The Energy Trilemma of Indigenous Peoples in the Canadian Arctic: A Way Forward

Image of the northern lights and moon over Iqaluit, Nunavut.
Source: https://www.flickr.com/photos/huntfiona/16309135970/

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Abstract

The Canadian Arctic is home to approximately 300 permanent remote/off-grid communities with the majority of these being Indigenous communities reliant on imported diesel fuel to meet their energy needs. Dependence on transportation of diesel and climate certainty for seasonal infrastructure introduces several dimensions of energy vulnerabilities. These insecurities are heightened by climate fragility of the Arctic, the reliance of Indigenous peoples on the environment for sustaining their traditional way of life and the high energy costs associated with this rigid energy framework. Given these challenges, this paper examines how new energy policy can help Indigenous people in the Canadian arctic solve energy vulnerabilities resulting from the energy trilemma. Through literature review and interviews, this work will identify the macro drivers of energy vulnerability in these communities using the lens of the energy trilemma or measures of energy affordability, security and sustainability. Second, it will quantify and analyze specific impacts at the community level as well as qualify the energy needs and overarching values. Lastly, the project will evaluate of relevant policy and technology cases to address issues like regulatory barriers and the feasibility of alternative and decentralized energy technologies. This research will aim to highlight policy gaps and opportunities to enable these communities to negotiate the barriers to affordable, secure and sustainable energy in the face of threats like climate change accelerated by energy exploration in the Arctic and reliance on increasingly obsolete infrastructure.

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On a personal note, I am indebted to the loving support and encouragement of my family. For the mettā sent to me each morning over the first cup of chai in our home in Toronto and endless kindness of my parents, Geetha and Richard Hobson, as well as his support and inspiring drive to work towards something better, I thank Cailean Iain Macleod.

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Introduction

Alongside many countries across the world, Canada is working to transition away from fossil fuels and work toward sustainable development goals of "access to affordable, reliable, sustainable and modern energy for all"[1]. Although highly commendable, the approach taken has routinely excluded remote Indigenous communities from the development process.[2] This exclusion is evident in the mismatch between the methods of electricity generation at a national level and those in these communities, with the fact most electricity generation in Canada stems from renewable sources juxtaposed with the existence of approximately 300 permanent remote communities largely reliant on isolated diesel systems (Figure 1), of which close to 170 are Indigenous.[3] The extensive subsidies these systems require means they are increasingly unaffordable, with further issues also experienced at a local level: the diesel systems used are responsible for spills, leakages, carbon emissions and other environmental issues,[4] and the poor-quality service these systems provide often places hard limits on community development.[5] With the geographical isolation of the communities precluding any connection to the electricity grid, locally generated alternatives to diesel electricity are being examined, including different fuels such as natural gas or biofuels, and locally employed renewable energy technologies.[6] In any context such a transition would be challenging, but in northern Canada the extreme geographic isolation combined with some of the harshest environmental conditions on the planet makes the development and large-scale roll out of any economically viable alternatives uniquely difficult. Aiming to address these challenges, this analysis will primarily focus on remote Indigenous

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[1] United Nations. (2018). *The Sustainable Development Goals Report 2018*. New York: United Nations Publications. Retrieved from https://unstats.un.org/sdgs/files/report/2018/TheSustainableDevelopmentGoalsReport2018-EN.pdf

[2] Lovekin, D., & Dronkers, B. (2016). *The True Cost of Fuel in the Arctic*. WWF-Canada.

[3] "Remote Communities Energy Database". *Government of Canada*, 2018, http://atlas.gc.ca/rced-bdece/en/index.html. Accessed 9 Nov 2018.

[4] Karanasios, K., & Parker, P. (2018). Tracking the transition to renewable electricity in remote indigenous communities in Canada. *Energy Policy*, *118*, 169-181. doi: 10.1016/j.enpol.2018.03.032

[5] Ibid

[6] Ibid

communities of the Canadian arctic, the dimensions of their energy vulnerabilities and how policy development can address these challenges.

The Government of Canada considers permanent remote communities to be *permanent* after five years or more without connection to the North American electricity grid or piped natural gas network.[7] The remoteness of these communities means the majority are dependent on imported diesel, with some reliant on seasonal bulk deliveries, but in spite of the cost and precarious nature of such dependence there have been few successful projects aimed at reducing diesel use. Although alternatives such as clean power plants and small-scale hydro power do exist, uptake is low with just 5% of remote communities in Canada dependent on diesel powered microgrids developing their own clean power projects.[8] Successful projects have been supported by net metering policies and are generally small in size, often less than 10 kW. Although the population of the northern territories is small, more than two-thirds of all diesel used in power generation in Canada occurs in the Yukon, Northwest Territories and Nunavut, meaning power generation in these jurisdictions is significant not just for the local communities themselves but, also the country as a whole. As mentioned, there are unique difficulties associated with supplying power in these regions, but the exclusion from advancement has also been linked to a lack of policy and program support[9]. This is changing, however, with evidence of a mandate for new, innovative and creative approaches to clean energy development in Canadian remote communities on behalf of Indigenous leaders through to the federal government and its increasingly salience.[10]

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[7] Government of Canada. Status of Remote/Off-Grid Communities in Canada. Government of Canada, 2011.

[8] Lovekin, D., Dronkers, B., & Thibaut, B. (2016). *Power purchase policies for remote Indigenous communities in Canada*. Calgary: The Pembina Institute.

[9] Ibid

[10] Ibid

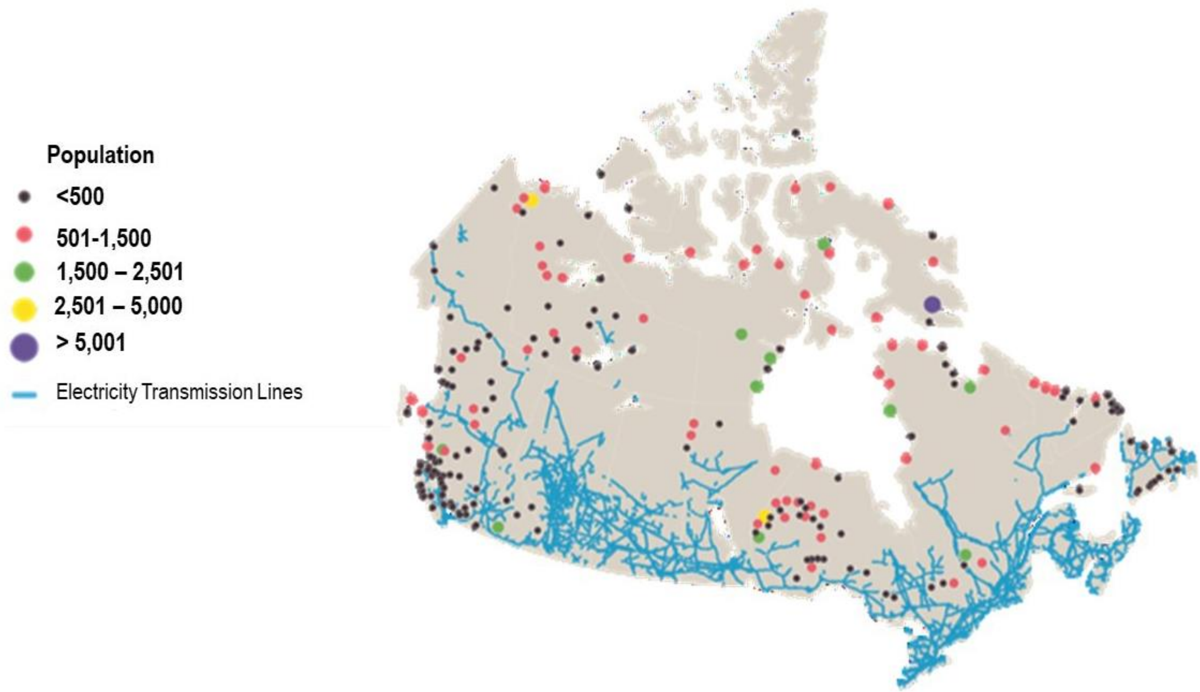


Figure 1 – Diesel Dependent Communities in Canada[11]

The World Energy Council considers energy sustainability to be comprised of three core dimensions: energy security, energy equity and environmental sustainability (Figure 2). The pursuit of these three goals implies a trade-off in choosing one over the other and the result in what is termed the 'energy trilemma'[12]. The energy trilemma "*entail[s] complex interwoven links between public and private actors,*

[11] Brooks, M., & Moore, N. (2017). Open Access Energy Blueprint. Waterloo Global Science Initiative.

[12] Five minute guide to the Energy Trilemma. (2019). Retrieved from https://www.arup.com/perspectives/publications/promotional-materials/section/five-minute-guide-to-the-energy-trilemma

governments and regulators, economic and social factors, national resources, environmental concerns, and individual behaviours."[13]

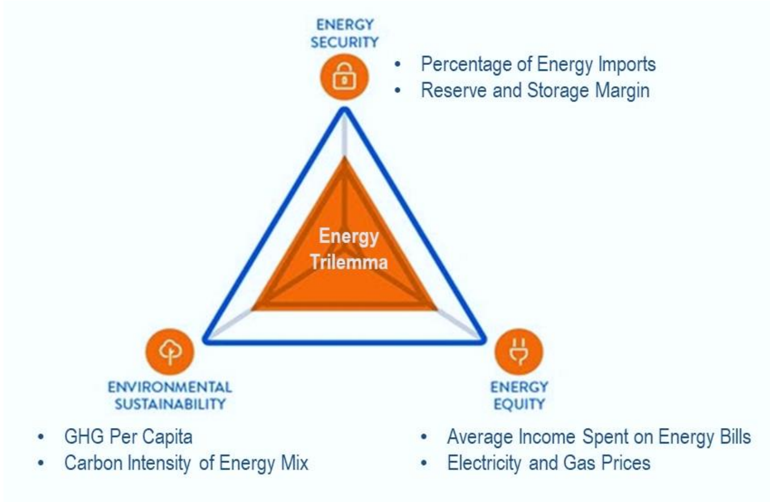


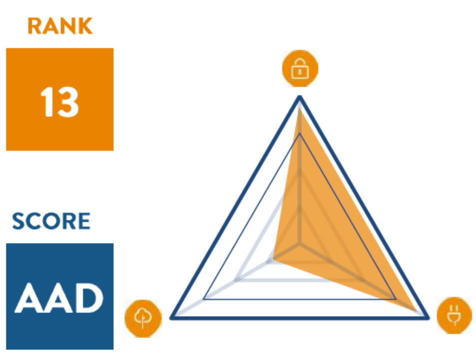
Figure 2 – Illustration of the Energy Trilemma and its Indicators[14,]

According to the World Energy Council's Energy Index, Canada ranks among the top fifteen countries in the world with respect to its energy index on affordability, security and sustainability. Its recent gains in this index come from the latest price statistics that depict Canada as a leader in energy affordability. Although it has improved its grade in terms of equity, its sustainability score is the worst of the highest ranked 30 nations. Its trend of gradual improvement in terms of sustainability resulted in the lower relative score due to greater improvements made in other countries. The overall result is an imbalanced trilemma grade of AAD, A for equity, A for security and D for sustainability, (Figure 3).[15]

[13] World Energy Trilemma. (2019). Retrieved from https://www.worldenergy.org/work-programme/strategic-insight/assessment-of-energy-climate-change-policy/

[14] Figure modified by the author with indicators from Arup's Five minute guide to the Energy Trilemma. Main image sourced from World Energy Council. *World Energy Trilemma Index 2018*. World Energy Council in partnership with OLIVER WYMAN, 2018, https://www.oliverwyman.com/our-expertise/insights/2018/oct/world-energy-trilemma-2018.html. Accessed 30 Mar 2019.

[15] WEC Energy Trilemma Index Tool. (2019). Retrieved from https://trilemma.worldenergy.org/#!/country-profile?country=Canada&year=2018



	2016	2017	2018	Trend	Score
Overall rank and balance score	22	21	13	▶	AAD
Energy performance					
Energy security	5	4	3	▶	A
Energy equity	11	22	7	▶	A
Environmental sustainability	96	100	107	▶	D
Contextual performance	14	11	8	▶	

Figure 3 – Canada's Energy Trilemma Index Ranking and Balance Score

Analysis behind the ranking points to opportunities for policy impact in Canada. Issues of focus named are managing environmental issues from end-use applications such as transport, buildings, industry and electricity, as well as from oil and gas development. Presently 58% of total emissions are from end-use applications and 25% are from oil and gas development. Other issues named are improvement of review processes for energy infrastructure, to provide greater inclusion, predictability and attraction of investment, and widen engagement and distribution of benefits of resource development projects "most notably with Canada's Indigenous population on whose traditional lands most major energy projects will be located."[16] These critical issues are magnified in remote Indigenous communities were climate change could act as a catalyst for energy exploration in the Arctic, with communities voicing concern over contamination of harvest species and changes resulting from day-to-day oil and gas activities.[17] Moreover, emissions profiles associated with electricity

[16] WEC Energy Trilemma Index Tool. (2019). Retrieved from https://trilemma.worldenergy.org/#!/country-profile?country=Canada&year=2018
[17] Nunami Stantec Limited. (2018). *Strategic Environmental Assessment for Baffin Bay and Davis Strait.*

generation in remote Arctic communities are disproportionately high due to import dependence of diesel, lengthy transportation and poor housing stock.[18]

While Canada as a nation makes strides as a leader in energy equity, the benefits of broad affordability do not extend as far north as the Arctic. There is great disparity in electricity rates across Canada where Ontario's domestic rate peaks below $0.20/kWh and in Nunavut it reaches $1.14/kWh. Although energy is highly subsidized in these jurisdictions, geography and population density of remote communities play a significant role in determining cost. The representative territorial and provincial residential electricity prices for 2016 are depicted in Figure 4. A strong division between the territories and provinces in terms of costs at the household level is observed.

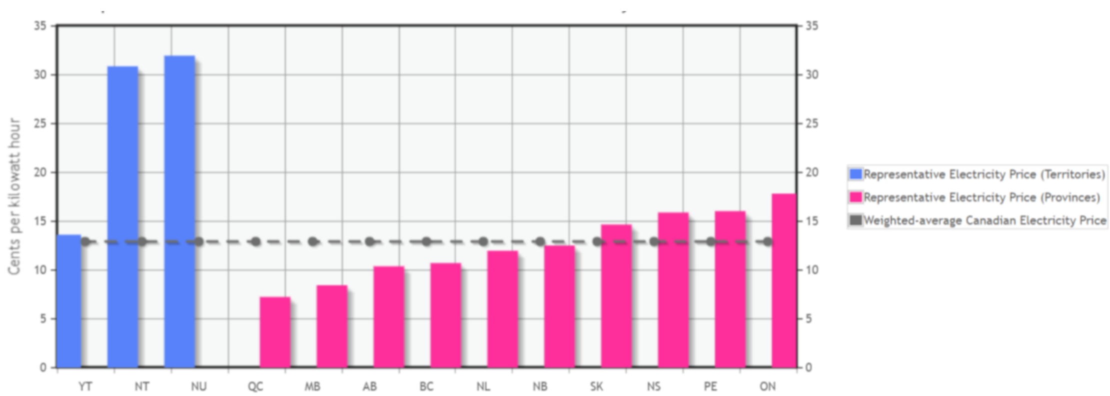


Figure 4 – Representative Residential Electricity Prices in 2016[19]

By definition the energy supply provided to these off-grid communities is highly insecure on the basis of interrupted availability and high costs.[20] The most import dependent jurisdiction is Nunavut. The supply mix of the territory highlights the insecurity and absence of diversification of energy sources in these areas. This

[18] Census in Brief: The housing conditions of Aboriginal people in Canada. (2017). Retrieved from https://www12.statcan.gc.ca/census-recensement/2016/as-sa/98-200-x/2016021/98-200-x2016021-eng.cfm
[19] National Energy Board. Market Snapshot: Explaining the High Cost of Power in Northern Canada. National Energy Board, 2017. https://www.neb-one.gc.ca/nrg/ntgrtd/mrkt/snpsht/2017/02-03hghcstpwr-eng.html
[20] "Energy Security". *International Energy Agency*, 2018, https://www.iea.org/topics/energysecurity/. Accessed 9 Nov 2018.

problem persists today as Nunavut is being almost entirely supplied by imported diesel transported in bulk quantities over the summer months with diversification of the supply mix not anticipated until 2040, when hydropower is expected to be introduced. Forecasts of the capacity by territory and for Canada as a whole are depicted in Figure 5. The lack of diversification of the electricity supply are similar in the Northwest Territories while the Yukon has a more substantial share of hydro. Looking forward, hydro power plants also face challenges for reliability with changing weather patterns and rainfall many attribute to climate change.[21] The need for extensive transportation and as well as seasonal/climate dependence for many of these communities introduces several dimensions of energy insecurity as well as an intensified emission profile.

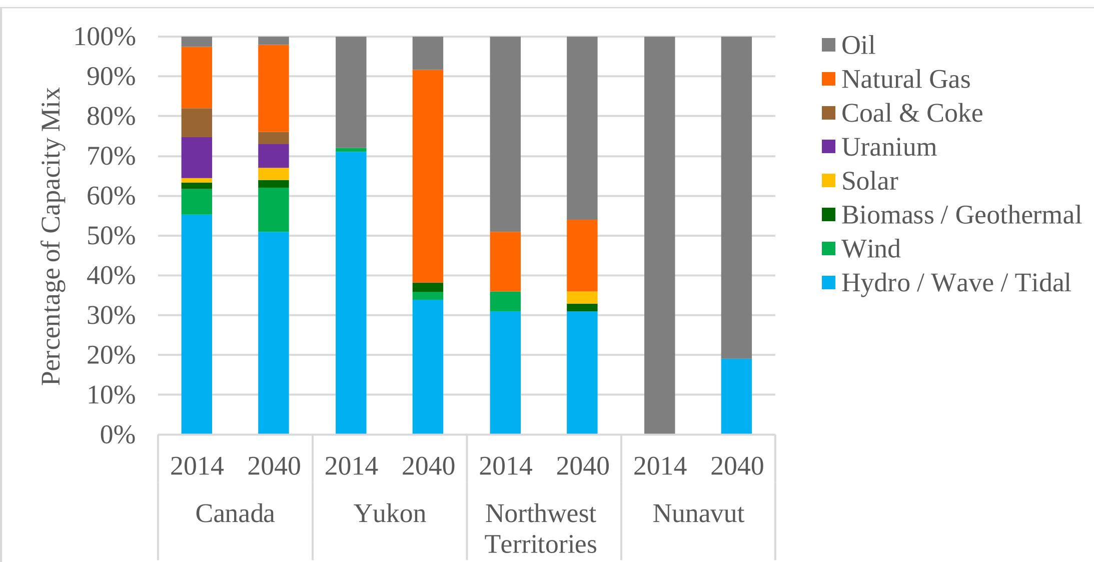


Figure 5 - Capacity Mix by Territory and Canada, 2014 and 2040[22]

Further to the environmental concerns over the existing or lacking infrastructure and fossil fuel dependency in the area is the climate fragility of the Arctic and reliance of

[21] Mallett, A., & Cherniak, D. (2018). Views from above: policy entrepreneurship and climate policy change on electricity in the Canadian Arctic. *Regional Environmental Change*, *18*(5), 1323-1336. doi: 10.1007/s10113-018-1317-7

[22] Recreated by the author with data from the National Enegry Board. Source: "NEB - Canada's Energy Future 2016: Province and Territory Outlooks". National Energy Board, 2017, https://www.neb-one.gc.ca/nrg/ntgrtd/ftr/2016pt/prvnc-trrtrl-cmprsn-eng.html. Accessed 7 Nov 2018.

Indigenous peoples on the environment for sustaining their traditional way of life and livelihoods. Once a harvesting ground for Indigenous hunters, the Arctic has become gradually more and more occupied with activities like resource extraction, commercial fishing, tourism, transport and shipping in addition to nature conservation. As such, traditional livelihoods are already experiencing pressure, and climate change adds to these impacts.[23] Climate change has repercussions on hunting, whaling and fishing for Arctic peoples as populations of harvested species and their health change as does their availability. Furthermore, fluctuating weather and disappearing sea ice also disrupt successful and safe harvesting activities as well as access to hunting areas as a result of delayed autumn freeze-up and sooner spring melting.[24] The potential impacts or decreases to harvest have "implications for indigenous economies, societies, cultures, and health."[25] Changing ocean productivity and water salinity from greater river run-offs and melting ice are anticipated to give way to new disease and insect populations. Moreover, animal hides and the quality of meat are expected to worsen leading to a more reliance on commercial foods "which can be more costly and have negative dietary implications."[26] The arrival of new diseases and allergies linked with the influx of southern animal species, insects and plants is predicted to add to changing diets. Furthermore, traditional methods of food preservation will also become less viable. The probability of food contamination due to damage to pipelines and permafrost based waste containers is increased.

In terms of infrastructure, coastline erosion, community sewage systems, powerlines, airstrips and roads built on permafrost are in danger of impacts from climate change due to stronger storms, river run-off, flooding and permafrost thawing.[27] Certain coastal communities of the Arctic have already been forced to relocate to more central locations due to erosion.

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[23] Tedsen, E., Cavalieri, S., & Kraemer, A. (2014). *Arctic Marine Governance* (pp. 71-99). Berlin: Springer.
[24] Ibid
[25] Ibid
[26] Ibid
[27] Ibid

It is undeniable that the implications from climate change and the energy trilemma for Indigenous Arctic communities are numerous and complex.[28] The current energy framework has demonstrated unaffordable energy costs, import dependence and high emissions profiles. Given these challenges, to what extent can new energy policy help Indigenous people in the Canadian arctic solve the energy vulnerabilities resulting from the energy trilemma?

The master's thesis project is designed to explore energy vulnerability dimensions of remote Indigenous communities in the Canadian Arctic. Through literature review and conducting interviews, this work will first identify the macro drivers of energy vulnerability in these communities using the lens of the energy trilemma or measures of energy affordability, security and sustainability. Second, it will quantify and analyze specific impacts at the community level as well as qualify the energy needs and overarching values. The third part of the project will be to evaluate of relevant policy cases to address issues like funding of energy projects, regulatory barriers and the feasibility of alternative and decentralized energy technologies. This work will aim to present policy gaps and opportunities to enable these communities to negotiate the barriers to affordable, secure and sustainable energy in the face of threats like climate change accelerated by energy exploration in the Arctic and increasingly obsolete infrastructure.

[28] Tedsen, E., Cavalieri, S., & Kraemer, A. (2014). *Arctic Marine Governance* (pp. 71-99). Berlin: Springer.

Chapter 1: Macro Drivers of Energy Vulnerability

This chapter will identify the macro drivers of energy vulnerability in Indigenous Arctic communities using the lens of the energy trilemma or measures of energy affordability, security and sustainability. Macro drivers to be considered include factors governed or dealt with at the international, national or territorial level as well as drivers occurring as a result of actors external to the communities.

Security

Energy security is traditionally understood to be an uninterrupted supply of energy that is necessary for an economy to function.[29] It is further associated with safeguarding access to oil supplies in the face of fossil fuel depletion; however, energy security has an evolving meaning based on the different stakeholders at various moments in time.[30] Concepts of energy security are moving from purely physical values of fossil fuel resources to include the price of energy, conversion and transportation, resiliency in case of extreme events, political stability of areas of supply and transit and environmental sustainability.[31] The Asia Pacific Energy Research Centre groups these elements of energy security into categories of a*vailability–or elements relating to geological existence, accessibility–or geopolitical elements, affordability–or economical elements* and a*cceptability–or environmental and societal elements.*[32] While these categories interact and interplay, Kruyt argues that security of supply (SOS) or energy security is highly context and perspective dependent.[33]

For the majority of remote communities in the Canadian Arctic the issues of availability and accessibility are the most critical factors in SOS. Since these

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[29] Kruyt, B., van Vuuren, D., de Vries, H., & Groenenberg, H. (2009). Indicators for energy security. *Energy Policy, 37*(6), 2166-2181. doi: 10.1016/j.enpol.2009.02.006.
[30] Ibid
[31] Ibid
[32] Asia Pacific Energy Research Centre. *A Quest For Energy Security In The 21St Century*. Asia Pacific Energy Research Centre, Institute Of Energy Economics Japan, Tokyo, 2007.
[33]Kruyt, B., van Vuuren, D., de Vries, H., & Groenenberg, H. (2009). Indicators for energy security. *Energy Policy, 37*(6), 2166-2181. doi: 10.1016/j.enpol.2009.02.006

communities are largely or entirely import dependent and only accessible during certain times of the year, transportation is an added cost and vulnerability of security.

Perspectives can be understood through a stakeholder's outlook on the development of globalization, economic efficiency and technology optimism.[34] In a world developing globalization, moving toward multilateralism, market trust and cooperation, the concern over dependence on external regions is lessened and the larger indicator of supply security is production capacity.[35] In this worldview, geopolitics are a less of a priority than physical availability and production cost. In a Canadian context, this worldview is compatible with the federal government as it positions the country to participate in more global markets with mechanisms like trade agreements. Businesses often fall into the same perspective, with heavy reliance on carbon intensive transportation of goods to source inexpensive products and services. For remote communities in Canada, this world view normalizes reliance on imports of energy as long as there is availability and low production costs. Alternatively, stimulating competition between regions introduces political barriers between regions and drives prioritization of energy independence. In this case, the critical element of SOS will be considered accessibility. Another mechanism for SOS can also be diversification of suppliers, sources and routes of transportation.

Looking next at the tension between environmental aspirations and energy costs, there are generally two streams of thought or worldviews. The first worldview values low energy costs as a paramount for economic growth, exhibits optimism with respect to environmental threats and resource scarcity. In an Arctic context, this view aligns with pro energy exploration stances for economic benefit of communities. The opposing worldview prioritizes concern over environmental costs and resource depletion more than low energy costs. This view is congruent with principles of environmental stewardship and advocates for alternative and renewable energy

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[34] Kruyt, B., van Vuuren, D., de Vries, H., & Groenenberg, H. (2009). Indicators for energy security. *Energy Policy*, *37*(6), 2166-2181. doi: 10.1016/j.enpol.2009.02.006
[35] Ibid

technologies in the Arctic while strongly opposing energy exploration. These dichotomies are illustrated in Figure 6 and offer four storylines as presented by the IPCC's Special Report on Emissions Scenarios: A1 (high level of globalization and focus on economic efficiency), B1 (high level of globalization and focus on equity), A2 (low level of globalization and focus on economic efficiency) and B2 (low level of globalization and focus on equity).

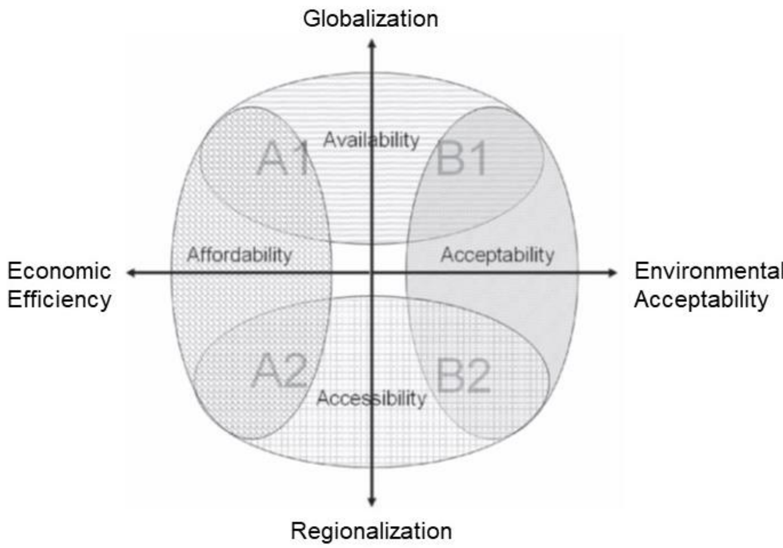

Figure 6 – Energy Security Spectrum[36]

Governance over energy in Canada is divided between the federal and provincial governments and at times considered a shared responsibility. As designated in the Constitution Act of Canada, the provinces are primarily responsible for energy and electricity within their own boundaries except for aboriginal or Indigenous and federal lands, this includes ownership and managements of energy resources, electricity production, distribution and regulation, land use planning, laws on regulation on exploration, development, conservation and energy use. The federal

[36] Kruyt, B., van Vuuren, D., de Vries, H., & Groenenberg, H. (2009). Indicators for energy security. *Energy Policy, 37*(6), 2166-2181. doi: 10.1016/j.enpol.2009.02.006

government is responsible for the management of energy resources on federal Crown lands, offshore areas and Canada's North (defined as the area North of 60° N in latitude). Its responsibilities also extend to international and interprovincial energy trade and infrastructure. Shared responsibilities include energy efficiency, environmental regulation of energy projects, scientific research and development as well as the management of offshore resources. As the energy resources for Indigenous groups and Canada's north fall outside of the jurisdiction of provincial governments, the vision for integrated energy infrastructure or inclusive centralized systems becomes fragmented.

The dominance of conventional energy options in the Arctic can be understood from the global context of decision makers and focus on traditional economic growth. Looking forward, there is motivation for change as greater consensus builds that security for remote communities will stem from affordability, less reliance on subsidies and diversification.[37]

Affordability

Electricity rates are designed to incorporate the supply, transmission and distribution components in addition to applicable taxes. Factors like consumption level of the consumer, geographic location, time-of-use rate and adjustment clauses can also impact prices.[38] Affordability of energy is based on income as traditional metrics of energy poverty are based on the percentage of household income required to pay for energy, with the typical marker of 10% or more indicating energy poverty.

There is great disparity in electricity rates across Canada where Ontario's peak domestic rate has been under $0.20/kWh and in Nunavut it reaches $1.14/kWh.

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[37] Mallett, A., & Cherniak, D. (2018). Views from above: policy entrepreneurship and climate policy change on electricity in the Canadian Arctic. *Regional Environmental Change*, *18*(5), 1323-1336. doi: 10.1007/s10113-018-1317-7

[38] Hydro Quebec. (2018). *Comparison of Electricity Prices in Major North American Cities 2018*. Retrieved from http://www.hydroquebec.com/data/documents-donnees/pdf/comparison-electricity-prices.pdf

However, the Government of Nunavut subsidizes energy costs through a variety of programs.[39] Analysis of the case of Nunavut as the most import dependent jurisdiction of the Canadian Arctic, shows that geography plays a significant role in determining cost. This is again highlighted when looking at Nunavik (Northern Québec) where residents pay higher second tier rates of $0.3762/kWh than residents in the south of the province.[40] Comparing rates in major urban centers and the majority of the country, remote communities have a vastly different financial challenge when it comes to electricity. Figure 7 demonstrates the distribution in the average cost of electricity for residential customers in cities across Canada as well as the difference carbon emission intensity associated with generation. It is evident that populations in Nunavut and the Northwest Territories are most affected by the affordability and sustainability measures of the trilemma.

[39] Touchette, Y., Gass, P., & Echeverría, D. (2017). *Costing Energy and Fossil Fuel Subsidies in Nunavut: A mapping exercise*. International Institute for Sustainable Development.
[40] Ibid

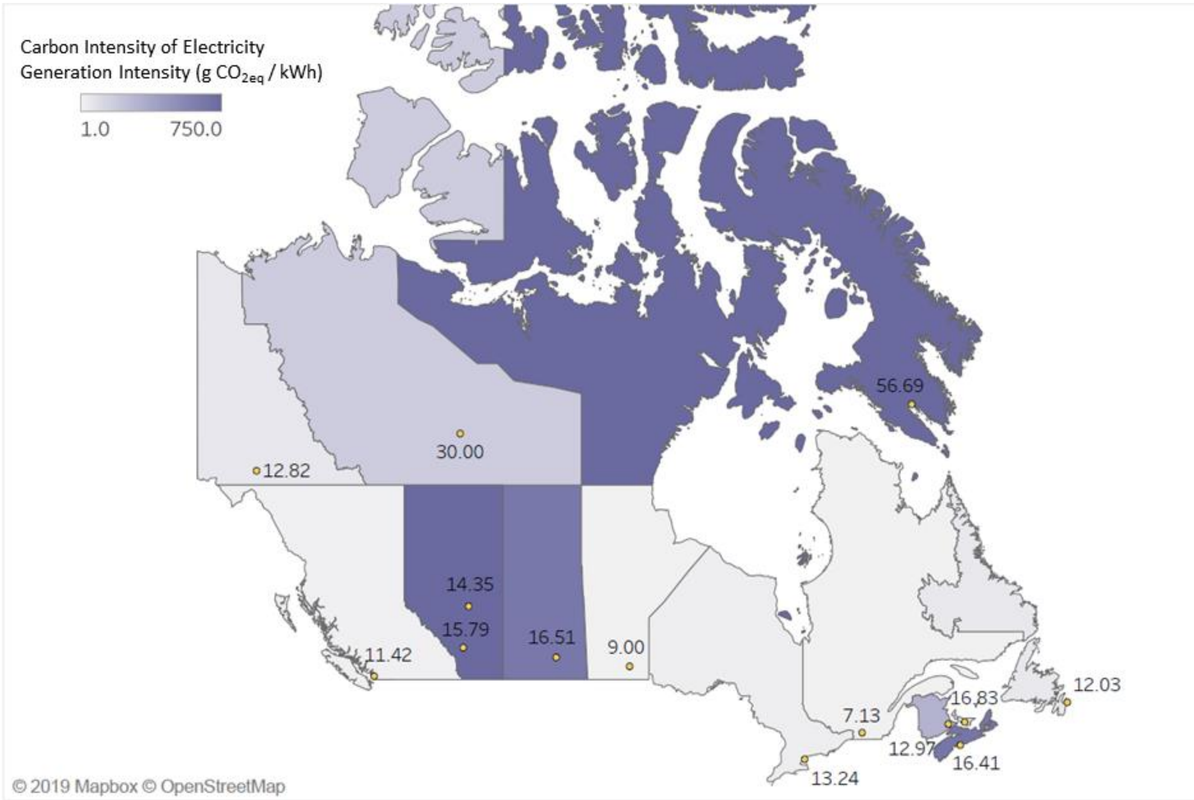

Figure 7 - Average Electricity Price for Residential Customers in Cities across Canada (¢/kWh)[41]

The stakeholder responsible for fossil fuel import in Nunavut is the Petroleum Product Division (PPD) of the territory. This department is mandated to run at-cost, in other words, the cost of fuel in its entirety is paid by residential and commercial customers.[42] These customers are then subsidized for their high fuel costs through numerous government programs operated by the Departments of Finance, Family Service and the Nunavut Housing Corporation.[43] The Government of Nunavut spends

[41] Map Drawn by Author using Tableau Software. Price data sourced from Hydro Quebec's *Comparison of Electricity Prices in Major North American Cities 2018* Report, Yukon Energy, Arctic Energy Alliance – Fuel Cost Library, Quilliq Energy Corporation (for Nunavut). Generation Intensity Data is for 2017 and sourced from Canada's 2019 National Inventory Report.

[42] Touchette, Y., Gass, P., & Echeverría, D. (2017). *Costing Energy and Fossil Fuel Subsidies in Nunavut: A mapping exercise*. International Institute for Sustainable Development.

[43] Ibid.

60.5 million dollars on average annually to subsidize diesel fuel, of which, more than half is spent on electricity subsidies.[44] The Nunavut Housing Corporation administers the largest share and more than three quarters of all territorial subsidies for fossil fuel, paying an average of 45.9 million dollars between 2012 and 2016.[45] Reported subsidies for fossil fuel in the territory have generally been in decline over the past five years (Figure 8). The downward trend is driven partially by the lower global cost of bulk energy costs.[46] It is uncertain if the trend will continue going forward as it reflects fluctuations of the energy market.

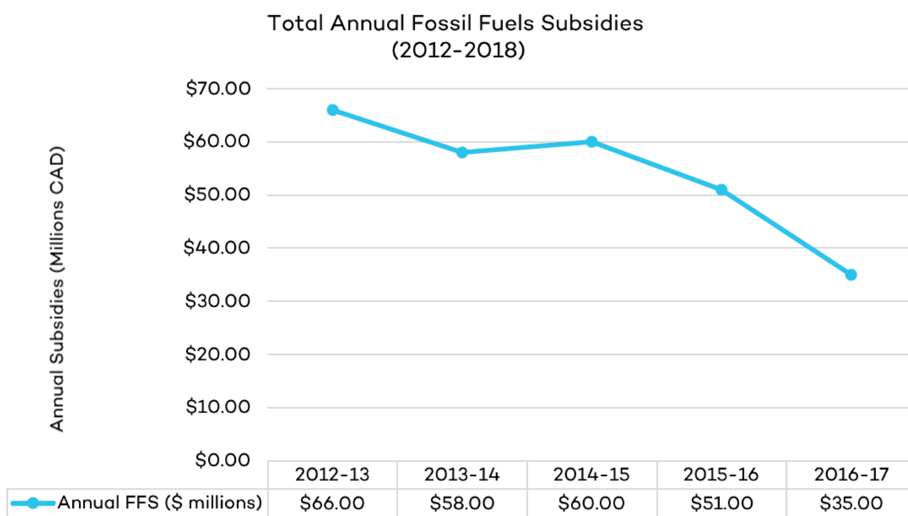

Figure 8 – Annual Cost of Nunavut's Fossil Fuel Subsidies (2012 – 2018)[47]

PPD manages the bulk purchase of all fuel for the territory. Since there is a single purchase, the cost of fuel is set for twelve-month intervals.[48] The Financial

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[44] Touchette, Y., Gass, P., & Echeverría, D. (2017). *Costing Energy and Fossil Fuel Subsidies in Nunavut: A mapping exercise*. International Institute for Sustainable Development.
[45] Ibid
[46] Ibid
[47] Ibid
[48] Ibid

Management Board sets retail prices for communities served by PPD based on the following inputs: actual product cost, actual transportation cost, commissions for local fuel sales, dispensing and delivery services, operation and maintenance expenses, product evaporation and shrinkage, and taxes.[49] The overall cost of fuel for the territory fluctuates based on bulk market prices. From 2012 to 2017, the cost fuel ranged from 170 – 195 million dollars and the revenues over the same period were from approximately 205 to 223 million dollars.[50]

As macro drivers of affordability are closely entwined with sustainability and security dimensions, e.g. the cost of climate change or energy infrastructure and related subsidies, carbon taxation is another factor to consider. With increasing global pressure to move away fossil fuels, it is another dimension of energy vulnerability for these isolated communities. It is worth noting that Indigenous peoples are exempt from certain taxes[51] and remote diesel dependent communities are exempt from the federal scheme in Canada or Federal Carbon Pollution Pricing System[52] set to begin in mid-2019[53]; however, the impact on of rising energy costs and market pressure for the region remain significant. Global trends and the development of carbon taxation as a method for shaping markets and human behavior has led to the anticipation of these mechanisms and their ramp up. There are currently more than 70 carbon pricing initiatives in national and subnational jurisdictions worldwide.[54]

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[49] Touchette, Y., Gass, P., & Echeverría, D. (2017). *Costing Energy and Fossil Fuel Subsidies in Nunavut: A mapping exercise*. International Institute for Sustainable Development.
[50] Ibid
[51] GST/HST and Indigenous peoples. (2019). Retrieved from https://www.canada.ca/en/revenue-agency/services/tax/businesses/topics/gst-hst-businesses/charge-collect-indigenous-peoples.html
[52] Pollution pricing: technical briefing. (2018). Retrieved from https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/putting-price-on-carbon-pollution/technical-briefing.html
[53] "Statement on The Introduction Of Canadian Carbon Taxes". *International Institute For Sustainable Development*, 2018, https://www.iisd.org/media/statement-introduction-canadian-carbon-taxes.
[54] Carbon Pricing Dashboard. (2019). Retrieved from https://carbonpricingdashboard.worldbank.org/map_data

In attempt to gain insight to future energy costs and how prices could evolve, the IISD International Institute for Sustainable Development applied an estimated carbon price[55] to consumption projections for Nunavut for the next two decades to illustrate the potential impacts of a carbon pricing model. The IISD's simulation depicts the impact of a carbon pricing model on the cost of energy for five remote communities in Nunavut as a territorial sample (Figure 9). *"Using annual energy projections and the implementation of the Pan-Canadian Framework on Clean Growth and Climate Change as a guide, IISD estimates that greenhouse gas emissions emitted by fossil fuels will add on average roughly CAD 2.8 million to the cost of energy annually between 2016 and 2036."*[56] Given the high energy costs and level of subsidies, increasing need for government resource may motivate strategic integration of renewable energy systems.[57]

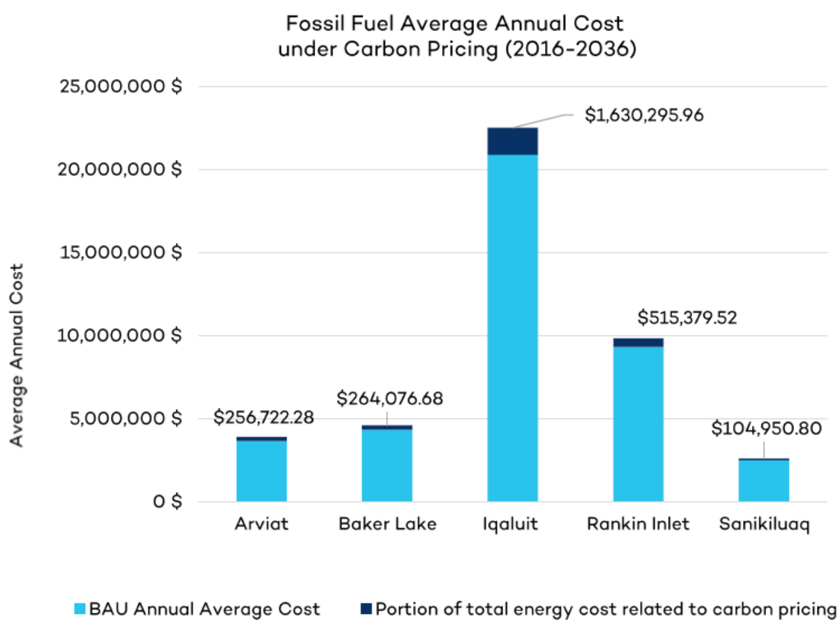

Figure 9 – Annual average cost of fossil fuels under carbon pricing (2016 – 2036)[58]

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[55] Based on the Pan-Canadian Framework on Clean Growth and Climate Change model

[56] Touchette, Y., Gass, P., & Echeverría, D. (2017). *Costing Energy and Fossil Fuel Subsidies in Nunavut: A mapping exercise*. International Institute for Sustainable Development.

[57] Ibid

[58] Ibid, 18

One can speculate that given the unique position of remote communities, adapting to the market pressures stemming from carbon taxation would be difficult compared to the urban dwelling majority of Canadians. Researchers examining carbon taxation in British Columbia found that rural households shouldered a larger burden of the tax due to a greater percentage of income being spent on transportation fuels.[59] Since its inception in 2008, there has been a broad public perception of unfairness on rural and northern portions of the population and this has been vocalized by local interest groups, municipal politicians.[60] Northern communities in British Columbia suggested that their "*consumption of heating fuels and gasoline was inherently higher and more difficult to be substituted than that of households in the urban centers of the province's South".* It is further claimed that *"the geographical remoteness and cold temperatures of northern communities raise demand for space heating and require people to buy larger cars and drive longer distances to work, shops, and medical care"* moreover, the lack of public transit as an alternative to conventional fossil fuel consuming vehicles has left northerners to view fuel consumption as a necessity rather than a choice or lifestyle.[61] In the case of British Colombia, protests led to the creation of a benefit program for northern and rural homeowners in the year following implementation of the carbon tax.[62] The challenges of these negative perceptions of carbon taxation for the northern and rural populations coupled with limited diversification of the energy supply in remote areas and existing high cost and subsidized energy in these areas pose a large question to the potential impact of the national carbon tax scheme and greater market pressure. With increasing political and environmental tension to move away from fossil fuels, exposure in remote communities is an explicit vulnerability.

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[59] Beck, M., Rivers, N., & Yonezawa, H. (2016). A rural myth? Sources and implications of the perceived unfairness of carbon taxes in rural communities. *Ecological Economics*, *124*, 124-134. doi: 10.1016/j.ecolecon.2016.01.017.
[60] Ibid
[61] Ibid
[62] Ibid

Another example of this vulnerability are growing subsidies needed in the Northwest Territories for electricity. Starting in 1998, the Government of the Northwest Territories (GNWT) provided 5 million dollars for electricity subsidies that then doubled in 2008. In 2014 – 2015 GNWT provided close to 50 million dollars in subsidies for diesel to electricity consumer due to low water level on the hydro grid system.[63] As some attribute low water levels to climate change, the interconnected nature of affordability, security and sustainability is evident.

Sustainability

As it has been established that the Arctic region is particularly susceptible to climate change and environmental changes, it is important to consider the applicable climate and policies of the key actors, namely Canada at a federal level due to the governance structure. However, other groups and countries such as the U.S.A., European Union and Russia play a role as they influence critical petroleum and shipping activities in the Arctic region.

Energy exploration and energy exploration infrastructure in the Arctic is globally significant not only from a supply standpoint, but also in terms of eminent climate impacts. Geological valuations of the Arctic Circle have assessed that close to a third of the world's undiscovered gas and 13% of undiscovered oil may be found in the region.[64] The majority of speculated oil and gas is offshore and below less than 500 meter of water and "many onshore areas have already been explored; by 2007, more than 400 oil and gas fields, containing 40 billion barrels of oil (BBO), 1136 trillion cubic feet (TCF) of natural gas, and 8 billion barrels of natural gas liquids had been developed north of the Arctic Circle, mostly in the West Siberian Basin of Russia and

[63] Mallett, A., & Cherniak, D. (2018). Views from above: policy entrepreneurship and climate policy change on electricity in the Canadian Arctic. *Regional Environmental Change*, *18*(5), 1323-1336. doi: 10.1007/s10113-018-1317-7

[64] Gautier, D., Bird, K., Charpentier, R., Grantz, A., Houseknecht, D., & Klett, T. et al. (2009). Assessment of Undiscovered Oil and Gas in the Arctic. *Science*, *324*(5931), 1175-1179. doi: 10.1126/science.1169467

on the North Slope of Alaska." [65] This energy context in the Arctic region has led an increasing role for international companies, while extraction can only take place through resource ownership, the states with legal right to exploit oil and gas in the Arctic as per the United Nations' Convention on the Law of the Sea are Canada, Denmark, Iceland, Norway, the USA and Russia.[66]

Moreover, the European Union along with external states including China, India and Japan in have displayed interest in projects in the Arctic ranging from research to extraction, with a number of foreign companies participating in joint ventures with Arctic-based companies (e.g. the Italian company ENI has developed a joint exploration agreement with Russia's Rosneft). [67] Drawbacks to exploration include the remote and harsh climate and cost for advanced technologies, long investment cycle and potential for sovereignty disputes.[68]

Natural gas is thought to comprise 70% of undiscovered petroleum resources in the Arctic.[69] Considered in many ways a "last large frontier" outside of the Middle East and North African (MENA) region globally, the significance of these reserves is becomes more critical on the world stage.[70] Furthermore, as the world transitions away from coal demand for natural gas could change as both fuels are substitutes for one and other in power generation. While both fuels are focus of climate policy, natural gas is less carbon intensive and less of a contributor to air pollution.[71] Therefore, it follows that the future of the natural gas and coal is closely related.

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[65] Gautier, D., Bird, K., Charpentier, R., Grantz, A., Houseknecht, D., & Klett, T. et al. (2009). Assessment of Undiscovered Oil and Gas in the Arctic. *Science, 324*(5931), 1175-1179. doi: 10.1126/science.1169467

[66] McCauley, D., Heffron, R., Holmes, R., & Pavlenko, M. (2017). Energy justice: A new framework for examining Arcticness in the context of energy infrastructure development. In Kelman I. (Ed.), *Arcticness: Power and Voice from the North* (pp. 77-88). London: UCL Press. Retrieved from http://www.jstor.org/stable/j.ctt1tm7jp1.15

[67] Ibid, 80

[68] Ibid, 80

[69] Lindholt, L., & Glomsrød, S. (2018). Phasing out coal and phasing in renewables – Good or bad news for arctic gas producers?. *Energy Economics, 70,* 1-11. doi: 10.1016/j.eneco.2017.12.015

[70] Ibid

[71] Ibid

Natural gas is the only fossil feedstock with an increasing share.[72] Driven by the global transition, rapid transitions away from coal by large countries like the USA following the boom of shale gas, divestment from coal pledges on the horizon from public and private sector across the world by bodies like the Norwegian Government Pension Fund Global and French insurance company AXA, and long term plans for coal phase-out in Germany in addition to regions of the world who have already transitioned like Ontario in Canada – the share of coal generated electricity globally is dropping. Although in 2012 coal contributed to 41% of global electricity, this piece of the global energy mix is in decline. These changes in behaviour and energy patterns globally may have regional implications on the position the Arctic takes as potential supplier of natural gas.[73] In parallel to the evolving dynamic between natural gas and coal, the introduction and adoption of renewables is projected to increase with the drive toward emissions reduction and greater feasibility through growing cost competitiveness on the part of solar and wind energy technologies.[74] Due to competing interests, climate policies and vulnerability of local populations, scenario modelling is important in the face of climate sensitivity and its social, cultural and economic implications.

Lindholt and Glomsrød are the first to present analysis on how the dynamics of competition between natural gas, coal and renewables in the power sector globally may impact regional gas production in the Arctic. These researchers applied the FRISBEE model, a "*recursive, dynamic partial equilibrium model for the global energy markets, previously used for studies of arctic petroleum production (Lindholt and Glomsrød, 2012), emission from shipping and petroleum activities in the Arctic (Peters et al., 2011), impacts of petroleum industry restructuring (Aune et al., 2010) and globalization of natural gas markets and trade (Aune et al., 2009)*".[75] The reference scenario is aligned with the New Policy Scenario of the International

[72] Lindholt, L., & Glomsrød, S. (2018). Phasing out coal and phasing in renewables – Good or bad news for arctic gas producers?. *Energy Economics, 70*, 1-11. doi: 10.1016/j.eneco.2017.12.015
[73] Ibid
[74] Ibid
[75] Ibid

Energy Agency that depicts the decline of coal contributors and increase of renewables in global electricity production. Lindholt and Glomsrød found that arctic gas supply strongly increases after 2030 to 850 Mtoe by 2050 as compared to its 2012 production level of 500 Mtoe.[76] Selected modelling results of Lindholt and Glomsrød, including their reference and coal-phase scenarios are shown in Figure 10.

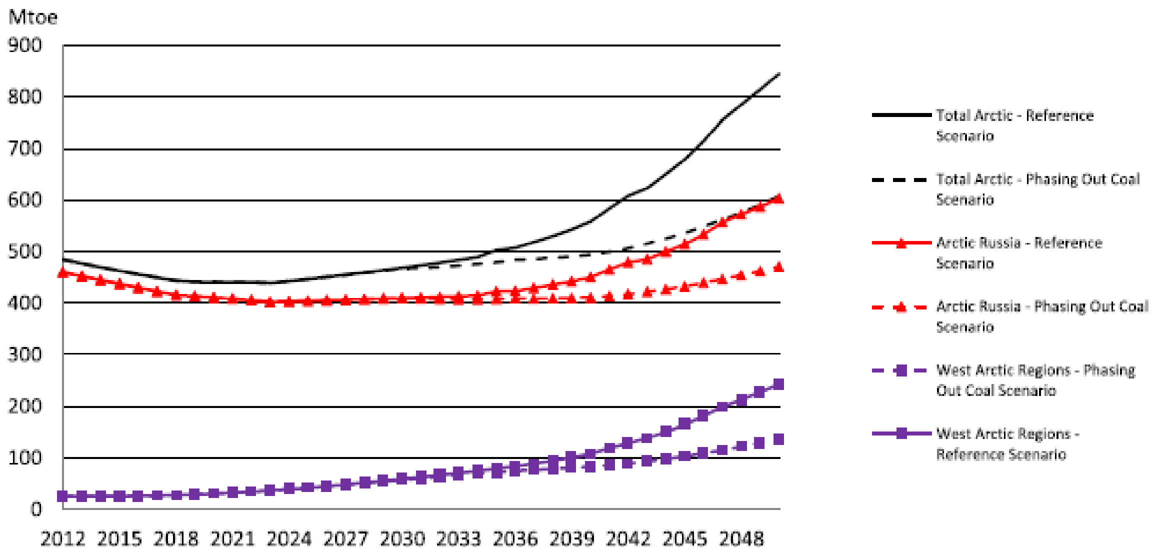

Figure 10 – Forecast Arctic Gas Production: Reference and Coal Phase Out Scenarios[77]

In the coal phase-out scenario presented natural gas faces limitations from climate policy, but to a lesser than extent than coal. Arctic gas production decreases as a result of these factors and is diminished in the longer term compared to the reference case. The impact of renewables crowding out gas is anticipated to appear more strongly after 2030. [78] While production is impacted, it is still continues in an uptrend after 2030. In a global this could result in the Arctic suppling 25% more than its 2012

[76] Lindholt, L., & Glomsrød, S. (2018). Phasing out coal and phasing in renewables – Good or bad news for arctic gas producers?. *Energy Economics*, *70*, 1-11. doi: 10.1016/j.eneco.2017.12.015
[77] Ibid
[78] Ibid

share by 2050 as reserves from the MENA regions are increasingly depleted and costly.[79]

In the event that only half of the Arctic supply is accessible, the level of supply is anticipated to slightly surpass its 2012 output.[80] The authors note that investment is required to maintain capacity though “no arctic gas bonanza seems to follow if coal is being phased out from electricity production worldwide.”[81] Over-anticipation of Arctic gas supply could lead to stranded capital assets either on or offshore.[82]

For Canada, acceleration of gas production from its Arctic region is similarly expected around 2030 with a production level mirroring that of Alaska. Canadian production is however expected to plateau in the longer term, by 2050.[83] The initial rapid momentum in gas supply is linked to advancement of LNG plants as well as possible pipeline infrastructure such as the Mackenzie pipeline.[84] The now concluded Mackenzie Valley Gas Project, a joint-venture of Imperial Oil, ConocoPhillips Canada, ExxonMobil Canada and the Aboriginal Pipeline Group, had been proposed to transport gas from the North West Territories to Alberta and further south. The “much-anticipated but long-doubted” project once set to begin in 2022 had an estimated cost greater than $16 billion Canadian dollars and included a proposed 1,200 kilometers of pipeline.[85] The current impact of shale gas being supplied by North American markets and low costs of natural gas did not signal commercial viability for this kind of project. However, this may change in the future. While some Indigenous groups looked to the development of the Mackenzie pipeline optimistically for community development, others invoked their right to postpone the

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[79] Lindholt, L., & Glomsrød, S. (2018). Phasing out coal and phasing in renewables – Good or bad news for arctic gas producers?. *Energy Economics*, *70*, 1-11. doi: 10.1016/j.eneco.2017.12.015
[80] Ibid
[81] Ibid
[82] Ibid
[83] Ibid
[84] Ibid
[85] Strong, W. (2017). Mackenzie Valley pipeline project officially one for the history books. *CBC News*. Retrieved from https://www.cbc.ca/news/canada/north/mackenzie-valley-gas-project-no-more-1.4465997

project numerous times.[86] Indigenous groups in Canada have stopped seismic surveys in the Baffin Bay area due to lack of consultant and infringement on their legal rights.

The reliance on fluctuating commodity prices and revenues from resource wealth can vary dramatically year to year for development are characteristic of the resource curse.[87] Moreover, the unpredictable nature of revenues presents extreme challenges for effective spending, with the governments, or in this case communities, highly susceptible to cyclical patterns of boom and bust. Extractive industries are also prone to challenges of people and environments in close proximity to extraction sites and is often a point of tension.

Private companies in the Arctic may be able to endure the costs of energy exploration; however, environmentalists warn of irreparable damage to the fragile environment of the region and its 400,000 Indigenous peoples inhabiting these Arctic nations.[88] Moreover, trends of a changing climate are being observed on a global scale as 80% of cod stock in the Barents Sea could disappear by 2100 according to The Intergovernmental Panel on Climate Change. [89] These effects filter down to the community level as fluctuations in traditional hunting species and fish populations, their availability and health directly impacts Indigenous communities. In addition to changing weather, such as later autumn freeze-up and earlier spring melts which have affected accessibility of hunting areas, the productivity of oceans and their salinity levels are also shifting due to larger amounts of river run-off and melting sea ice. The birth of new diseases linked to an influx of customarily southern animal species and

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[86] Strong, W. (2017). Mackenzie Valley pipeline project officially one for the history books. *CBC News*. Retrieved from https://www.cbc.ca/news/canada/north/mackenzie-valley-gas-project-no-more-1.4465997
[87] Natural Resource Governance Institute. (2015). The Resource Curse [Ebook]. Retrieved from https://resourcegovernance.org/sites/default/files/nrgi_Resource-Curse.pdf
[88] McCauley, D., Heffron, R., Holmes, R., & Pavlenko, M. (2017). Energy justice: A new framework for examining Arcticness in the context of energy infrastructure development. In Kelman I. (Ed.), *Arcticness: Power and Voice from the North* (pp. 77-88). London: UCL Press. Retrieved from http://www.jstor.org/stable/j.ctt1tm7jp1.15
[89] Brzozowski, A. (2019). Arctic nations bet on 'blue economy' to reconcile climate, development goals. Retrieved from https://www.euractiv.com/section/global-europe/news/arctic-nations-bet-on-blue-economy-to-reconcile-climate-development-goals/

the rise of insect populations are equally anticipated in face of these environmental changes. Moreover, the quality of animal meat and hides is anticipated to diminish and lead to a greater dependence of commercial food for remote communities. Reliance on store food can be more costly and have negative health or dietary effects. Exacerbating the problem is the harmful implications for viability of traditional methods of food preservation. The probability of food contamination is expected to rise because of infrastructure damage to pipelines and permafrost-based waste containers.

As well as the social imperative for mitigating climate change, the economic impacts of disappearing fish populations forecast in the longer-term are crucial for countries such as Norway and one of its most significant industries; however, there are immediate economic impacts for communities already experiencing this wave of change. Remote northern communities have mixed economies that are a "combination of formal economies based on cash flows and traditional methods of acquiring food, clothing, and commodities." The economic characteristics of these communities play a critical role is the assessment of vulnerability and adaptive capacity.[90] While there is no longer complete reliance on harvesting and raising livestock for livelihood in the Arctic, it remains significant for health, food security as well as cultural and social ties.[91] Traditional cash flows in this kind of mixed economy are typically acquired "through wage income (often through government jobs or resource extraction), governmental transfers, leisure and hunting tourism, and the selling of harvested goods and handicraft."[92] The drivers for resource extraction in terms of economic gain in mixed economies become more visible as traditional aspects are impacted by climate change, changes in lifestyle, new standards of living and a diminishing of resources.[93]

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[90] Tedsen, E., Cavalieri, S., & Kraemer, A. (2014). *Arctic Marine Governance* (pp. 71-99). Berlin: Springer
[91] Ibid
[92] Ibid
[93] Ibid

In terms of a Canadian stance on energy exploration in the region, a moratorium on new oil and gas activities in all offshore Canadian Arctic waters was instituted by the Federal Government of Canada in 2016 and is subject to review in 2021.[94] Based on the proximity of the review period, discussions on energy exploration of the Baffin Bay and Davis Strait are currently underway.[95] The Nunavut Impact Review Board is currently facilitating a Strategic Environmental Assessment in Baffin Bay and Davis Strait to recognize the "possible types of offshore oil and gas related activities that could one day be proposed in the Canadian offshore waters of Baffin Bay and Davis Strait and their associated risks, benefits, and management strategies."[96] The assessment is a method of addressing regional issues related to human activity on the environment as well as transparently engage stakeholders, local communities and regulatory bodies. Consulting firm, Nunami Stantec, was retained for a literature review of the present status of knowledge on the physical, biological, and human environments of the area of interest including the possible impacts stemming from oil and gas activities on "Valued Ecosystem Components" and "Valued Socio-Economic Components".[97] The Strategic Environmental Assessment considered the typical life cycle of oil and exploration, including development activities, which was assumed to be 15-20 years for exploration and 30-60 for field development and production.[98] The following scenarios were analyzed with consideration of estimated timelines, activities, financial feasibility, domestic policy and environmental constraints: (1) Exploration including offshore seismic surveys; (2) Exploration drilling; (3) Field development and production drilling; and (4) No offshore oil or gas activity. [99]

Assessing a variety of potential effects on the physical, biological and human environments, the review found that potential changes such as to air quality would

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[94] Strategic Environmental Assessment | Nunavut Impact Review Board. (2019). Retrieved from http://www.nirb.ca/content/strategic-environmental-assessment
[95] Ibid
[96] Ibid
[97] Nunami Stantec Limited. (2018). *Strategic Environmental Assessment for Baffin Bay and Davis Strait*.
[98] Ibid
[99] Ibid

not be expected to exceed regulatory standards.[100] Similarly, increased noise levels or water quality changes would localized or negligible.[101] The report identified underwater noise as a potential concern to the sustainability of marine organisms as it can affect a large area.[102] Furthermore, the impact of an oil spill on water quality, sediment quality, sea ice, marine and shoreline habitat as well as behaviour, health and mortality risks to marine life were listed as adverse effects, while the probability of such an event was not likely.[103] In terms of human environment, an increase in economic activity in predicted in local communities coming from greater spending on goods and services from local businesses as well as increased direct and in direct employment.[104] Other possible positive effects include the potential developmental legacy of oil and gas activity on infrastructure and service capacity within communities that could possibly outlast the extraction process.[105] The change in access to resources was also named as having a potential effect as the need for ice breaking to enable ships may disrupt over-ice paths for traditional harvesting.[106]

In terms of overall perceived health and well-being of communities, possible positive effects could stem from new economic activity and gain, increased employment, reduced social assistance or support and greater access to food.[107] Additional taxes, royalties or benefit agreements may afford governments new revenues to invest in infrastructure and services.[108] Potential negative effects to community health and wellbeing include reduced ability for hunting activities, fewer opportunities for cultural sharing and community cohesion, higher housing costs, an existing issues in Nunavut and changes in access to traditional harvesting sites and harvest quality.[109]

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[100] Nunami Stantec Limited. (2018). *Strategic Environmental Assessment for Baffin Bay and Davis Strait.*
[101] Ibid
[102] Ibid
[103] Ibid
[104] Ibid
[105] Ibid
[106] Ibid
[107] Ibid
[108] Ibid
[109]Ibid

The report notes that people of Nunavut voiced concern over contamination of harvest species and changes in their distribution resulting from discharges in the course of day-to-day oil and gas activities.[110]

In contrast to new extraction, it is important to note the environmental impact of existing diesel electricity generation in the Arctic. In addition to the air contaminants such as NOx and black carbon particulate matter which have long recognized roles in climate change acceleration, there is significant leakage of diesel in faulty fuel storage and supply operations.[111] Diesel and gasoline spillage in Nunavut communities accounted for $1.5 million in accrued liability, whilst the North West Territories has lost more than 33,000 litres of spilled fuel on average over the last five years.[112]

It also important to quantify emissions in the Arctic from external stakeholders such as the EU as it represents one of the most ambitious group of stakeholders pushing climate policy and targets. When looking at greenhouse gas emissions, contributions of the EU made up 15% of the global footprint and impact on the region while its demand for oil and gas products made up close to a quarter of the industry.[113] It was further reported that "t*he EU contributed a 59% share of black carbon emissions in the region. As black carbon deposition increases the rate of melting in snow and ice, this should have clear policy implications for the EU's Arctic agenda*"[114]. The need for multi-lateral coordination and governance strategy in addressing climate goals and the environmental fragility of the Arctic becomes clear when considering the large component of emissions coming from outside immediate region. Looking forward, this need intensifies as climate change progresses and development of LNG strategy

110 Nunami Stantec Limited. (2018). *Strategic Environmental Assessment for Baffin Bay and Davis Strait*.
111 McFarlan, Andrew. "Techno-Economic Assessment of Pathways for Electricity Generation in Northern Remote Communities in Canada Using Methanol and Dimethyl Ether to Replace Diesel." *Renewable and Sustainable Energy Reviews* 90 (2018): 863-876. Web. 22 Apr. 2019.
112 Ibid
113 Dobson, N., & Trevisanut, S. (2018). Climate Change and Energy in the Arctic—The Role of the European Union. *The International Journal Of Marine And Coastal Law, 33*(2), 380-402. doi: 10.1163/15718085-13320011
114 Ibid, 384.

or expected large shifts away from coal increase in demand for natural gas and Arctic production.

Chapter 2: Energy Affordability, Security and Sustainability at the Community Level

After analyzing the macro-dimensions of the energy vulnerabilities of the Arctic communities through the lens of the dimensions of the energy trilemma, this section will quantify and analyze specific impacts of the energy dimensions identified in Chapter 1 at the community or micro level. It will then qualify the energy needs of the communities going forward.

Measuring Energy Affordability and Household Costs

While there is common agreement that progress toward greater equity has been made in recent years *"an enormous economic gap still exists between First Nations and mainstream Canadian society."*[115] The proposed methodology for this section will map income data from Statistics Canada and consider scenarios of household expenditure for basic energy needs. This analysis and a cost breakdown of energy expenditure in each household is developed as part of the Canadian Survey of Household Spending program. Since, the program does not collect this information from Indigenous groups, this section draws lessons from country-wide data.[116] Bridging this data gap will inform context for looking at policy and technology implementation as well as the social and economic value of these solutions. Moreover, drawing a link between energy efficiency, housing and affordability is critical due to their interconnection. As a starting point for this discussion, this section will assess the current status of housing for Inuit peoples in Arctic regions and its implications on energy supply.

[115] Krupa, J. (2012). Identifying barriers to aboriginal renewable energy deployment in Canada. *Energy Policy*, *42*, 710-714. doi: 10.1016/j.enpol.2011.12.051
[116] "Surveys and statistical programs - Survey of Household Spending (SHS). (2019). Retrieved from http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=3508

A recent paper analyzed the Canadian Survey of Household spending for British Columbia and found that house energy expenditures show a regressive pattern.[117] In other words, lower-income homes spend a larger share of their income on meeting energy needs than other income-brackets. According to 2010 census data from Statistics Canada for all persons in Canada, this trend holds true for the country. The lowest income quintile in 2010 spent approximately 7% of their income on energy for a principal accommodation whereas the highest quintile spent roughly 3%. While the difference in energy expenditure is relatively low, the contrast in earnings is more significant and points to inequity for lower incomes households where the issue of affordability is more pronounced, this quantitative data is displayed in Figure 11. Lee et al. further confront other barriers to low-income households like capital required for efficiency upgrades and target group for single-family homes as opposed to multi-unit residential buildings or tenants. Looking to the German model, electricity is 3-4 times as expensive as British Columbia; however, monthly bills remain similar due to improved energy efficiency. [118]

[117] Lee, M., Kung, E., & Owen, J. (2011). *Fighting Energy Poverty in the Transition to Zero-Emission Housing: A Framework for BC.* Vancouver: Canadian Centre for Policy Alternatives.
[118] Ibid, 10.

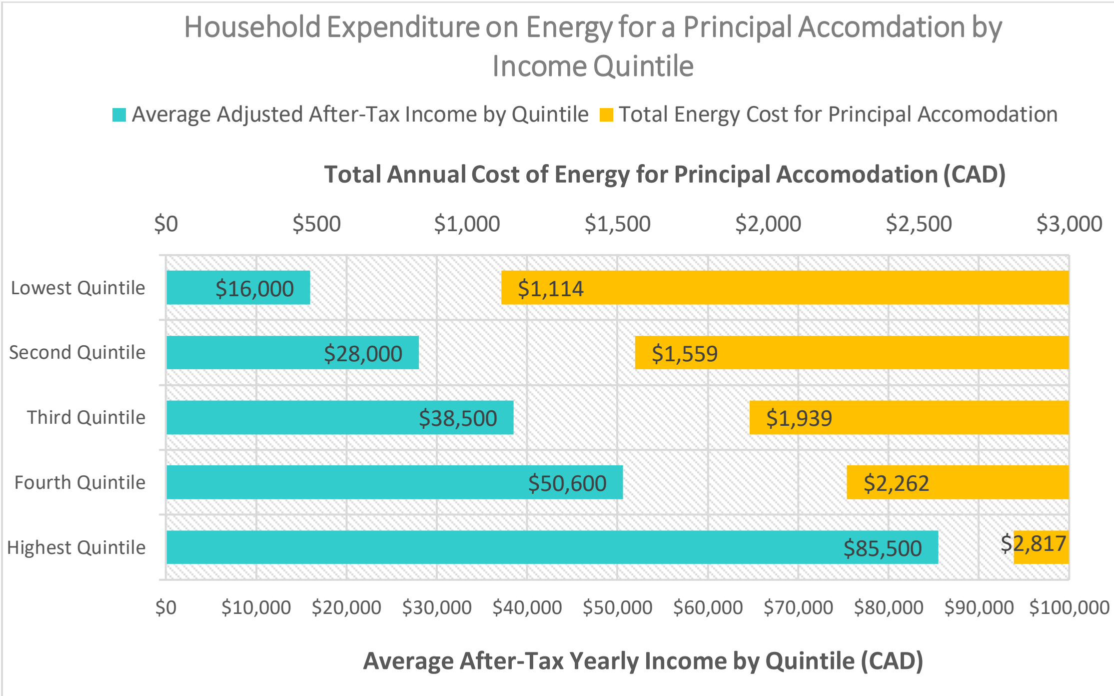

Figure 11 – 2010 Energy Expenditure on Energy for a Principle Accommodation by Income Quintile[119]

Indigenous communities face layered energy issues when accounting for old and inefficient housing stock. Reporting on the housing conditions of Indigenous populations paint this picture and reflect homes failing to meet decent standards and a vast shortage of units in the north. In 2016, 26% of Inuit lived in a dwelling requiring major repairs and more than 40% of the population lived in crowed housing.[120] It was also found that compared to First Nations people living off-reserve, 44% of the proportion of First Nations people who lived on-reserve were in a dwelling that was more than three times more likely in need of major repairs.[121]

[119] Graph created by the author with data sourced from Statistics Canada's Survey of Labour and Income Dynamics, (catalogue no. 75-202-X2010000) and Survey of Household Spending

[120] Census in Brief: The housing conditions of Aboriginal people in Canada. (2017). Retrieved from https://www12.statcan.gc.ca/census-recensement/2016/as-sa/98-200-x/2016021/98-200-x2016021-eng.cfm

[121] Ibid.

Arguably, legacy social implications and governance in bands correspond to the need for the development of community solutions for addressing these large-scale issues. Furthermore, on First Nations reserves, land ownership is restricted in Canada and property is instead held in trust by councils for the government.[122] Certain communities however have a limited form of individual property ownership that can be acquired through certificates of possession.[123] In the Arctic, Inuit peoples are entitled to home ownership although in most regions, home-owners are the small minority, in part due to enormous housing shortage.[124]

The housing crisis that faces Inuit peoples in northern Canada has been ongoing for decades.[125] Not only does the crisis poses threat to the well-being and safety of Inuit peoples but the increasing shortage of houses is seen as one of the most critical public health emergencies in Canada.[126] In addition to extreme overcrowding, homes are poorly constructed, not suitable for the climate and unaffordable. Nunavut's Housing Corporation has estimated that 3,000 units were required to "close the housing gap between Nunavut and the rest of Canada", approximately three times the number needed in Nunavik.[127] The shortage of adequate housing has resulted in extensive waitlists for public housing and serious overcrowding. A map of the Nunavut and Nunavik regions is shown in Figure 12.

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[122] Gerson, J. (2013). Allowing private home ownership on reserves could be key to improving well-being for Natives: report. *National Post*. Retrieved from https://nationalpost.com/news/canada/allowing-private-home-ownership-on-reserves-could-be-key-to-improving-well-being-for-natives-report

[123] Ibid

[124] Standing Senate Committee on Aboriginal Peoples. (2017). *We Can Do Better: Housing in Inuit Nunangat*. Senate of Canada.

[125] Ibid

[126] Ibid

[127] Ibid

Figure 12 - Map of the Nunavut and Nunavik regions[128]

To aggravate the situation, many housing units in existence were built decades ago with poor quality materials and not suitably designed for the Arctic conditions.[129] In addition to lighter building standards, Nunavik witnesses describe the inappropriate nature of wood for housing in northern climate due to bending and sagging that occurs from temperature fluctuation and results in leaks.[130] Other design features that are lacking include wind barriers to mitigate snow accumulation and adequate insulation as many homes experience over-heating in the summer and lack of warmth in the winter.[131] The issues of leaking, inadequate insulation and weather protection intensify energy consumption to supply adequate heating in homes.

[128] Inuit Nunangat. (2019). Retrieved from https://indigenouspeoplesatlasofcanada.ca/article/inuit-nunangat/
[129] Standing Senate Committee on Aboriginal Peoples. (2017). *We Can Do Better: Housing in Inuit Nunangat*. Senate of Canada.
[130] Ibid
[131] Ibid

Significant vulnerabilities for this population stem from the degree of housing insecurity include health risks of respiratory infection among children such as chronic lung disease, mental health issues and domestic violence.[132] The shortage of decent housing has also resulted in the heighted occurrence of tuberculosis which has been reported among Inuit at a rate more than 250 times higher than non-Indigenous Canadians.[133]

Figure 13 – Photograph of a wooden shelter constructed by a young family in Igloolik, Nunavut, to serve as housing as a result of the shortage.[134]

[132] Standing Senate Committee on Aboriginal Peoples. (2017). *We Can Do Better: Housing in Inuit Nunangat*. Senate of Canada.
[133] Ibid
[134] Ibid

Access to adequate housing is directly linked to educational performance, wellbeing, health, economic prosperity and healthy relationships.[135] With a median age of 23 years, the Inuit are Canada's youngest population.[136] As such, the urgency to implement solutions to crisis is growing. Figure 13 shows the wood home constructed by a young family in Igloolik, Nunavut facing the housing shortage. Unfortunately, escalating pressure around the shortage has resulted in poor quality homes being built as quickly as possible with contracts awarded to the lowest bidder.[137] As expressed to the Standing Senate Committee on Aboriginal Peoples, "if we are serious about providing young Inuit with the ability to participate fully in the life of their communities, investments in housing must be a priority."[138] An essential component is the availability of social housing since home ownership is inaccessible for a large part of the population. Recommendations have been made to implement a range of housing options that include co-operative housing and rent-to-own schemes in the face of affordability barriers and challenges of a nonexistent of a real estate market. These obstacles have proved to be sticking points in Inuit Nunangat. Although many Inuit aspire to own homes, the current conditions have been prohibitive as the rate of tenancy across all regions was close to 78% and is as high as 97% in Nunavik as of 2011.[139] Table 1 depicts the occupancy status of Inuit households in terms of ownership versus tenancy. Furthermore, the median income in Inuit Nunangat of $30,000 combined with higher costs of living than the rest of the country mean that homeownership – or even the cost to operate and maintain a house is out of reach for the majority of the population. [140]

[135]Standing Senate Committee on Aboriginal Peoples. (2017). *We Can Do Better: Housing in Inuit Nunangat*. Senate of Canada.
[136] Ibid
[137] Ibid
[138] Ibid
[139] Ibid
[140] Ibid

Table 1 – Occupancy Status of Inuit Households by Region in 2011[141]

Region	**Owner**	**Tenant**
Nunavut	21.9%	78.0%
Nunavik	3.2%	96.8%
Inuvialuit	35.6%	64.0%
Nunatsiavut	72.4%	27.6%
All regions	22.4%	77.5%

Many of these complications come from the 1950s when the federal government in Canada began to provide social welfare programs to Inuit communities.[142] At this point in time, the federal government influenced Inuit "to settle permanently in sedentary communities" through providing low-rent or free housing; however, upon arrival at the settlements, Inuit found there were not a sufficient number of homes.[143] Inuit describe being forced to remain in poor housing in spite of the conditions, described by one witness as "basically a square box with no utilities and wooden walls with hardly any insulation."[144] After the initial housing programs, the direct participation of the federal government in Inuit housing has been decreasing and reallocation of responsibility to the provincial or territorial level started in the early 1970s.[145] The problems have since compounded due to fast population growth.[146]

[141] Standing Senate Committee on Aboriginal Peoples. (2017). *We Can Do Better: Housing in Inuit Nunangat*. Senate of Canada.
[142] Ibid
[143] Ibid
[144] Ibid
[145] Ibid
[146] Ibid

Measuring Security by Quantifying Import Reliance Community Costs

This section will evaluate the cost and reliance of the current framework on diesel imports to various remote communities. The security of communities relative to size and viability in the face of infrastructure upgrades will also be analyzed.

The non-subsidized energy cost to remote/off-grid customers reported in 2011 by the Government of Canada demonstrates the extraordinary cost of the lack of infrastructure, where in Ontario, non-subsidized electricity costs per kilowatt-hour for remote communities were 94 cents/kWh and customers were receiving 77 cents/kWh of subsidy.[147] In Arctic regions like that of Nunavut, electricity rates to consumers averaged 60 cents/kWh, as reported in 2011.[148] In 2017, the National Energy Board reported a less staggering difference in electricity rates between consumers in Nunavut and the Northwest Territories compared to the rest of Canada; however, "households in the NWT and Nunavut pay more than 30 cents per kilowatt hour (kWh) for electricity" where "the Canadian average electricity price is 12.9 cents per kWh."[149] This highlights issues of disparity and cost burden on small remote populations.

In Nunavut, in addition to government actors, utilities are responsible for electricity distribution to communities and price setting. In Nunavut, Qulliq Energy Corporation (QEC) holds this responsibly as the utility. In the territory, electricity rates vary from community to community and capture individual generation costs that can vary based on transportation of energy from the source to communities. The Community Based Rate Structure is a legacy of the Northwest Territories Power Corporation rate structure that Nunavut has adopted. Nunavut recently reviewed alternate rate

[147] Government of Canada. Status of Remote/Off-Grid Communities in Canada. Government of Canada, 2011, p. 21.
[148] Ibid, 38.
[149] National Energy Board. Market Snapshot: Explaining the High Cost of Power in Northern Canada. National Energy Board, 2017. https://www.neb-one.gc.ca/nrg/ntgrtd/mrkt/snpsht/2017/02-03hghcstpwr-eng.html

structures such as a blended or territorial rate structure but chose to maintain the existing system despite the variance in rate between communities. An example of the community-based rates are shown in Table 2.[150]

[150] Customer Rates. (2018). Retrieved from https://www.qec.nu.ca/customer-care/accounts-and-billing/customer-rates

Table 2 – Qulliq Energy Corporation Rate Schedule effective May 1, 2018[151]

Community	**Domestic Rates**		**Commercial Rates**	
	Non-government (¢/kWh)	Government (¢/kWh)	Non-government (¢/kWh)	Government (¢/kWh)
Cambridge Bay	72.98	72.98	62.66	62.66
Gjoa Baven	86.81	89.74	83.21	83.21
Taloyoak	96.02	104.38	94.39	94.39
Kugaaruk	112.34	112.34	99.54	99.54
Kugluktuk	90.81	96.35	84.48	84.48
Rankin Inlet	58.7	58.7	51.27	57.05
Baker Lake	67.04	67.04	62.68	62.68
Arviat	76.16	76.16	70.88	70.88
Coral Harbour	92.2	92.2	84.4	84.4
Chesterfield Inlet	95.17	95.17	88.56	88.56
Whale Cove	87.82	143.99	109.26	121.17
Naujaat	82.28	82.28	72.2	72.2
Iqaluit	56.69	56.69	46.76	48.17
Pangnirtung	62.32	66.86	55.01	60.79
Cape Dorset	65.26	68.65	61.01	68.65
Resolute Bay	99.11	100.97	94.42	94.42
Pond Inlet	87.33	94.91	80.03	80.03
Igloolik	59.73	59.73	54.69	54.69
Hall Beach	86.38	89.78	83.16	83.16
Qikitarjuaq	74.9	86.05	70.92	86.05
Kimmirut	101.57	101.34	85.01	85.45
Arctic Bay	85.18	85.18	75.99	75.99
Clyde River	75.18	75.68	66.37	66.37
Grise Fiord	89.54	108.86	103.83	103.83
Sanikiluaq	79.38	79.38	76.03	76.03

[151] Customer Rates. (2018). Retrieved from https://www.qec.nu.ca/customer-care/accounts-and-billing/customer-rates

Another implication of the community rate structure is that populations bear the cost for specific infrastructure upgrades. An example of this is in Grise Fiord where the average electricity cost was $0.57/kWh, and since 2014 has climbed to $0.9202 - $1.1097/kWh.[152] The QEC warned the community that building a new power plant would cause significant increases to their electricity rate. To aggravate the problem, Grise Fiord experienced a decline in its population, going from 141 people in 2006 to 129 in 2016. This leaves fewer residents to shoulder the cost of energy for the community.[153] In contrast, Iqaluit, the largest community in the territory experiences the lowest base rate, currently for non-government customers this sits at $0.567/kWh. Moreover, in certain cases, QEC bills residential customers living in government homes at higher rates. As observed in Figure 10, rates of electricity are significantly lower for larger communities than smaller, even if they are in a geographically similar area. An example are the communities of Kimmirut and Iqaluit where Kimmirut has 389 residents and pays 101.57 cents/kWh and Iqaluit is home to 7,740 residents and electricity costs 56.69 cents/kWh. This price structure discourages people to live in small communities and has extreme cost implications for customers who directly carry the system costs. The same burden of costs applies to transportation of import costs, where communities that require longer transit routes carry the associated costs. Please find further information on sealift rates in Appendix A.

[152] Touchette, Y., Gass, P., & Echeverría, D. (2017). *Costing Energy and Fossil Fuel Subsidies in Nunavut: A mapping exercise*. International Institute for Sustainable Development.
[153] Ibid

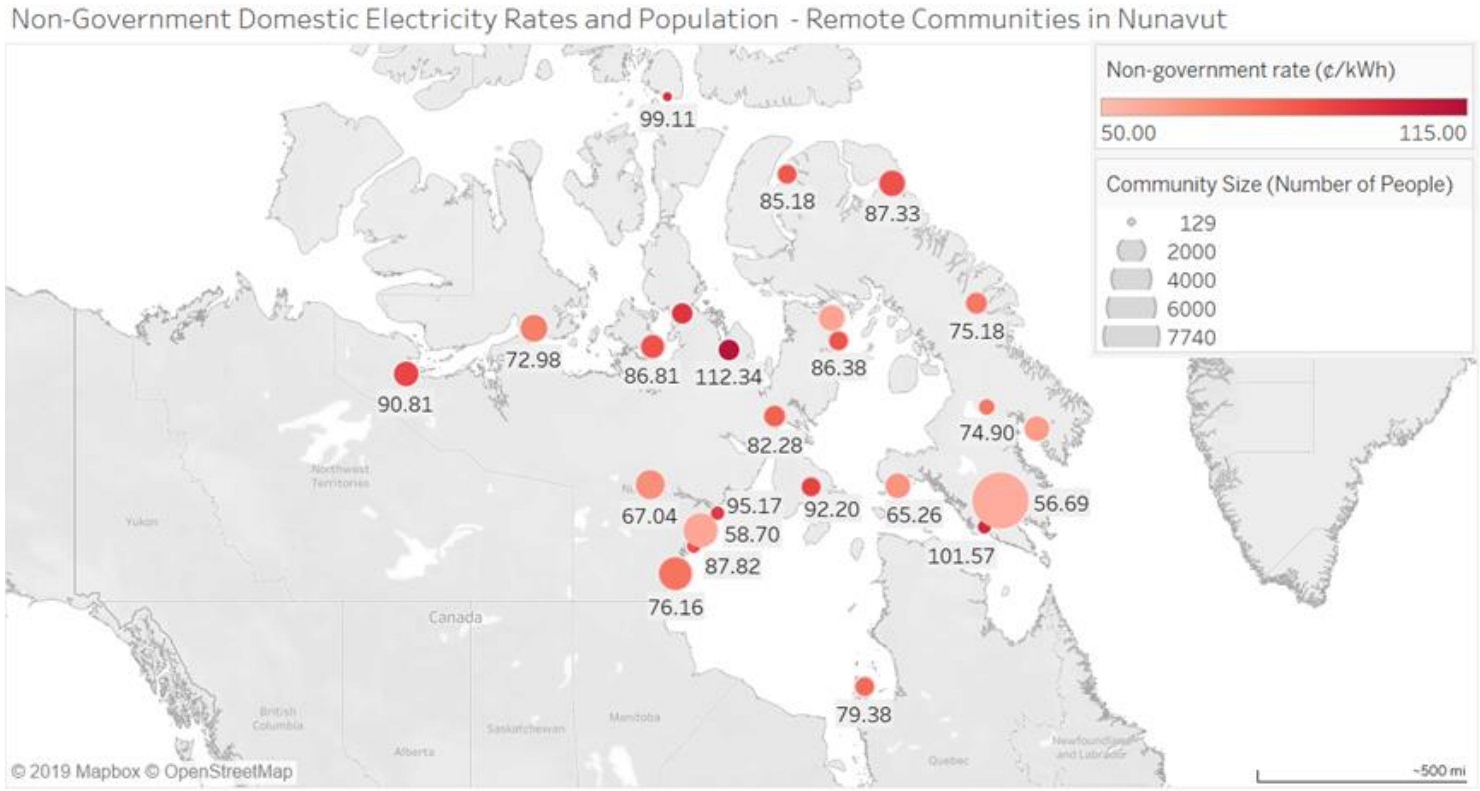

Figure 10 – Non-Government Domestic Electricity Rates and Populations of Remote Communities in Nunavut[154]

[154] Map drawn by the author using Tableau software. Data from the rate schedule published by Qulliq Energy Corporation and "The Atlas of Canada - Remote Communities Energy Database" published by Natural Resources Canada.

Measuring Impacts of Climate Change at the Community Level

Storm surges, forest fires and coastal erosion are jeopardizing the safety and economic security of populations settled at the shores of the Arctic Ocean. Costal Arctic communities have already been forced to relocate to more central locations due to erosion. An example of one such community is the Alaskan Iñupiat community of Shishmaref whose historical town was situated on a spit in the Bering Sea. [155] The town of 600 people was forced to reestablish themselves on the mainland after housing and infrastructure damage following decades of flooding and erosion from storm surges, please refer to Figure 12. The cost of this relocation was estimated at $180 million USD in 2004.[156] Thirty-one other communities in Alaska have been identified by the Arctic Institute as facing an "imminent threat of destruction" from erosion and flooding with an estimated livability of 10 to 20 years before community infrastructure collapsed.[157] These costs of climate change have undoubtedly come in many forms: social, cultural and economic, to name a few. Contemplating the serious implications of adaptation to climate as opposed to mitigation includes these cost for communities and large-scale relocation in the future if the trajectory of change continues at its current pace.

Simultaneously, populations on the mainland are experiencing the thawing of permafrost that threatens foundational infrastructure necessary for transportation, sanitation and public services.[158] These environmental changes have been observed in northern Yukon as the region has experienced accelerated warming and winter

[155] Mele, C., & Victor, D. (2016). Reeling From Effects of Climate Change, Alaskan Village Votes to Relocate. *The New York Times*. Retrieved from https://www.nytimes.com/2016/08/20/us/shishmaref-alaska-elocate-vote-climate-change.html
[156] Ibid
[157] Herrmann, V. (2018). Enabling Families to Adapt to Climate Change Independently | The Arctic Institute. Retrieved from https://www.thearcticinstitute.org/enabling-families-adapt-climate-change-independently/
[158] Ibid

temperatures that have increased by 4 degrees Celsius over the last 50 years.[159] Communities such as Old Crow have seen firsthand soil erosion and landslides due to permafrost thaw and heavier rainfalls.[160]

The effect of warmer temperatures on infrastructure spill over to impact subsistence of Indigenous groups as the instability of winter roads used to access to areas for fishing and hunting grows coupled with delayed autumn freeze-up and sooner spring melting. Traditional methods of food preservation will also become less feasible as the likelihood of food contamination for damaged pipelines and waste containers based in permafrost grows.

Further repercussions of climate change on hunting, whaling and fishing activities are changes to availability of harvested species and their health. Migration patterns of caribous have been observed to change in addition to the amount of bird and fish for harvesting.[161]

Shifting weather patterns and disappearing sea ice also disrupt successful and safe harvesting activities.[162] Correspondingly, changes to ocean productivity and water salinity from greater river run-offs and melting ice are anticipated to bring new disease and insect populations to the north. Moreover, animal hides and the quality of meat are estimated to suffer and give way to a greater dependence on commercial or store foods. These foods are frequently more expensive as well as linked to negative dietary impacts.[163] The incoming of disease and allergies corresponding to the arrival of southern animal species, insects and plants is predicted to accelerate dietary changes.

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[159] Wright, L., Bender, A., & Desson, C. (2018). Facing the Change: 5 Canadian Communities Threatened by Climate Change | CBC Radio. Retrieved from https://www.cbc.ca/radio/day6/facing-the-change-5-canadian-communities-threatened-by-climate-change-now-1.4447042
[160] Ibid
[161] Ibid
[162] Tedsen, E., Cavalieri, S., & Kraemer, A. (2014). *Arctic Marine Governance* (pp. 71-99). Berlin: Springer.
[163] Ibid

Previously the harvesting ground for Indigenous hunters, the Arctic has become increasingly occupied with activities like resource extraction, commercial fishing, tourism, transport and shipping in addition to nature conservation. Climate change, as a catalyst for several of these activities, amplifies growing pressure that already exists for traditional livelihoods.[164]

Figure 12 – Storm damaged home in Shishmaref, Alaska[165]

As metrics of energy affordability, security and sustainability demonstrate serious consequences for the viability of Arctic communities facing the consequences climate change, the opportunity for policy changes are resounding.

[164] Tedsen, E., Cavalieri, S., & Kraemer, A. (2014). *Arctic Marine Governance* (pp. 71-99). Berlin: Springer.

[165] Mele, C., & Victor, D. (2016). Reeling From Effects of Climate Change, Alaskan Village Votes to Relocate. *The New York Times*. Retrieved from https://www.nytimes.com/2016/08/20/us/shishmaref-alaska-elocate-vote-climate-change.html

Overall, this chapter has aimed to illustrate and quantify dimensions of the energy trilemma for remote Indigenous communities of the Arctic. In terms of energy affordability, lower-income homes spend a larger share of their income on meeting energy needs than other income-brackets. Before broaching energy efficiency for Indigenous groups, access to decent housing and resolution to chronic housing shortages must first be achieved. These issues illustrate the extent to which inefficient housing stock is commonplace as well as out of reach and how the problem compounds itself with the construction of poor quality homes as a temporary solution to a chronic problem. Moreover, the large absence of homeownership in Indigenous communities demonstrates a lack of autonomy and control over housing combined with inappropriate western or euro-centric design that performs poorly in the climate.[166] The absence of home ownership has also been correlated to lowered incentive for maintenance or repair of homes.[167] Addressing these systemic issues is essential for sustainable development of communities.

In addition to cost, path dependence on imported diesel leaves small remote communities in precarious situations as expenses incurred for transportation of diesel to the community and its specific infrastructure upgrades are uniquely billed back to them. This price structure dissuades settlement in small or remote communities and imposes significant cost implications for customers who directly carry the system costs.

Insecurity for remote communities are further highlighted by distinct risks posed by climate change for remote Indigenous communities of the Arctic, some of whom have already faced relocation. Given these consequences, moving away from fossil fuel dependency and toward alternative solutions in these communities is imperative.

[166] Stout, R. (2018). *The built environment: Understanding how physical environments influence the health and well-being of First Nations peoples living on-reserve*. Prince George, BC: National Collaborating Centre for Aboriginal Health.

[167] Ibid

Chapter 3: Addressing Barriers to Alternatives

This chapter will discuss policy, financial and technological methods for addressing dimensions of energy vulnerabilities described in the first two chapters. It will first look at energy exploration in the Canadian Arctic and draw parallels to the oil sand extraction in northern Alberta before analyzing mechanisms of wealth redistribution as possible policy tools. It will then assess specific barriers to energy alternatives in remote Arctic Indigenous communities including the hurdle of making initial capital investments and funding, financing mechanisms for renewable energy technologies and the role of stakeholders like non-profit organizations, Indigenous corporations and utilities.

Energy Exploration

Understanding the impact on and fragility of mixed economies is important when making decisions considering opportunities for energy exploration and development. The emerging exploitability of the energy resources in the Arctic has similar elements to prior conflicts over oil sand exploitation, and on-going tensions around the construction of pipelines on Indigenous lands. As concern in Canada has developed around the perpetuation of the resource curse from petroleum activities in northern Alberta, many characteristics of the situation arguably apply to the Arctic.

The "resource curse", or "paradox of plenty", is the inability for resource abundant countries to benefit from domestic natural resource wealth or sufficiently care for public welfare. In this case it can be applied to communities situated in resource rich regions, who would rationally be well-positioned to benefit from economic opportunity and development but are instead left with stunted economic growth.[168] In the scenario of a regional resource development, cost and benefits associated with

[168] Parlee, B. (2015). Avoiding the Resource Curse: Indigenous Communities and Canada's Oil Sands. *World Development*, *74*, 425-436. doi: 10.1016/j.worlddev.2015.03.004

resource development are unequally distributed. Therefore certain populations and regional economic are more susceptible to impacts of the resource curse than others.[169] This inequality has been demonstrated in the environmental effects encountered by Indigenous peoples living downstream of the oil sands.[170] Moreover, economic gains are captured at the provincial and federal levels of government leaving the perception of little to trickle down as per income distribution statistics.[171] To this point, some of largest disparities in well-being between non-Indigenous and Indigenous peoples have been discovered in northern Alberta. [172]

Certain policy analyst suggest that employment in extractive industries is a cure for poverty of Indigenous communities.[173] However, as employment grew in Alberta, the informal economies of many communities continued and "may indeed be serving to offset some of the symptoms of a resource curse."[174] The fluctuation of benefits from the formal economy leaves individuals to rely on the traditional economy more or less. "Subsistence in a mixed economy acts like a sponge, absorbing labor when other opportunities decline and releasing it when they arise."[175] The risk of extraction hampering traditional economies and ways of life is therefore amplified if extraction and exploration is prohibitive to traditional hunting, fishing and harvesting performed by Indigenous peoples. Moreover, although there are simultaneous efforts to improve employment of Indigenous peoples in the mineral and petroleum sector in northern Alberta as well as Canada, it has remained consistent at 5% from 2007 – 2012.[176]

Sustainable development theory is another tool to evaluate development activities. According to the theory, environmental and socio-economic cost should be at least

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[169] Parlee, B. (2015). Avoiding the Resource Curse: Indigenous Communities and Canada's Oil Sands. *World Development, 74*, 425-436. doi: 10.1016/j.worlddev.2015.03.004
[170] Ibid
[171] Ibid
[172] Ibid
[173] Ibid
[174] Ibid
[175] Ibid
[176] Ibid

outweighed by benefits of the development.[177] Looking again at the Canadian Arctic, costs of climate change acceleration are difficult to measure, although the severity is plain. The risks to traditional ways of life, livelihood, health and culture of Indigenous communities and in some cases overall viability of communities are amplified with threats of energy exploration. While economic benefits for communities have been considered the imperative for pursuing energy exploration in the north as it becomes more feasible, these risks and potential dis-benefits cannot be ignored. As noted in the World Energy Council country index ranking, Canada should look to widen engagement and distribution of benefits of resource development projects "most notably with Canada's Indigenous population on whose traditional lands most major energy projects will be located."[178] Policy mechanisms and tools for distribution and sustainability of benefits from these types of economic rents have been an area of focus for research with Indigenous peoples in Canada, Australia and Alaska.[179] These mechanisms include "informal resource-sharing arrangements, impact and benefit agreements, and business contracts with community organizations or corporations."[180] Securing benefits from extractive revenues has been proposed though revenue allocation on a per capita basis for entitled individuals, or for communities who could use some or all of the revenues for re-investment in community operations, programs or infrastructure.[181] An example is the Alaskan oil as a trust fund model where a payment of dividends is made to every Alaskan four times each year.[182] This model is considered one of the most effective and transparent arrangements of redistribution.[183]

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[177] Parlee, B. (2015). Avoiding the Resource Curse: Indigenous Communities and Canada's Oil Sands. *World Development*, *74*, 425-436. doi: 10.1016/j.worlddev.2015.03.004
[178] WEC Energy Trilemma Index Tool. (2019). Retrieved from https://trilemma.worldenergy.org/#!/country-profile?country=Canada&year=2018
[179] Parlee, B. (2015). Avoiding the Resource Curse: Indigenous Communities and Canada's Oil Sands. *World Development*, *74*, 425-436. doi: 10.1016/j.worlddev.2015.03.004
[180] Ibid
[181] Ibid
[182] Ibid
[183] Ibid

Due to the threat of energy exploration and extraction to the subsistence of Indigenous communities and evidence of its necessity in mixed economies, facing commodity price fluctuations combined with small "trickle down" benefits, if behaviours of new resource extraction in the Arctic follow suit of northern Alberta, the advantages of extraction do not appear to outweigh the costs. In the event that extractive activities move forward, the policy recommendation put forward is the development of a wealth fund similar to the Alaskan PFD for frontline populations as a means of a more beneficial engagement and wealth redistribution.

Sovereign Wealth Funds as a Mechanism of Wealth Redistribution

The Alaskan PFD is similar to a Sovereign Wealth Fund (SWF) known for its remarkable success in ensuring Norway's oil was a resource blessing. This idea is not novel for Canada as it has several past experiences of SWFs on a provincial and more recently territorial scale.[184] The first instance was the creation of the Alberta Heritage Fund, enacted in 1975 by Premier Lougheed, which offered an initial seed of $1.5 billion generated from provincial revenues.[185] The fund was set up to acquire 30% of non-renewable resource revenues annually which for Alberta at the time would have been an additional $620 million in year one.[186] Following a period of declining contributions and stagnation, investments were entirely stopped in 1987.[187] An investigation performed by The Fraser Institute demonstrated that had Alberta kept to the contribution parameters of the Alaskan PFD or Norwegian model, the fund's performance would have eliminated the provincial deficit and contributed $42 billion or $170 billion, respectively (this analysis can be found in Appendix B).[188]

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[184] Poelzer, G. (2015). *What Crisis? Global Lessons from Norway for Managing Energy-Based Economies*. The Macdonald-Laurier Institute.
[185] Ibid
[186] Ibid
[187] Ibid
[188] Ibid

A similar failure occurred in Saskatchewan with the initiation of a SWF in 1978.[189] Although the fund was designed to capture all revenues from non-renewable resources, it also permitted the transfer of the majority of funds to non-specific government revenues and only required the retention of 20% contributions.[190] The fund quickly turned into a "flow through account" that was later cut as part of austerity measures in the face of debt.[191] In recent years, the Saskatchewan government commissioned to produce recommendations on the recreation of similar fund in 2013.[192] Largely mirroring practices of the Norwegian SWF, the report had two outliers.[193] Firstly that investment should remain within the bounds of province as opposed to being allowed globally.[194] The report asserts this investment should be neither privileged nor preferred for the reason that they are within the province.[195] Critics argue that this undermines the intention behind the fund and the economic merits of evading resource curse symptoms such as Dutch disease and inflation.[196] Moreover, MacKinnon proposed a cap of 26% for the share of resource revenues that could be contributed as a means of allowing the province to maintain its use of and budgeting with revenues.[197]

The Government of Northwest Territories created a comparable heritage fund in 2012. It does not prescribe a fixed contribution but inhibits withdrawals that are more than 5% of the fund's principal.[198] Suffering from both infrastructure deficit and public debt, amongst critical reaction there have been proposals to curtail

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[189] Poelzer, G. (2015). *What Crisis? Global Lessons from Norway for Managing Energy-Based Economies.* The Macdonald-Laurier Institute.
[190] Ibid
[191] Ibid
[192] Ibid
[193] Ibid
[194] MacKinnon, P. (2013). *A Future Fund for Saskatchewan: A Report to Premier Brad Wall on the Saskatchewan Heritage Initiative*.
[195] Ibid
[196] Poelzer, G. (2015). *What Crisis? Global Lessons from Norway for Managing Energy-Based Economies.* The Macdonald-Laurier Institute.
[197] MacKinnon, P. (2013). *A Future Fund for Saskatchewan: A Report to Premier Brad Wall on the Saskatchewan Heritage Initiative*.
[198] Poelzer, G. (2015). *What Crisis? Global Lessons from Norway for Managing Energy-Based Economies.* The Macdonald-Laurier Institute

contributions to the fund.[199] In the last year, the fund has gained scrutiny for losing value and not keeping up with interest.[200] Fed with external funds, the government has committed not to withdraw from the fund for the next two decades.[201]

Successful cases of SWFs developed in Canada have been in Quebec. While deviating from more common resource stream of non-renewables revenues, the two alternative examples are the pension fund, Caisse de dépôt et placement du Québec (CDPQ), and Generations Fund.[202] The Generations Funds serves to help payback provincial debt and is mainly derived from hydro revenues.[203] Similarly, ideas for a SWF with contributions from the LNG sector have developed for British Columbia.[204]

The potential of the SWFs in cases like Norway, Alaska and Quebec demonstrate the value that can be generated from consistent contributions stemming from revenue rich projects whether derived from non-renewable resource extraction or hydro generation. The ability of SWFs to mitigate symptoms of the resource curse while giving states greater ability to ride out fluctuating commodity prices or boom and bust cycles is important in terms of benefit creation and sustainability of these benefits. In spite of past failures, the willingness of governments in Canada to reconsider SWFs for non-renewable resource revenues as well as emerging sectors like LNG may serve as evidence of the valuable nature of this mechanism and its ability to offer "intergenerational fairness" in the extraction of non-renewable resources.[205] Moreover, this approach provides a vital mechanism for investment in innovation and education for simulating future growth.[206] As witnessed in the case of the Alaskan PFD, tangible benefit for Indigenous populations have been observed specifically for

[199] Poelzer, G. (2015). *What Crisis? Global Lessons from Norway for Managing Energy-Based Economies.* The Macdonald-Laurier Institute
[200] Ibid
[201] Ibid
[202] Ibid
[203] Ibid
[204] Ibid
[205] Ibid
[206] Ibid

children and seniors.[207] Even more pertinent in a Canadian framework where energy exploration occurs on or is enabled by transport through Indigenous lands, is the establishment of this type of redistribution mechanism for addressing immediate needs and investing a fairer future.

Case Study of The Alaskan Permanent Fund Dividend

The Alaska Permanent Fund Dividend (PFD) program offers a partial universal basic income to all Alaskans.[208] Created in 1976 as a sovereign wealth fund and capture mechanism of revenues from oil, the state began putting aside a minimum of 25% of royalties and other earnings from oil extraction for public welfare.[209] Along with high oil prices came high revenues and surplus for Alaska and by 1980 the state legislated the PFD program as means of distributing a share of earnings to residents.[210] Designed as a populist program opposed to a poverty reduction tactic, the fund gained support for conservative management that ensured it would grow as time passed.[211]

Continual reinvestment coupled with the input of yearly revenues allowed the fund to reach close to 60 billion USD.[212] Berman's analysis of the effectiveness of Alaska's PFD in lower poverty rates among rural Indigenous peoples was positive and income maintenance was found to significantly benefit low-income households. An illustrated in Figure 13, the reported and estimated poverty rates of rural Alaskan Indigenous groups are significantly decreased with the PFD. Moreover, Berman also

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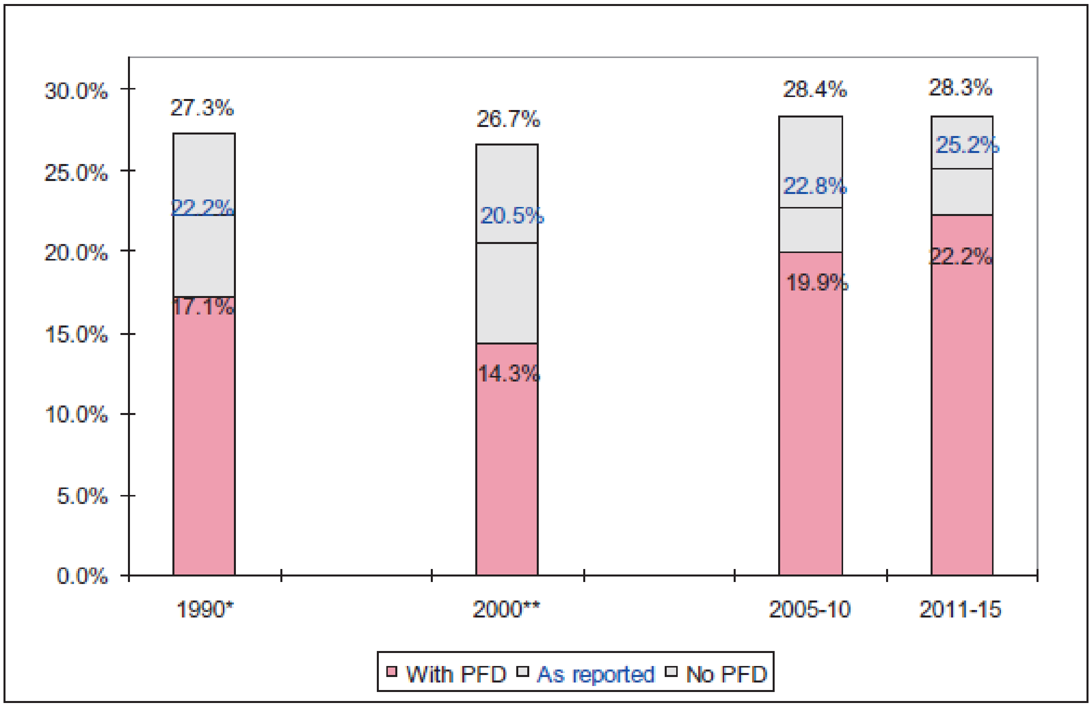
[207] Berman, M. (2018). Resource rents, universal basic income, and poverty among Alaska's Indigenous peoples. *World Development*, *106*, 161-172. doi: 10.1016/j.worlddev.2018.01.014
[208] Ibid
[209] Ibid
[210] Ibid
[211] Ibid
[212] Ibid

concludes that the PFD income is most beneficial to Indigenous seniors and children.[213]



* based on 1989 income
** based on 1999 income

Figure 13 – Reported and estimated poverty rates of Rural Alaska Natives with and without PFD income.[214]

[213] Berman, M. (2018). Resource rents, universal basic income, and poverty among Alaska's Indigenous peoples. *World Development*, *106*, 161-172. doi: 10.1016/j.worlddev.2018.01.014
[214] Ibid, 167

Addressing Barriers to Energy Alternatives

The following subsections will address barriers to energy alternatives for diesel dependence and potential solutions.

Biofuel as an Alternative to Diesel

In the current energy situation, environmental vulnerability for communities stems from import reliance, spillage as a result of faulty fuel storage and supply operations as well as the resulting carbon intensive electricity generation and air contaminants. In addition to environmental costs, oil tanker spills may have economic costs of hundreds of millions dollars per incident. [215] Driven by a clean replacement fuel for diesel that eliminates the risk incurred by a marine fuel leakage, there has been investigation into electricity generated from clean biofuels for remote communities.[216] Derivatives from biomass, methanol and dimethyl ether (DME) are possible alternatives since from a technical standpoint they can entirely displace diesel electricity generation capacity, lower emissions and remove spill risks.[217] Moreover, in terms of feasibility, DME-fueled engines are commercially available and a proven technology.[218] There is similarly significant application of methanol in transportation.[219] DME also has the potential to act as a replacement for heating fuel.[220] McFarlan evaluates the full cost of electricity generation from diesel as base case to compare with DME for three remote communities in Nunavut.

In spite of the technical viability, the transition to clean fuels will be sparked from a financial perspective as per the cost models put forward by McFarlan. "*Furthermore,*

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[215] McFarlan, A. (2018). Techno-economic assessment of pathways for electricity generation in northern remote communities in Canada using methanol and dimethyl ether to replace diesel. *Renewable And Sustainable Energy Reviews*, *90*, 863-876. doi: 10.1016/j.rser.2018.03.076
[216] Ibid
[217] Ibid
[218] Ibid
[219] Ibid
[220] Ibid

as a disincentive to fossil fuel use, carbon pricing at current levels does not strike sufficiently hard to spur the transition. However, if clean alternative fuels are disregarded, remote northern communities will almost certainly remain entrenched in the practice of importing diesel for electricity generation."[221]

As demand for electricity and the region grows, there are calls for significant investment to replace aging power plants. As bulk fuel storage will remain a pillar of the energy strategy of the north going forward, biofuels are an important alternative that could be increasingly strategic.

The mapping of perspectives in conducted in Chapter 1 provides context illustrating the potential here for viewpoints between stakeholders on security to diverge. At a federal level a sharp transition to these fuels may be appealing, as fuels such as DME would address environmental issues such as fuel spills and reduce emissions, whilst use of proven technology would significantly lower development costs. Moreover, for a federal government responsible for both large-scale interprovincial energy projects and the Arctic region, it fits neatly with the goals of economic efficiency and globalization, as security of supply could be guaranteed through cost-efficient bulk purchases from the global market.

These proposals hold evident merit, and especially considering the large-scale federal government is working from but could run against the values of local communities. While use of replacement fuel alternatives would be favourable for the environment in terms of safeguarding against spills and leaks as well as reducing emissions greater compared to the present diesel technology, at a local level security and import dependence is still not addressed. Bulk purchases from a global market may provide guarantees of supply for the country as a whole, but for communities already facing potentially devastating loss of existing transport infrastructure, it is simply replacing one source of dependence for another. Moreover, with the economic impact of

[221] McFarlan, A. (2018). Techno-economic assessment of pathways for electricity generation in northern remote communities in Canada using methanol and dimethyl ether to replace diesel. *Renewable And Sustainable Energy Reviews*, *90*, 863-876. doi: 10.1016/j.rser.2018.03.076

climate change on these communities still unknown, and energy costs already crippling, it is questionable whether reliable and secure transport links could be developed to convince the communities of the security of these alternatives.

The potential conflict between these two definitions of security means that if diesel is to be replaced by an alternative fuel source, it is vital a detailed discussion including all levels of government and the local stakeholders takes place. This would have the two-fold aim of raising awareness of local concerns to those responsible for making decisions at a macro level and assuring the communities affected of the security of their local supply regardless in the coming years of changing circumstances. The latter aim would require prior development of comprehensive plan addressing the technical issues associated with this security, a potentially costly but necessary step.

Barriers to Renewable Energy Technologies

Barriers to energy alternatives in remote arctic communities can be broadly attributed to the fact that efficient microgrid systems powered by solar and wind technologies are relatively new.[222] To make matters more difficult, community involvement in getting projects off the ground has been hampered by negative perception, with part of this stemming from the implementation of failed first generation technology in certain rural communities that has since damaged public opinion.[223] This is was the case of wind turbine pilot projects in the Nunavut communities of Rankin Inlet, Cambridge Bay and Kugluktuk (installed in 2000 for Rankin Inlet and the 1990s for the latter two communities).[224]

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[222] Strand, H. (2018). Breaking Barrier To Renewable Energy Production in the North American Arctic. *Alaska Law Review, 35*(1).
[223] Ibid
[224] Rankin Inlet wind turbine loses its blades. (2012). Retrieved from https://www.cbc.ca/news/canada/north/rankin-inlet-wind-turbine-loses-its-blades-1.1208272

Technical viability of technologies in extreme weather poses additional challenge when combined with inaccessibility of the grid and the limited access to technical and maintenance assistance.[225] One type of system that has proved reliable are solar-diesel systems that are in operation and suitable for use in Arctic environments.[226]

A review of seventy-one small renewable energy technology projects from 1980-2016 was conducted by Karanasios and Parker to track the energy transition into renewable electricity in remote Indigenous communities in Canada. This review identified non-technical barriers to community participation in renewable energy projects as "institutional weaknesses and capacity issues, vested interests in diesel generated electricity, lack of capital, high capital costs, lack of expertise, missing infrastructure, and limited community acceptance."[227] Similarly, technological constraints across these projects involved the need industry expertise (development, installation and operation), readiness of "distribution infrastructure, information systems, smart grids, lower cost storage, packaged systems control technologies, and robust equipment able to operate in extreme climatic conditions and variable load configuration."[228]

Moreover, the analysis of financial performance of these projects for 96 remote Indigenous communities based on feasibility and optimization studies show a small number are financially viable due to restricted economies of scales and high costs of electricity generated by renewables.[229] Several studies attribute minimal community participation in renewable electricity generation to concerns on behalf of communities regarding lack of control or ownership over assets and economic benefits as well as high electricity costs for households.[230] Analysis of these concerns

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[225] Strand, H. (2018). Breaking Barrier To Renewable Energy Production in the North American Arctic. *Alaska Law Review*, *35*(1).
[226] Ibid
[227] Karanasios, K., & Parker, P. (2018). Tracking the transition to renewable electricity in remote indigenous communities in Canada. *Energy Policy*, *118*, 169-181. doi: 10.1016/j.enpol.2018.03.032
[228] Ibid
[229] Ibid
[230] Ibid

and barriers give way to policy opportunities and mechanisms to address specifically non-technical and strategic challenges.

In spite of the myriad of challenges, there have been renewable energy projects successful at reducing dependence on diesel for remote communities, climate-specific technology advancements made by organizations like the Arctic Remote Energy Networks Academy (ARENA) and the University of Alaska-Fairbanks' energy consortium and proposed solutions barriers financing and non-technical barriers.[231] These subchapters will look at addressing the barriers for clean energy technologies in terms of Power Purchase Agreements, financing mechanisms, the role of non-profit and Indigenous organizations, before introducing several case studies.

Power Purchase Agreements

While there are few government grant programs that have been game-changing in the advancement of clean power projects for remote communities, the development of power purchase agreements has been enabled by governments and their utilities.[232] Advancement has come in the form of more open regulatory environments, government-driven policy such as net metering or Independent Power Producer (IPP) projects as well as utility-driven policy.[233]

In spite of regulatory progression, uptake of PPA projects in remote communities has been slow and limited to certain jurisdictions (refer to Table 3).[234] The basis of the majority of PPAs between remote community IPPs and utilities is the avoided cost of diesel to the utility.[235] Therefore the motivation in purchasing electricity from clean power projects is grounded in the cost incurred by the utility to obtain diesel fuel and generate electricity.

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[231] Strand, H. (2018). Breaking Barrier To Renewable Energy Production in the North American Arctic. *Alaska Law Review*, *35*(1).
[232] Lovekin, D., Dronkers, B., & Thibaut, B. (2016). *Power purchase policies for remote Indigenous communities in Canada*. Calgary: The Pembina Institute.
[233] Ibid
[234] Ibid
[235] Ibid

The Ontarian Hydro One Remote Communities Inc. Renewable Energy INnovation DiEsel Emission Reduction (REINDEER) program offers community specific rates for PPAs averaging approximately $0.40/kWh while the national average for clean power in remote communities is roughly $0.30/kWh.[236] Utilities such as BC hydro and NTPC have offered additional payment to account for reduced use and maintenance of diesel generators.[237] In spite of the augmented rates, financial support for capital costs was required from the government to make the projects economically viable.[238] According to the Pembina Institute, "*a guaranteed revenue requirement at current rates is not enough to attract private financing to projects, especially considering the challenges and complexities of developing projects in harsh and remote regions."*[239]

[236] Lovekin, D., Dronkers, B., & Thibaut, B. (2016). *Power purchase policies for remote Indigenous communities in Canada*. Calgary: The Pembina Institute.
[237] Ibid
[238] Ibid
[239] Ibid

Table 3 - PPAs by Jurisdiction in Remote Indigenous Communities in Canada

Jurisdiction	*Approximate No. of Remote Indigenous Communities*	*No. of Communities with current PPAs*[240]	*No. of Communities developing PPAs*[241]	*Technology Types*
British Columbia	25	4	3	Micro-hydro, Solar, Biomass
Alberta	7	0	-	-
Saskatchewan	1	0	-	-
Manitoba	4	0	-	-
Ontario	25	7	2	Assumed solar
Quebec	19	0	-	-
Newfoundland and Labrador	16	0	-	-
Yukon	21	0	1	-
Northwest Territories	26	1	-	Solar
Nunavut	25	0	-	-

For remote communities, a conventional costing method for energy alternatives fails account for government subsidization applied to diesel fuel and generation.[242] Furthermore, savings in operation time for diesel generation, reduction in capital costs by means of smaller replacements for older diesel equipment and extending the lifespan of the current technology are also neglected in the traditional costing

[240] Includes net metering projects
[241] Includes net metering projects
[242] Lovekin, D., Dronkers, B., & Thibaut, B. (2016). *Power purchase policies for remote Indigenous communities in Canada*. Calgary: The Pembina Institute.

approach.[243] The societal cost of GHG emissions and carbon pollution is similarly missing in evaluation.

Another factor to consider in costing is the lack of available information on the amount of subsidization for diesel fuel, from import and delivery cost to generation.[244] Further absent is assessment of externalized costs for carbon pollution.

Policy support for the advancement of PPAs as a basis for remote Indigenous community projects can come from mandated targets imposed at the territorial or provincial levels, such as in British Columbia, to help in scaling up adoption.[245] Other policy recommendations include the requirement of a minimum level of Indigeous ownership (e.g. at least 50 percent).[246] However, as much as PPAs offer a premise for remote Indigenous community projects, the need for capital from banks and private development remain a hurdle.[247] Catalysts are still required to "*to get community-scale projects off the ground, to help transition ownership, further develop local capabilities, and drive economic growth in these communities."*[248]

Financing Mechanisms

In many parts of the world, financing mechanisms for renewable or clean energy technologies and energy efficiency provisions target homeowners as the primary stakeholder. In the case of Alaska and other states across the USA, Property Assessed Clean Energy (PACE) programs as a form for financing have been introduced where local governments offer property owners low-interest loans for capital improvements to energy efficiency that are then paid back through additional property tax

[243] Lovekin, D., Dronkers, B., & Thibaut, B. (2016). *Power purchase policies for remote Indigenous communities in Canada*. Calgary: The Pembina Institute.
[244] Ibid
[245] Ibid
[246] Ibid
[247] Ibid
[248] Ibid

assessments by the municipality.[249] In spite of various setbacks PACE programs have faced in the U.S., it has proved effective in increasing community involvement in clean energy technology, incentivizing homeowners to invest in these technologies and increased accessibility for lower-income households.[250]

As the program is administered at the municipal level in Alaska, many villages and smaller communities fall outside the criteria for participation.[251] Ameliorations to legislation to increase the support of rural communities are "reasonable and achievable".[252] In addition to the administering of the programs at the state level, a method for achieving greater inclusion could be through public-private partnership with Indigenous and community corporations.[253] While Canada already has a multi-level governance structure for energy in the north, land ownership is restricted among First Nations peoples in Canada and property is instead held in trust by councils for the government. Certain communities however have a limited form of individual property ownership referred to a certificate of possession.[254] Moreover, as presented in Chapter 2, home ownership rates among Inuit are extremely low due to low affordability and the ongoing housing crisis. The need for collective community action and potential role of Indigenous corporations is becoming more and more evident.

Alternative loan structures exist in the developing world to reduce upfront costs of energy solutions and improvements. Margin money financing has been successful in India by helping homeowners seeking a loan and can meet terms payments but unable

[249] Strand, H. (2018). Breaking Barrier To Renewable Energy Production in the North American Arctic. *Alaska Law Review, 35*(1).
[250] Ibid
[251] Ibid
[252] Ibid
[253] Ibid
[254] Gerson, J. (2013). Allowing private home ownership on reserves could be key to improving well-being for Natives: report. *National Post*. Retrieved from https://nationalpost.com/news/canada/allowing-private-home-ownership-on-reserves-could-be-key-to-improving-well-being-for-natives-report

to supply the down payment.[255] Margin financing offers the difference by supplying the amount needed for a down payment. Traditionally these were government-sponsored programs because of the high default risk. As climate change becomes more and more critical, think tanks among other groups are advocating for funding in "undersupplied" areas, including energy efficiency measures for homes.[256] It is further important to note that margin money financing spark investment as benefits from initial installations can be put toward purchasing addition "green power generation" through self-financing. Examples are small villages such as Doddaullarthi in India were the Solar Electric Light Company (SELCO) offered a margin money financing scheme to allow wearers to continue their work after sunset.[257] Margin money financing may be a valuable strategy for North American Arctic villages as a financing measure for renewables.[258] Strand argues that like villages in India, communities of the arctic are similarly diesel dependent. The success of cases of SELCO shows the potential of microfinancing schemes and regional rural banks[259]. In an Arctic context, Indigenous corporations or community-oriented third parties could play a larger role as the actor in between government sponsorship and boots on the ground.

Subsidized capital funding is also necessary for certain cases since direct funding is a critical component of funding schemes for large scale energy projects.[260] In order for effective spending in climates of limited funding, Strand proposes states like Alaska follow the model of groups like the Arctic Energy Alliance (AEA) that offers funding on technical viability, availability of matching funds and level of community engagement.[261]

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[255] Strand, H. (2018). Breaking Barrier To Renewable Energy Production in the North American Arctic. *Alaska Law Review*, *35*(1).
[256] Ibid
[257] Ibid
[258] Ibid
[259] Ibid
[260] Ibid
[261] Ibid

The Role of Indigenous and Non-for-profit Organizations

In Canada, the Makivik Corporation of Nunavik in northern Quebec, is seen as an example of a "*corporate form as a way to empower rural native cultures".*[262] It has been successful in developing political and economic status for people of the Nunavik region. While designed as a non-profit corporation in 1978, it further incorporates "*traditional communal governance structures of native tribes with the western market economy"* to bridge the gap.[263] Since incorporation it has given more than 80 million dollars towards it mandate of poverty relief, promotion of welfare and education of the Inuit, development and improvement of Inuit communities and "to foster, promote, protect, and assist in preserving the Inuit way of life, values and traditions."[264] Today, elections for the board of Makivik are considered the most important for the region in spite of the regional government in place.[265]

Unlike Native Corporations in Alaska that have diversified outside the state, Makivik's portfolio is exclusive to ventures that directly benefits Nunavik communities and boasts "*two airlines, Nunavik Creations (a clothing and art company for local artisans), Nunavik Furs, Halutik Enterprises (a fuel and heavy equipment company for Nunavik), and Kautaq Construction.*"[266]

Although Makivik has been successful in its many venture, renewable energy is not one. Nunavik communities continue to be without access to the grid and rely on heating oil for energy.[267] In spite of Makivik's subsidy program for heating oil in villages, "*the recent decision by Hydro Québec to increase the heating oil rates in*

[262] Strand, H. (2018). Breaking Barrier To Renewable Energy Production in the North American Arctic. *Alaska Law Review, 35*(1).
[263] Ibid
[264] Ibid
[265] Ibid
[266] Ibid
[267] Ibid

these communities shows how Makivik has not focused on energy as a major goal of environmental justice for Nunavik peoples."[268]

Similar to Makivik but culturally neutral, the Northwest Territories created a non-profit organization called Arctic Energy Alliance approximately two decades ago to meet the needs of affordable, effective and efficient energy sources for their rural communities.[269] Since its inception it has become the "lead not-for-profit organization helping communities, consumers, producers, regulators, and policymakers to work together to reduce the cost and environmental impacts of energy usage in the Northwest Territories."[270]

The AEA has worked on projects within 32 rural villages in the Northwest Territories.[271] Their approach involved interested community members to create a group, assemble and inventory of energy use for the community, evaluate possible projects as well partnerships, put forward the most promising projects in a "Community Energy Plan (CEP) call to action" followed by implementation and monitoring of the proposed projects and revising the CEP as required.[272] The idea is that plans are developed and customized for each the individuals in each community. Moreover, the AEA mandates community engagement through financial accountability. Each community is required to contribute 50% of the funding needed for their CEP. [273]

Considered a success for its facilitation of community energy planning in the Arctic, there have been calls to replicate this model in other jurisdictions such as Nunavut.[274]

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[268] Strand, H. (2018). Breaking Barrier To Renewable Energy Production in the North American Arctic. *Alaska Law Review*, *35*(1).
[269] Ibid
[270] Ibid
[271] Ibid
[272] Ibid
[273] Ibid
[274] Ibid

In order to be effective, political will is needed to drive these programs forward and positively impact remote communities. [275]

Case Study of Colville Lake - Solar/Diesel Hybrid System

Colville Lake is an arctic settlement the Northwest Territories that experienced an energy crisis in 2015. According to Northwest Territories Power Company, Colville Lake was among the most expensive communities to fuel due to the unreliable diesel generators.[276] The community was spending over $140,000 on diesel annually for a population of 190 residents. The community suffered from poor air quality, "low hanging odorous air" and poor reliability, experiencing on average one power outage per week.[277] Outages were caused by day-to-day loads of the community such as too many stoves being used at the same time.

The community was able to come together to work with the AEA, to develop and implement a solar/diesel hybrid system. The total construction cost of the hybrid solution was $7.7 million Canadian; however, the Northwest Territories government was only required to contribute $1.3 million. [278]

This project is an example of the utility ownership model where the Northwest Territories' Crown utility owns and operate the Colville Lake solar assets.[279]

The Role of Utilities

As demonstrated in the case of Colville Lake, the utility ownership model may offer advantages like lightening the burden in rising capital for the project and providing expertise on the remote grid; however, the weaknesses of the model may arise if the

[275] Strand, H. (2018). Breaking Barrier To Renewable Energy Production in the North American Arctic. *Alaska Law Review*, *35*(1).
[276] Ibid
[277] Ibid
[278] Ibid
[279] Lovekin, D., Dronkers, B., & Thibaut, B. (2016). *Power purchase policies for remote Indigenous communities in Canada*. Calgary: The Pembina Institute.

community is not involved or consulted and depending on the structure of the arrangement, how benefits are returned to the community.[280] Benefits of the utility partnership with AEA lies in the fact that the AEA CEP model ensures that communities have a core group of engaged people who receive tangible support in the form of a financial commitment on behalf of the community. [281]

Utilities play a vital role in enabling renewable energy projects. Prohibitive policy environments against the integration of energy alternatives through IPP arrangements in monopoly utilities like Qulliq Energy Corporation in Nunavut are changing as of late 2018.[282] Yukon is considered a leading jurisdiction where IIP policy was introduced three years earlier after government support for the mechanism as a means of improving energy security and affordability.[283] The Yukon has been successful in enabling more IIP projects by offering a PPA rate 10-20% greater than marginal cost.[284] This has resulted in cost savings from reduced operation of diesel systems and allowed more viable revenue streams for community ownership. Further to community ownership, Indigenous ownership is an aim of the Yukon's IPP policy. A recent case enabled by IIP policy and the PPA with utilities is the 300 kW wind turbine system with battery storage developed by Kluane Community Development Corporation, owned by Kluane First Nation in Yukon.[285] Inspired by Alaskan

[280] Lovekin, D., Dronkers, B., & Thibaut, B. (2016). *Power purchase policies for remote Indigenous communities in Canada*. Calgary: The Pembina Institute.
[281] Ibid
[282] Ibid
[283] Ibid
[284] Ibid
[285] Croft, D. (2019). Yukon opens up power generation to communities and private sector. Retrieved from https://www.cbc.ca/news/canada/north/yukon-electricity-generation-independent-1.4997677

Indigenous-operated Chaninik Wind Group,[286] the wind project is the first in northern Canada owned by a First Nation group.[287]

As a key stakeholder in energy provision for communities, utilities can enable integration of renewable energy through infrastructure planning and modernization. As per recommendation by the Pembina Institute, the end-of-life for energy infrastructure in the community allows opportunity for new investment.[288] Traditional diesel generators can be replaced by high-efficiency units, or alternatively variable speed generators that can accommodate renewable integration more easily. An example of this window of opportunity was the needed replacement of diesel generators in Whitehorse installed in the 1970s and 80s.[289] Instead of simply replacing the generators with newer models, the infrastructure was switched to run on natural gas, with implementation of systems equipped for LNG.[290]

Conversely, utilities have been found to have conservative perspectives on the readiness and deployability of technologies like wind diesel systems.[291] A review of the perspectives on wind-diesel systems in Canada showed that utilities were the more hesitant than any other stakeholder surveyed.[292] This included governments, developers, researchers and manufacturers. Utilities attributed this lack of confidence in the limited economies of scale in the North that could lower costs of operation and

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[286] The Chaninik Wind Group ("the Group") was created by the United Tribal Governments of Kongiganak, Kwigilliingok, Tuntutuliak, and Kipnuk, Alaska and represents more than 2,000 tribal members Alaska. Its formation in 2005 come from the recognition of tribal leaders that “only by working together could they survive the impacts of increasing fuel costs and begin to harness the renewable energy resources available in the region.” The group’s ambition is to “reduce dependency on diesel fuel, lower energy costs and foster opportunities for economic development in their communities.” Chaninik Wind Group - 2010 Project. (2019). Retrieved from https://www.energy.gov/indianenergy/chaninik-wind-group-2010-project

[287] Lovekin, D., Dronkers, B., & Thibaut, B. (2016). *Power purchase policies for remote Indigenous communities in Canada*. Calgary: The Pembina Institute.
[288] Pembina Institute. (2019). *Pembina Institute comments on Qulliq Energy Corporation’s proposed IPP policy*. Pembina Institute.
[289] Lovekin, D., Dronkers, B., & Thibaut, B. (2016). *Power purchase policies for remote Indigenous communities in Canada*. Calgary: The Pembina Institute.
[290] Ibid
[291] Weis, T., Ilinca, A., & Pinard, J. (2008). Stakeholders’ perspectives on barriers to remote wind–diesel power plants in Canada. *Energy Policy*, *36*(5), 1611-1621. doi: 10.1016/j.enpol.2008.01.004
[292] Ibid

maintenance.[293] Prohibited further by perception that the economic case is lacking and that investment in wind diesel systems may be an inefficient use of funds. [294]

Breaking of path dependence on diesel can come in the form harnessing new innovations such as this reinvestment in natural gas systems, but focus should not lie solely on non-renewable alternatives. Renewable energy presently offers incredible seasonal potential, and ongoing innovations in areas ranging from battery energy storage to advanced microgrid technologies. The climate specificity of the Arctic may allow certain communities to run entirely from renewables seasonally once a certain level of technological penetration has been achieved.[295]

As witnessed in other parts of the country, utilities have been confronted with upgrading distribution infrastructure and assets. The congestion in tackling these infrastructure projects has led to discussion of "non-wires alternatives" especially in cases of remote communities. Though seen as costly investments, battery storage can be used as a non-wires alternatives for these upgrades and allow utilities to postpone larger infrastructure projects. The remote Gull Bay First Nation community can be seen as a case study of the use of battery storage as a non-wires alternative.[296] The ground-mount solar and battery storage project being commissioned by partners including the Independent Electricity System Operator is expected to be operational by the end of 2018. Gull Bay First Nation had experienced economic constraint preventing it from connecting to the grid. Projects like this microgrid will offset the need for the existing diesel generator and provide communities with capacity alongside resilience and security.

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[293] Weis, T., Ilinca, A., & Pinard, J. (2008). Stakeholders' perspectives on barriers to remote wind–diesel power plants in Canada. *Energy Policy, 36*(5), 1611-1621. doi: 10.1016/j.enpol.2008.01.004
[294] Ibid
[295] Pembina Institute. (2019). *Pembina Institute comments on Qulliq Energy Corporation's proposed IPP policy*. Pembina Institute.
[296] Fully-integrated microgrid at Gull Bay First Nation first of its kind in Canada. (2018). Retrieved from http://www.ieso.ca/en/Powering-Tomorrow/Efficiency/Fully-integrated-microgrid-at-Gull-Bay-First-Nation-first-of-its-kind-in-Canada

Conclusion

The increasingly occupied Arctic as a host for resource extraction and other commercial activities catalyzed by climate change intensifies existing pressure on traditional livelihoods of Indigenous peoples. These disruptions coupled with repercussions of diesel dependence perpetuate a uniquely amplified energy trilemma for Indigenous communities. This has been evidenced with cost disparities and rate structures for northern remote communities, low income households with unaffordable and poor quality housing, high levels of dependency on imported fossil fuel and carbon intensive electricity generation that qualitatively leads to poor air quality and a restricted quality of life in many communities.

The importance of collective action becomes apparent when facing issues like the systemic absence of home ownership and community-based electricity rate structures for remote Indigenous communities. Moreover, this work recommends the inclusion of non-profit and Indigenous organizations like the Arctic Energy Alliance and Makivik Corportation, who have undoubtedly garnered favour and acceptance in these communities, as actors in energy transition. These stakeholders could promote or facilitate policy instruments like Power Purchase Agreements as a basis for renewable generation projects with proven technologies for the harsh climate such as solar-diesel systems. In terms of governance and divergent perspectives on issues like energy security, these groups could function as advocates for communities with pivotal stakeholders like utilities, often the key decision makers for technological changes and advancement of infrastructures, as well as governments.

As greater cooperation on the part of utilities and governments is needed to effect an energy transition, this tangibly looks like greater transparency and the accurate evaluation of the current economic costs of diesel generated electricity and subsidies. The theme of cooperation similarly resonates for larger scale issues of energy extraction and exploration in the region. The need for multilateral governance and accountability when it comes to climate change is clear and has been illustrated through the contributing footprints of many nations linked to detrimental impacts on subsistence and viability of Arctic communities.

The policy recommendation put forward as a safeguard for frontline Indigenous communities falling victim to the resource curse in the event of Canadian extraction is the development a wealth fund similar to the Alaskan Permanent Fund Dividend as a means of a more beneficial engagement of Indigenous groups in national energy projects, one of Canada’s recurrent shortfalls, and wealth redistribution from extraction.

References

1. "Energy Security". *International Energy Agency*, 2018, https://www.iea.org/topics/energysecurity/. Accessed 9 Nov 2018.
2. "Remote Communities Energy Database". *Government of Canada*, 2018, http://atlas.gc.ca/rced-bdece/en/index.html. Accessed 9 Nov 2018.
3. "Statement on The Introduction Of Canadian Carbon Taxes". *International Institute For Sustainable Development*, 2018, https://www.iisd.org/media/statement-introduction-canadian-carbon-taxes.
4. "Surveys and statistical programs - Survey of Household Spending (SHS). (2019). Retrieved from http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=3508
5. Asia Pacific Energy Research Centre. *A Quest For Energy Security In The 21St Century*. Asia Pacific Energy Research Centre, Institute Of Energy Economics Japan, Tokyo, 2007.
6. Beck, M., Rivers, N., & Yonezawa, H. (2016). A rural myth? Sources and implications of the perceived unfairness of carbon taxes in rural communities. *Ecological Economics*, *124,* 124-134. doi: 10.1016/j.ecolecon.2016.01.017.
7. Berman, M. (2018). Resource rents, universal basic income, and poverty among Alaska's Indigenous peoples. *World Development*, *106*, 161-172. doi: 10.1016/j.worlddev.2018.01.014
8. Brooks, M., & Moore, N. (2017). Open Access Energy Blueprint. Waterloo Global Science Initiative.
9. Brzozowski, A. (2019). Arctic nations bet on 'blue economy' to reconcile climate, development goals. Retrieved from https://www.euractiv.com/section/global-europe/news/arctic-nations-bet-on-blue-economy-to-reconcile-climate-development-goals/
10. Carbon Pricing Dashboard. (2019). Retrieved from https://carbonpricingdashboard.worldbank.org/map_data
11. Census in Brief: The housing conditions of Aboriginal people in Canada. (2017). Retrieved from https://www12.statcan.gc.ca/census-recensement/2016/as-sa/98-200-x/2016021/98-200-x2016021-eng.cfm
12. Chaninik Wind Group - 2010 Project. (2019). Retrieved from https://www.energy.gov/indianenergy/chaninik-wind-group-2010-project

13. Croft, D. (2019). Yukon opens up power generation to communities and private sector. Retrieved from https://www.cbc.ca/news/canada/north/yukon-electricity-generation-independent-1.4997677

14. Customer Rates. (2018). Retrieved from https://www.qec.nu.ca/customer-care/accounts-and-billing/customer-rates

15. Dobson, N., & Trevisanut, S. (2018). Climate Change and Energy in the Arctic—The Role of the European Union. *The International Journal Of Marine And Coastal Law*, *33*(2), 380-402. doi: 10.1163/15718085-13320011

16. Environment and Climate Change Canada. (2019). *National Inventory Report 1990–2017: Greenhouse Gas Sources and Sinks in Canada*.

17. Five minute guide to the Energy Trilemma. (2019). Retrieved from https://www.arup.com/perspectives/publications/promotional-materials/section/five-minute-guide-to-the-energy-trilemma

18. Fully-integrated microgrid at Gull Bay First Nation first of its kind in Canada. (2018). Retrieved from http://www.ieso.ca/en/Powering-Tomorrow/Efficiency/Fully-integrated-microgrid-at-Gull-Bay-First-Nation-first-of-its-kind-in-Canada

19. Gautier, D., Bird, K., Charpentier, R., Grantz, A., Houseknecht, D., & Klett, T. et al. (2009). Assessment of Undiscovered Oil and Gas in the Arctic. *Science*, *324*(5931), 1175-1179. doi: 10.1126/science.1169467

20. Gerson, J. (2013). Allowing private home ownership on reserves could be key to improving well-being for Natives: report. *National Post*. Retrieved from https://nationalpost.com/news/canada/allowing-private-home-ownership-on-reserves-could-be-key-to-improving-well-being-for-natives-report

21. Government of Canada. Status of Remote/Off-Grid Communities In Canada. Government Of Canada, 2011.

22. GST/HST and Indigenous peoples. (2019). Retrieved from https://www.canada.ca/en/revenue-agency/services/tax/businesses/topics/gst-hst-businesses/charge-collect-indigenous-peoples.html

23. Herrmann, V. (2018). Enabling Families to Adapt to Climate Change Independently | The Arctic Institute. Retrieved from https://www.thearcticinstitute.org/enabling-families-adapt-climate-change-independently/

24. Hydro Quebec. (2018). *Comparison of Electricity Prices in Major North American Cities 2018*. Retrieved from http://www.hydroquebec.com/data/documents-donnees/pdf/comparison-electricity-prices.pdf

25. Inuit Nunangat. (2019). Retrieved from https://indigenouspeoplesatlasofcanada.ca/article/inuit-nunangat/

26. Karanasios, K., & Parker, P. (2018). Tracking the transition to renewable electricity in remote indigenous communities in Canada. *Energy Policy*, *118*, 169-181. doi: 10.1016/j.enpol.2018.03.032

27. Karanasios, K., & Parker, P. (2018). Tracking the transition to renewable electricity in remote indigenous communities in Canada. *Energy Policy*, *118*, 169-181. doi: 10.1016/j.enpol.2018.03.032

28. Krupa, J. (2012). Identifying barriers to aboriginal renewable energy deployment in Canada. *Energy Policy*, *42*, 710-714. doi: 10.1016/j.enpol.2011.12.051

29. Kruyt, B., van Vuuren, D., de Vries, H., & Groenenberg, H. (2009). Indicators for energy security. *Energy Policy*, *37*(6), 2166-2181. doi: 10.1016/j.enpol.2009.02.006

30. Lee, M., Kung, E., & Owen, J. (2011). *Fighting Energy Poverty in the Transition to Zero-Emission Housing: A Framework for BC*. Vancouver: Canadian Centre for Policy Alternatives.

31. Lindholt, L., & Glomsrød, S. (2018). Phasing out coal and phasing in renewables – Good or bad news for arctic gas producers?. *Energy Economics*, *70*, 1-11. doi: 10.1016/j.eneco.2017.12.015

32. Lovekin, D., & Dronkers, B. (2016). *The True Cost of Fuel in the Arctic*. WWF-Canada.

33. Lovekin, D., Dronkers, B., & Thibaut, B. (2016). *Power purchase policies for remote Indigenous communities in Canada*. Calgary: The Pembina Institute.

34. MacKinnon, P. (2013). *A Future Fund for Saskatchewan: A Report to Premier Brad Wall on the Saskatchewan Heritage Initiative*.

35. Mallett, A., & Cherniak, D. (2018). Views from above: policy entrepreneurship and climate policy change on electricity in the Canadian Arctic. *Regional Environmental Change*, *18*(5), 1323-1336. doi: 10.1007/s10113-018-1317-7

36. McCauley, D., Heffron, R., Holmes, R., & Pavlenko, M. (2017). Energy justice: A new framework for examining Arcticness in the context of energy infrastructure development. In Kelman I. (Ed.), *Arcticness: Power and Voice from the North* (pp. 77-88). London: UCL Press. Retrieved from http://www.jstor.org/stable/j.ctt1tm7jp1.15

37. McFarlan, A. (2018). Techno-economic assessment of pathways for electricity generation in northern remote communities in Canada using methanol and dimethyl ether to replace diesel. *Renewable And Sustainable Energy Reviews*, *90*, 863-876. doi: 10.1016/j.rser.2018.03.076

38. Mele, C., & Victor, D. (2016). Reeling From Effects of Climate Change, Alaskan Village Votes to Relocate. *The New York Times*. Retrieved from https://www.nytimes.com/2016/08/20/us/shishmaref-alaska-elocate-vote-climate-change.html

39. National Energy Board. Market Snapshot: Explaining the High Cost of Power in Northern Canada. National Energy Board, 2017. https://www.neb-one.gc.ca/nrg/ntgrtd/mrkt/snpsht/2017/02-03hghcstpwr-eng.html

40. Natural Resource Governance Institute. (2015). The Resource Curse [Ebook]. Retrieved from https://resourcegovernance.org/sites/default/files/nrgi_Resource-Curse.pdf

41. Nunami Stantec Limited. (2018). *Strategic Environmental Assessment for Baffin Bay and Davis Strait*.

42. Parlee, B. (2015). Avoiding the Resource Curse: Indigenous Communities and Canada's Oil Sands. *World Development*, *74*, 425-436. doi: 10.1016/j.worlddev.2015.03.004

43. Pembina Institute. (2019). *Pembina Institute comments on Qulliq Energy Corporation's proposed IPP policy*. Pembina Institute.

44. Poelzer, G. (2015). *What Crisis? Global Lessons from Norway for Managing Energy-Based Economies*. The Macdonald-Laurier Institute.

45. Pollution pricing: technical briefing. (2018). Retrieved from https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/putting-price-on-carbon-pollution/technical-briefing.html

46. Rankin Inlet wind turbine loses its blades. (2012). Retrieved from https://www.cbc.ca/news/canada/north/rankin-inlet-wind-turbine-loses-its-blades-1.1208272

47. Standing Senate Committee on Aboriginal Peoples. (2017). *We Can Do Better: Housing in Inuit Nunangat*. Senate of Canada.

48. Stout, R. (2018). *The built environment: Understanding how physical environments influence the health and well-being of First Nations peoples living on-reserve*. Prince George, BC: National Collaborating Centre for Aboriginal Health.

49. Strand, H. (2018). Breaking Barrier To Renewable Energy Production in the North American Arctic. *Alaska Law Review, 35*(1).

50. Strategic Environmental Assessment | Nunavut Impact Review Board. (2019). Retrieved from http://www.nirb.ca/content/strategic-environmental-assessment

51. Strong, W. (2017). Mackenzie Valley pipeline project officially one for the history books. *CBC News*. Retrieved from https://www.cbc.ca/news/canada/north/mackenzie-valley-gas-project-no-more-1.4465997

52. Tedsen, E., Cavalieri, S., & Kraemer, A. (2014). *Arctic Marine Governance* (pp. 71-99). Berlin: Springer.

53. Touchette, Y., Gass, P., & Echeverría, D. (2017). *Costing Energy and Fossil Fuel Subsidies in Nunavut: A mapping exercise*. International Institute for Sustainable Development.

54. United Nations. (2018). *The Sustainable Development Goals Report 2018*. New York: United Nations Publications. Retrieved from https://unstats.un.org/sdgs/files/report/2018/TheSustainableDevelopmentGoalsReport2018-EN.pdf

55. WEC Energy Trilemma Index Tool. (2019). Retrieved from https://trilemma.worldenergy.org/#!/country-profile?country=Canada&year=2018

56. Weis, T., Ilinca, A., & Pinard, J. (2008). Stakeholders' perspectives on barriers to remote wind–diesel power plants in Canada. *Energy Policy*, *36*(5), 1611-1621. doi: 10.1016/j.enpol.2008.01.004

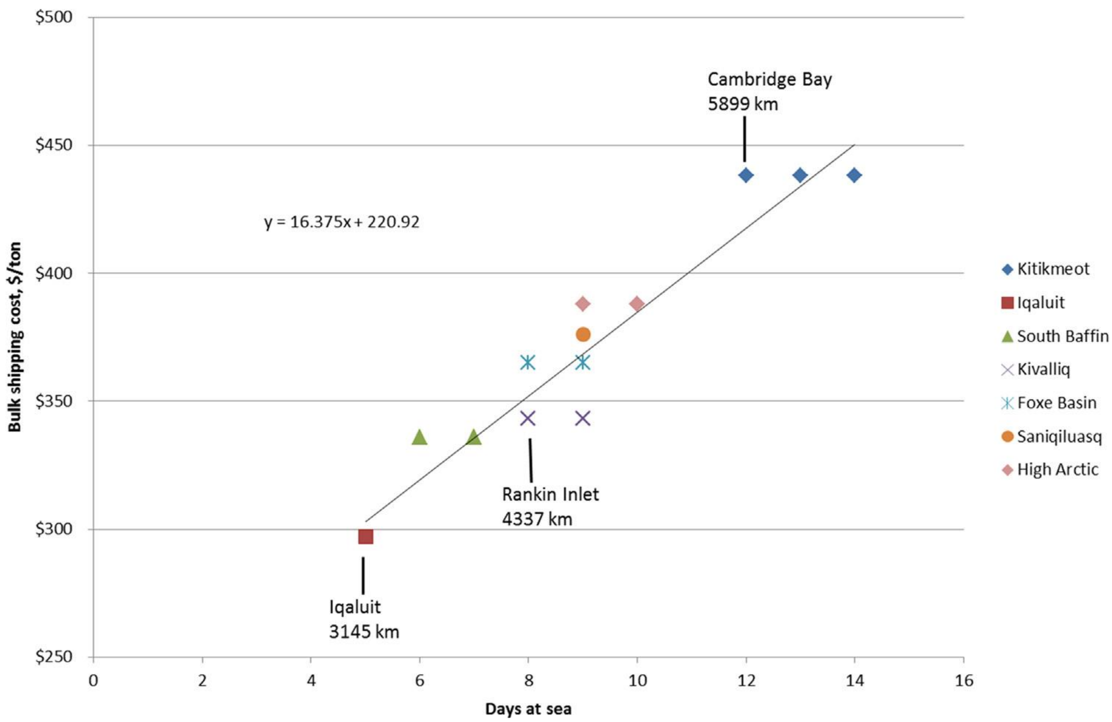
57. World Energy Trilemma. (2019). Retrieved from https://www.worldenergy.org/work-programme/strategic-insight/assessment-of-energy-climate-change-policy/

58. Wright, L., Bender, A., & Desson, C. (2018). Facing the Change: 5 Canadian Communities Threatened by Climate Change | CBC Radio. Retrieved from https://www.cbc.ca/radio/day6/facing-the-change-5-canadian-communities-threatened-by-climate-change-now-1.4447042

Appendices

Appendix A

Sealift Rate for Bulk Dry Freight per Short Ton vs Number of Days to Destination[297]



[297] McFarlan, A. (2018). Techno-economic assessment of pathways for electricity generation in northern remote communities in Canada using methanol and dimethyl ether to replace diesel. *Renewable And Sustainable Energy Reviews*, *90*, 863-876. doi: 10.1016/j.rser.2018.03.076

Appendix B

Analysis results from the Fraser Institute show actual and hypothetical contribution scenarios as the parameters of the Alaskan PFD and Norwegian models.

Source: Poelzer, G. (2015). What Crisis? Global Lessons from Norway for Managing Energy-Based Economies. The Macdonald-Laurier Institute.

TABLE 1: Actual Alberta Fund deposits versus hypothetical Alaskan and Norwegian models, fiscal year 1981/82 through 2010/11 (in C$millions)

Fiscal year (end)	Alberta natural resource revenue	Actual contribution to Heritage Fund	Alaskan rule – 25% contribution	Norwegian rule – 100% contribution
1982	4,748	1,434	1,187	4,748
1983	4,122	1,370	1,031	4,122
1984	4,779	720	1,195	4,779
1985	5,229	736	1,307	5,229
1986	4,932	685	1,233	4,932
1987	1,892	217	473	1,892
1988	2,626	—	657	2,626
1989	2,085	—	521	2,085
1990	2,240	—	560	2,240
1991	2,688	—	672	2,688
1992	2,022	—	506	2,022
1993	2,183	—	546	2,183
1994	2,817	—	704	2,817
1995	3,378	—	845	3,378
1996	2,786	—	697	2,786
1997	4,034	—	1,009	4,034
1998	3,778	—	945	3,778
1999	2,368	—	592	2,368
2000	4,650	—	1,163	4,650
2001	10,586	—	2,647	10,586
2002	6,227	-	1,557	6,227
2003	7,130	—	1,783	7,130
2004	7,676	—	1,919	7,676
2005	9,744	—	2,436	9,744
2006	14,347	1,750	3,587	14,347
2007	12,260	1,250	3,065	12,260
2008	11,024	918	2,756	11,024
2009	11,915	—	2,979	11,915
2010	6,768	—	1,692	6,768
2011	8,428	—	2,107	8,428
Total Principal		**9,080**	**42,366**	**169,462**