesel fuel through the life of the project (Chu Níikwän Limited Partnership, n.d.). The project includes technologically advanced, cold climate turbines and can contribute to more projects further north (Infrastructure Canada, 2022). Cold climate turbines are taller than average projects to ensure access to higher, stronger, and more consistent airflow. They are equipped with powerful generators to maximize the amount of energy generated by each turbine and have blades that are 30% longer and black in colour to reduce icing, with in-blade heating systems that keep them warm (Chu Níikwän Limited Partnership, n.d.). Experience from successful projects in Alaska is being applied to help projects in the Canadian Circumpolar North (A Northern Vision, 2011).

Renewable energy projects are continuing to crop up across the country, as seen in the "Clean Energy Resources and Projects (CERP)" interactive map, and although the Canadian North has fewer renewable energy projects than their southern counterparts, current projects are integral to the future of the energy industry. With each successful project and continuously improving technology, communities in Northern Canada help protect key environments from climate change due to fossil fuel use and benefit from reduced energy costs. The following section discusses social and cultural benefits that can also be gained from renewable energy projects.

Renewable Energy & Indigenous Energy Sovereignty

Past and present colonization has resulted in Indigenous peoples in Canada being disconnected from the land and water resources which are integral to their cultural identities and legal structures (Hoicka, Savic, & Campney, 2021). In 2015, the Truth and Reconciliation Commission of Canada (TRC) released 94 Calls to Action that supported reconciliation and healing, as well as encouraged meaningful discussion and collaboration between Indigenous peoples and Settler Canadians (Stefanelli, et al., 2019). The 92nd Call to Action is especially relevant in energy conversations, as it (1) encourages

corporations to commit to meaningful consultation, build respectful relationships, and gain prior and informed consent of Indigenous peoples before development projects, and (2) ensures that Indigenous peoples have equitable access to jobs, training, and education in the corporate sector and that communities gain long-term sustainable benefits from the development project (Stefanelli, et al., 2019). This is why transitioning to renewable energy and taking control of local resources can be a step towards reconciliation and Indigenous energy sovereignty. The Haeckel Hill project is an excellent example of this. The wind project is not only 100% Indigenous owned but also features various cultural initiatives that educate the public on renewable energy benefits and Kwanlin Dün First Nation heritage and values (Chu Níikwän Limited Partnership, n.d.). With Indigenous engagement in renewable energy projects, there can be opportunities for economic development, self-sufficiency, autonomy and self-determination, and positive impacts on the environment, such as reduction in GHG emissions (Hoicka et al., 2021).

There has been concern about whether energy transitions are just and democratic (Hoicka, Savic, & Campney, 2021). A transition to renewable energy often involves large capital and resources, which may put remote, northern Indigenous communities at a disadvantage. Hoicka, Savic & Campney (2021) suggest that community energy is the optimal framework for energy transition. Community energy refers to grassroots, bottom-up initiatives with local ownership and collective sharing (Hoicka et al., 2021). Community energy projects value planning, setting up, and running of the project to be open and participatory rather than closed and institutional, as historically done (Hoicka et al., 2021). Technology for these projects is often scaled down to local needs and demands are dependent on collaborations between local stakeholders, the private sector for technology, and the government for funding and capacity-building (Hoicka et al., 2021). This framework encourages federal and territorial governments to fund or partially fund projects, therefore reducing infrastructure costs while promoting local benefits like lower energy costs and fewer environmental impacts. Community energy projects can reduce many of the barriers discussed earlier in this paper.

Indigenous people in Northern Canada are also disproportionally affected by climate change, due to polar amplification (Hoicka, Savic, & Campney, 2021). The Arctic and Subarctic are two of the first areas in the world to experience the impacts of climate change (Canadian Geographic, 2018). There have been record loss rates of summer sea ice, noticeable loss of winter sea ice, rises in temperature and sea level, melting permafrost, severe coastal erosion, and extreme weather events affecting Inuit environments (Canadian Geographic, 2018). Climate change is also affecting Inuit people's ability to access traditional country foods (Canadian Geographic, 2018). Not only does changing ice and environments pose a physical danger to Indigenous peoples in northern Canada, but the loss of traditional ways of life can severely affect social and cultural aspects of life (Canadian Geographic, 2018). As discussed earlier in this paper, renewable energy reduces damage to the environment, such as air pollution and GHG emission rates.

Electricity is something that society heavily relies on. Indigenous peoples in northern Canada are still quite reliant on the use of diesel generation, which as discussed earlier, has clear adverse effects on the environment. Being able to supply their own clean energy has clear benefits for Indigenous peoples. Direct consultation and autonomy over projects is a huge step towards reconciliation, and the opportunity to slow or stop climate change and preserve traditional life has a huge positive impact.

Conclusion

Canada Energy Regulator found that 99.8% of electricity generated in Nunavut is from petroleum; 61% of electricity generated in the Northwest Territories is from petroleum and natural gas; and 27% of electricity generated in Yukon is from natural gas. By analyzing information found on the CER territorial profiles, it is clear that while the Northwest Territories and Yukon seem to be less reliant on non-renewables than Nunavut, most current renewable electricity generation occurs in the southern half of the two territories, leaving most mid to high latitude

communities non-renewable dependent. Northern Canadian communities are more likely to be diesel-dependent for electricity and heat, not because of a lack of resources, but because communities are remote and infrastructure for renewable energy projects must be able to withstand the harsh climate. As outlined by Krupa (2012), the main barriers are often the large amounts of capital needed and the inequality faced by many communities.

Fortunately, many current projects are being funded, at least partially, by the federal government, such as the Kugluktuk's solar/diesel hybrid plant or the Haeckel Hill Wind Project. As current projects are implemented and technology advances to be successful in cold, harsh weather, more renewable energy projects will be proposed in the far north. Renewable energy not only has the opportunity to mitigate climate change but can lead to energy sovereignty and reconciliation as Indigenous communities take charge of local resources. Though technology and infrastructure will need to continue to advance and become cost-efficient, and policies to reduce social and economic inequality are needed, renewable energy in the Canadian Circumpolar North has great potential to provide lower cost energy and support Indigenous reconciliation.

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