



*Standing Senate Committee on Energy,
the Environment and Natural Resources*

Powering Canada's Territories



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(Reports, witnesses and briefs)

41st Parliament – 2nd Session

Note: Any non-sourced photos are of Canadian scenes, from iStock.

Front cover photos, clockwise: northern lights, Nunavut, NWT, Yukon.



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MEMBERS

The Honourable Richard Neufeld, Chair
The Honourable Paul J. Massicotte, Deputy Chair

and

The Honourable Douglas Black, Q.C.
The Honourable Michael L. MacDonald
The Honourable Grant Mitchell
The Honourable Dennis Glen Patterson
The Honourable Pierrette Ringuette
The Honourable Judith G. Seidman
The Honourable Nick G. Sibbeston

Ex-officio members of the Committee:

The Honourable Senators Claude Carignan, P.C., (or Yonah Martin) and James S. Cowan (or Joan Fraser).

Other Senators who have participated from time to time in the study:

The Honourable Senators Diane Bellemare, Pierre-Hugues Boisvenu, Joseph A. Day, Linda Frum, Pierre Claude Nolin, Michel Rivard, David Tkachuk and John D. Wallace.

Parliamentary Information and Research Service, Library of Parliament:

Sam Banks and Marc LeBlanc, Analysts.

Clerk of the Committee:

Lynn Gordon

Senate Committees Directorate:

Monique Régimbald, Administrative Assistant.



ORDER OF REFERENCE

Extract from the *Journal of the Senate*, Tuesday, March 4, 2014:

The Honourable Senator Neufeld moved, seconded by the Honourable Senator Lang:

That the Standing Senate Committee on Energy, the Environment and Natural Resources be authorized to examine and report on non-renewable and renewable energy development including energy storage, distribution, transmission, consumption and other emerging technologies in Canada's three northern territories. In particular, the committee shall be authorized to:

Identify energy challenges facing northern territories including the state of existing energy services and infrastructure assets as well as related economic, social, geographic and environmental challenges;

Identify existing federal and territorial programs and measures aimed at improving energy use and supply in the north;

Examine ways of enhancing and diversifying energy production for domestic needs and export markets; and

Examine ways of improving the affordability, availability, reliability and efficiency of energy use for industries, businesses, governments, and residents in the north.

That the committee submit its final report no later than December 31, 2014 and that the committee retain all powers necessary to publicize its findings until 180 days after the tabling of the final report.

After debate

The question being put on the motion, it was adopted.

Gary W. O'Brien
Clerk of the Senate

Extract from the *Journal of the Senate* Tuesday, November 25, 2014:

The Honourable Senator Neufeld moved, seconded by the Honourable Senator Housakos:

That, notwithstanding the order of the Senate adopted on Tuesday, March 4, 2014, the date for the final report of the Standing Senate Committee on Energy, the Environment and Natural Resources in relation to its study of non-renewable and renewable energy development including energy storage, distribution, transmission, consumption and other emerging technologies in Canada's three northern territories be extended from December 31, 2014 to September 30, 2015.

The question being put on the motion, it was adopted.

Gary W. O'Brien
Clerk of the Senate



I. EXECUTIVE SUMMARY

On March 4, 2014, the Standing Senate Committee on Energy, the Environment and Natural Resources initiated a study of energy use and supply in Canada's territories.

The report examined existing territorial energy systems and identified obstacles and opportunities facing each territory in making energy affordable, reliable and sustainable for its residents and businesses. A focus was placed on electricity systems.

As a whole, the committee found electricity systems aging, underperforming and at capacity. Also, the committee observed that territorial communities were highly dependent on diesel generation. The committee also found a lack of financial capacity among utilities and territorial governments to advance major projects due to small rate and tax bases. Utilities face high costs associated with servicing many small remote communities which predominantly rely on diesel generation. Also, energy options are constrained as the territories are not connected to the North American electricity and natural gas grids.

Many energy issues are shared pan-territorially; however, each territory faces distinctive challenges and opportunities due to dissimilar geography and degree of community remoteness. Also, territories have different energy resources and asset profiles. Electricity prices in the Northwest Territories (NWT), and in particular Nunavut, are high compared to the rest of Canada, which increases the cost of living and requires subsidization to keep energy affordable. Nunavut's unique and sizable energy challenges stood apart from its territorial counterparts.

In all three territories, heating of homes and buildings is predominantly provided by furnace oil (diesel), which is reliable but costly and carbon-intensive. While substantial petroleum deposits are estimated in the territories, much of these resources are undeveloped and underexplored.

All three territories have developed energy strategies that differ in scope and implementation, to promote and support renewable energy, increase energy efficiency, and reduce the dependency on carbon-intensive fuels. In Yukon and NWT, new opportunities for natural gas generation and biomass heating are helping to diversify the territorial energy mix.

The report makes five recommendations to the federal government to help improve the energy circumstances of the territories. The recommendations are aimed at improving energy efficiency and conservation, enhancing community-based energy solutions and coordinating federal resources under a central hub. The committee also recommends that the federal government assist with upgrading and improving aging diesel generation facilities and infrastructure investment in qualified territorial energy projects.



II. SUMMARY OF RECOMMENDATIONS

Recommendation I

That the federal government develop a strategic plan to actively improve energy efficiency and conservation in the territories.

Recommendation II

That the federal government significantly increase funding to the ecoENERGY for Aboriginal and Northern Communities Program with the objective of reducing the consumption of carbon-intensive fuels, increasing energy efficiency and enhancing community economic viability.

Recommendation III

That the federal government create a federal resource and knowledge hub to focus on territorial energy issues and conditions, in supporting energy supply and technology evaluations, economic and environmental modelling and energy resource planning and assessments.

Recommendation IV

That the federal government assist in the acquisition, upgrading and installation of diesel generating facilities in remote off-grid northern communities.

Recommendation V

That the federal government support infrastructure investment in qualified territorial energy projects.



III. INTRODUCTION

Energy is something most of us take for granted even though, without it, modern life would not be possible. For many of us, energy is simply part of the background, always there when called upon, reliably fuelling virtually every aspect of our daily lives.

In Canada's territories, access to energy is much closer to the forefront. This is because per capita energy use, driven by long cold winters, is nearly twice the national average.¹ Many northerners live within eyesight of a diesel facility that powers their community. If that facility stops working in winter, it is much more likely to threaten public safety and there are fewer options for a timely remedy, risking extensive and costly damage and repairs.

Communities in the territories, most of which are Aboriginal, are predominantly small, isolated and widely dispersed across an immense landmass. All of these communities are considered off-grid since they are not connected to the North American electricity or natural gas grids. While hydro power is available for many communities, northerners rely on carbon-intensive fuels such as diesel much more heavily than the rest of Canada. This is because diesel is often the only reliable option for heat and electricity; the drawback is that it is costly to purchase and transport. It also presents environmental disadvantages.

In planning for the future, territorial governments must balance the need to supply affordable and reliable electricity to residents, businesses and industry while attempting to reduce the consumption of carbon-intensive fuels. In recent years, advances in renewable energy technologies, energy efficiency, other fuel options such as natural gas and the possibility of connecting to the North American energy grids, are creating new opportunities. That being said, the committee heard that territorial governments are financially limited in advancing many large energy projects.

The purpose of this report is to examine the territories' current energy systems and future energy opportunities and to make recommendations as to what role the federal government should play to improve energy use and supply while meeting its environmental objectives. Many communities in the northern regions of the provinces are isolated and off-grid and face similar challenges as those being studied in this report. The committee believes many of the findings of this report can be extended to assist provincial off-grid communities.

During the course of the study, the committee held 18 hearings and heard from 42 witnesses consisting of federal, territorial and municipal officials, the Alaskan Energy Authority, industry representatives, energy associations, aboriginal governments, territorial electric utilities, energy experts, business leaders and environmental groups.

Beginning May 9, 2014, committee members travelled for a week in the territories visiting each of the capitals and also smaller communities such as Kimmirut and Rankin Inlet in Nunavut and Whatì in NWT to listen to community leaders. This report benefited from several site visits such as the Agnico Eagle Meliadine Gold Mine Project near Rankin Inlet, Yukon Energy Corporation's (YEC) Whitehorse Rapid hydro plant and a newly constructed run-of-river project in Atlin, British Columbia near the Yukon border.



The report begins with an overview of the climate, geography, economic and fiscal profiles of the territories followed by an outline of existing territorial energy systems and resources. The study limits its examination to three major energy areas: electricity, heating, and oil and gas resources. More attention is devoted to electricity because territorial governments are owners of public utilities and thus are responsible for large energy assets, and have a direct influence on the consumption, delivery and supply of electricity. The next section outlines some of the major opportunities and challenges facing each territory and the final section discusses federal territorial priorities and makes recommendations to the federal government to improve the energy circumstances in the territories.





IV. PROFILE OF TERRITORIES

The territories of Yukon, NWT and Nunavut occupy Canada’s most northern region, a vast area covering 40% of Canada’s total landmass. It is home to approximately 116,700 residents dispersed in mostly isolated and predominantly aboriginal communities. Some communities are small, having a population of fewer than 100 people, most communities range in the several hundreds of residents and many are over a thousand. The capitals, Whitehorse, Yellowknife and Iqaluit are the largest cities in each of the territories (Table 1).

A. Climate and Geography

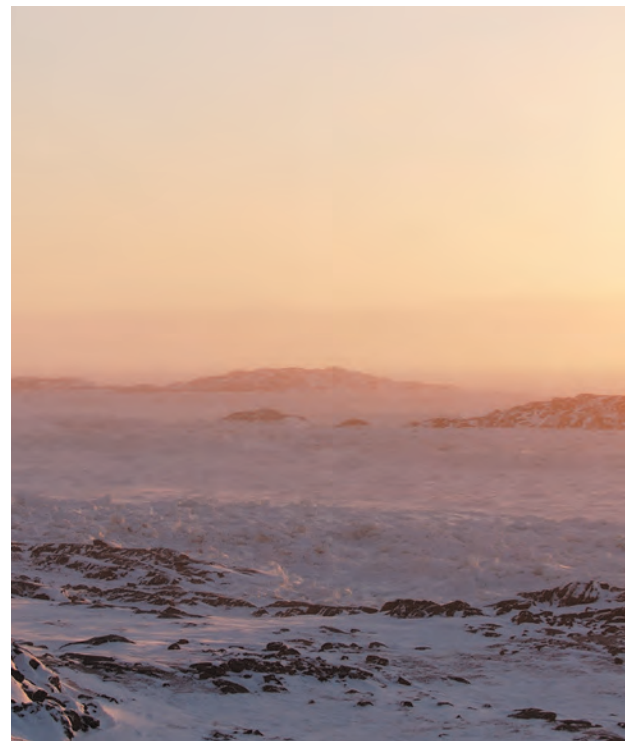
Canada’s territories encompass an immense area with varying climates. Generally, northerners are exposed to long cold winters and short cool summers. Precipitation is infrequent and concentrated in the warmer months. Average monthly high and low temperatures over the course of a year range from 20°C to -20°C in Whitehorse and from 20°C to -30°C in Yellowknife.² Overall, Iqaluit is subject to cooler temperatures ranging from 12°C to -32°C.³ It is not uncommon to reach low temperatures of -50°C in Canada’s high Arctic. The region’s eco-systems, permafrost and sea ice is particularly vulnerable to the current and future effects of climate change.

The geography varies widely across the territories which include mountain ranges, forested areas, tundra, numerous rivers and fresh water lakes, permanent sea ice and glaciers. Generally, the subarctic region contains taiga and boreal forests mostly within NWT and parts of Yukon. In contrast, Nunavut’s land consists of tundra and barren grounds which also describe parts of NWT, particularly in the territory’s northern region. The entire territory of Nunavut is continuous permafrost soil as are northern parts of Yukon and NWT.⁴

Table 1 – Area and Population – Canada’s Territories, 2014

	Yukon	NWT	Nunavut
Size Square Km	482,443	1,346,106	2,093,190
Total Population	36,510	43,623	36,585
Territorial capitals	25,058 Whitehorse	20,318 Yellowknife	7,713 Iqaluit

Source: Statistics Canada: [Land and freshwater area](#); Annual population estimates Cansim Table [051-0001](#).



Arctic Sun, Nunavut



Yukon has a system of all-weather roads that reach northern regions of the territory and crosses into northern NWT. NWT's highway system is localized in its southern region. Both Yukon and NWT have road access to southern provinces. In the winter, NWT ice-roads provide access to remote communities and mines.⁵ In contrast, no two communities in Nunavut are connected by roads nor is Nunavut road-connected to the rest of Canada. Most of Nunavut's population live in coastal communities but marine access is only available a few months of the year once the sea ice is cleared in the summer. Air travel is a common means of transportation between communities in Nunavut and isolated communities in NWT.

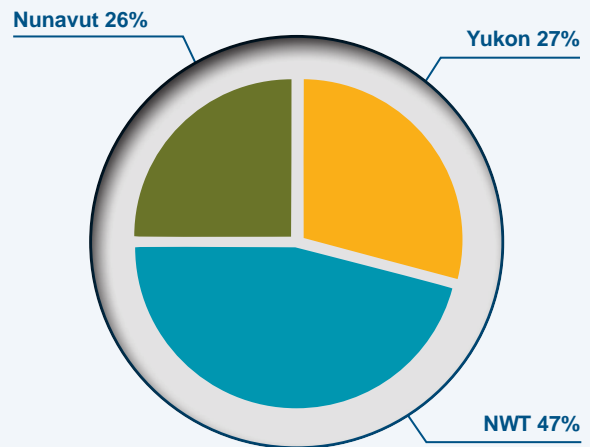
B. Economic Overview

The combined population of the territories is 0.3% of Canada's population and its economic output is 0.5% of Canada's GDP. The region holds much potential for growth as it is estimated to contain vast mineral and petroleum resources which are mostly undeveloped. NWT is the largest territorial economy accounting for nearly half of the GDP of the territories at \$3.8 billion in 2014 followed by Yukon at \$2.2 billion and Nunavut at \$2.1 billion.⁶ The Conference Board of Canada estimates that the annual average growth rates from 2014 to 2020 are 5.5% for NWT and 2.8% and 2.0% for Yukon and Nunavut.⁷

Mining, and its supporting industries, is the primary private sector economic driver accounting for roughly 15% of overall employment in the territories.⁸ In 2013, the territories accounted for over 6.4% of Canada's total mineral production.⁹

As a whole, the territories are still feeling the effects of a dampened global economy recovery which has lowered global commodity prices. According to the Conference Board of Canada, mining companies have scaled back planned exploration and deposit appraisal spending which has not grown in the territories as a whole since 2011.¹⁰ However, mining prospects are expected to improve in the longer term.

Figure 1 – Share of Territorial GDP 2014



Note: GDP at basic prices.

Source: Figure prepared by the Library of Parliament using data obtained from Statistics Canada, Table 379-0030, "Gross domestic product (GDP) at basic prices" CANSIM (database).



Economic Highlights

Yukon	<p>Many of Yukon's existing mines have slowed production levels. However, the advanced stage development of new gold mine sites such as Victoria Gold's Eagle mine, Western Copper and Gold's Casino is expected to lift the economy and provide a boost to the construction industry in the short term.¹¹</p>
NWT	<p>NWT's economy is recovering from recent declines in the territory's high quality diamond production. In the short term, the territory will benefit from new diamond mining activity such as the Gahcho Kué project and construction work on the Inuvik-to-Tuktoyaktuk road. A stagnant and declining population is contributing to low economic growth and hampering the territory's ability to fund programs as federal transfers are largely determined on a per capita basis.¹²</p>
Nunavut	<p>Nunavut is benefiting from a number of sizable projects including work on the Iqaluit airport and the Canadian High Arctic Research Station (CHARS) in Cambridge Bay. The mining sector is advancing with the Mary River iron ore mine which is entering its production phase. Agnico Eagle's Meliadine gold mine project near Rankin Inlet is in the process of determining if it will progress to full production phase.¹³</p> <p>Nunavut's population is growing more rapidly than the national average and the territory's existing population is relatively young, as those under 25 years of age account for nearly half of the total population.¹⁴ This represents a growing workforce but may also strain public services. There is a housing shortage in the territory and a relatively high dependency on income support and social housing.</p>



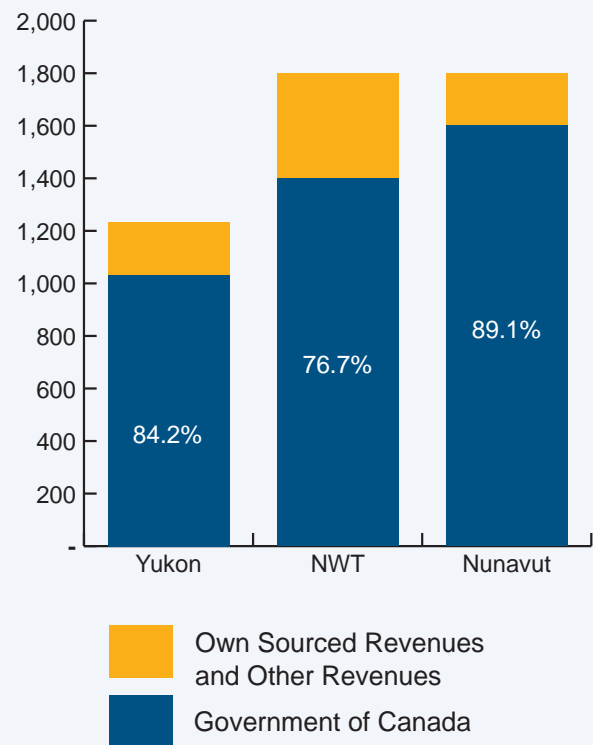
C. Fiscal Overview

While the mining sector is the largest private sector driver, the public sector is a dominant influence in the territories; it is the largest employer and occupies the largest share of territorial GDP. Federal transfers through territorial formula financing grants and other transfers account for a substantial share of each territory's budgetary revenues.

The maximum amounts that may be borrowed for each territory are set by the federal government through the Governor in Council. These amounts are commonly called debt caps. Any borrowing beyond these levels requires Governor in Council approval. Currently, the borrowing limits for Yukon and Nunavut are \$400 million and NWT is \$800 million. While debt caps are established by the federal government, the federal government does not guarantee borrowing by territorial governments.¹⁵

On 21 April 2015, the federal Budget 2015-16 proposed to raise the borrowing limits for NWT to \$1.3 billion and Nunavut to \$650 million in response to requests made by those territories.¹⁶ Yukon did not request an increase. The new limits will take effect once they are approved by the Governor in Council.

Figure 2 – Federal Government Contribution to Territorial Revenues 2015-16 Estimate (\$millions)



Note: Government of Canada revenues includes grants and transfers; other revenues may include third party service agreements.

Source: Figure prepared by Library of Parliament using data obtained from 2015-16 budgetary documents for [Yukon](#), [NWT](#) and [Nunavut](#).



V. ENERGY IN THE TERRITORIES

The territories are home to 80 communities, all of them considered off-grid as none are connected to the North-American electricity or natural gas grids and there are no energy connections between the territories. While the territories hold abundant petroleum deposits, few have been harvested and only two communities near maturing production wells have access to domestic natural gas. As previously stated, the territories are highly reliant on imported diesel for power and heating.

A. Overview of Existing Power Generation

For the most part, the territories' existing electricity facilities are a mixture of both diesel and hydro power; many of which were constructed in the 1950-60s. They were once owned and operated by the federal government through the Northern Canada Power Commission (NCPC) before being transferred to the territories in the 1980s.ⁱ

Diesel

Among the 80 communities in the territories, 53 rely exclusively on diesel electricity generators for power transmitted via locally-isolated grids in each community (Table 2).¹⁷ Diesel generation is prevalent in the territories because, in many cases, it is the only viable option for reliable power in remote communities and isolated mining sites.

Diesel and Mining

Northern mining projects require significant amounts of reliable electricity and heat to operate. Mines without access to electric grids rely on diesel fuel. Some mining operations have successfully adopted renewable energy technologies such as wind to reduce diesel consumption. Recently, natural gas has emerged as a lower cost diesel alternative for future mining projects.

Diesel generation is relatively easy to install and maintain. It requires much less upfront capital than other base load sources such as hydro and it is scalable - additional generators can be added to a plant or existing ones can be activated if demand increases. Diesel fuel is portable and also relatively easy to store. Diesel generation is flexible and extremely reliable, and it can respond rapidly to changing demand loads. This is why it is often also used as back-up power. However, its operating costs are high due to high volumes of fuel consumption and diesel fuel is subject to price volatility. In



Power Plant, Pond Inlet, Nunavut

Courtesy of: Qulliq Energy Corporation

ⁱ They were transferred to Yukon and the NWT in 1980s. At that time NWT included the region of Nunavut; electricity assets were transferred from NWT to Nunavut after Nunavut became a separate territory in 1999.



addition, the fuel must be trucked, marine shipped and sometimes flown over long distances in challenging climates. It has environmental disadvantages since it emits greenhouse gases (GHGs) and causes local air and noise pollution and there are risks of spills.

Hydro

Many hydro facilities operating today were built over 60 years ago, a legacy of a rapidly emerging mining sector. Today, hydro serves 16 communities in Yukon and 9 communities in NWT and continues to provide electricity to a mining operation in Yukon.¹⁸ Nearly all territorial hydro plants are run-of-river facilities and have limited ability to store energy in water reservoirs. All hydro facilities in the territories are part of regional electricity grid systems that serve several clusters of communities. Diesel generators are used for back-up power during outages (planned or unplanned) or to supplement during peak hours or during droughts.

Hydro power is a reliable, non-emitting, renewable energy source, although its output is subject to seasonal variations. It requires significant initial capital investment and it is site specific to where sufficient water resources are located which is not necessarily near where it is needed –this can lead to high transmission costs. Typically, hydro facilities produce power at lower cost than diesel generation because capital costs can be spread over the long life span of the hydro facility and operating costs are relatively low.

Natural Gas

There are only two communities Norman Wells and Inuvik in NWT that rely on electricity produced from natural gas. Norman Wells relies on natural gas and Inuvik is powered by liquefied natural gas (LNG). In recent years, due to historically low natural gas prices, LNG has emerged as an affordable alternative to diesel generation in Yukon and NWT, including diesel fuel used in remote mining sites. LNG is natural gas cooled to a liquid state at -162°C. This increases its energy density to make it cost effective to transport and store; it is then re-vaporized to use as a fuel for power generation.

Table 2 – Primary Electricity Generation for Communities in Canada’s Territories

	Yukon	NWT	Nunavut
Diesel-powered communities	5	23	25
Hydro-powered communities	16	9	0
Natural gas powered communities	0	2	0

Source: Table prepared by the Library of Parliament using data obtained from Aboriginal Affairs and Northern Development Canada, [Off-Grid Communities](#), [Yukon Energy Corporation](#), [Northwest Territories Power Corporation](#) and Qulliq Energy Corporation.



Whitehorse Rapids Generating Facility
 Courtesy of: Yukon Energy Corporation

Existing diesel generators can be converted to operate on both natural gas and diesel fuels.¹⁹ In many cases, natural gas is a less expensive alternative to diesel generation. Generally, year-long road access is required since long term LNG storage is costly. LNG generation has the advantage of emitting fewer GHGs and less air pollution than diesel generation.

Wind and Solar

Wind and solar account for a small but growing portion of the territorial electricity mix. For most communities, it is generally a higher cost option compared to diesel, but its economic viability is improving as technological advances reduce operating and installation costs. More than ever before, mining operations are turning to renewable technologies to reduce diesel consumption.

Wind and solar are intermittent sources of energy since the electricity is only produced when the sun is shining or when wind is blowing. While batteries and other forms of energy storage could improve their output, wind and solar technologies are not stand-alone solutions for communities. They are always coupled with diesel or hydro base load generation.²⁰ Renewable energy is site specific and there can be technical challenges in integrating and balancing wind and solar energy output with existing generation.



Figure 3 – Overview of Yukon’s Electricity Infrastructure



Generating stations



Diesel



Hydro



Wind

— Electricity transmission and distribution lines



Figure 4 – Overview of NWT’s Electricity Infrastructure



0 250 km

Generating stations



Diesel



Hydro



Wind



Solar

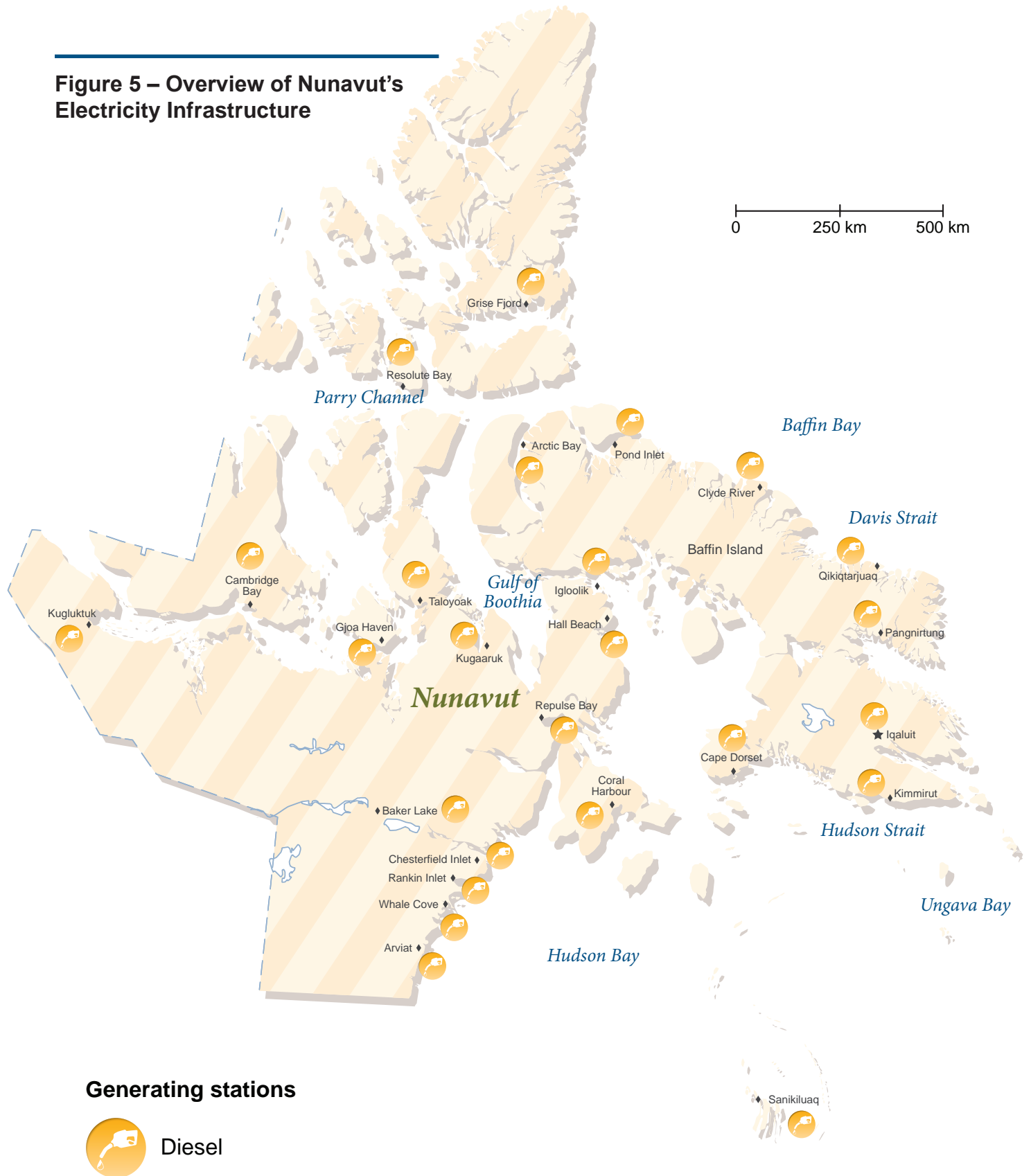


Naturel gas

— Electricity transmission lines



Figure 5 – Overview of Nunavut's Electricity Infrastructure



Generating stations





Comparing Electricity Generation

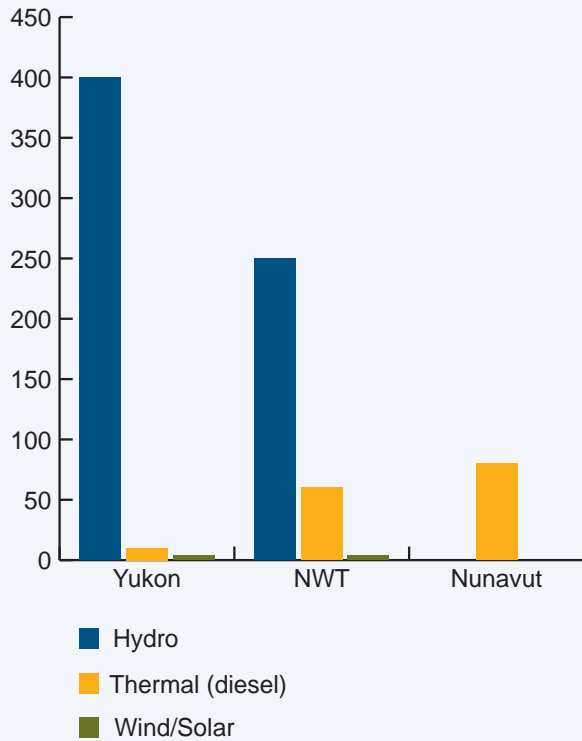
Electricity is produced, transmitted and delivered to territorial communities via regulated public and/or private utilities.

Yukon	Two regulated utilities generate and distribute electricity. Yukon Energy Corporation (YEC) is the territory's public utility and it produces most of the power, and owns and operates most of the grid. ATCO Electric Yukon (formerly Yukon Electrical) is a private utility and the major distributor of electricity; as such the company is YEC's primary customer. ATCO Electric Yukon generates and distributes electricity in six communities, five of which are Yukon's off-grid diesel communities.
NWT	NWT's public utility, Northwest Territories Power Corporation (NTPC), produces and distributes electricity to consumers in 26 of the territory's 33 communities and supplies electricity on a wholesale basis to two distributing utilities which then provides electricity to customers in Yellowknife and the Hay River area. ²¹ The two distributing utilities are called Northland Utilities (N.W.T.) Limited and Northland Utilities (Yellowknife) Limited, which are owned by ATCO. ²² Northland Utilities generates and distributes power to some diesel-powered communities.
Nunavut	The Qulliq Energy Corporation (QEC) is Nunavut's public electricity utility and the only generator, transmitter and distributor of electrical energy in the territory.

In 2013, most of Yukon's electricity mix was supplied by hydro at 94.7%, followed by diesel at 5.2% and a small amount of wind energy at less than 0.1%. Currently, all power is generated by Yukon's two regulated utilities; no mines self-supply their electricity. Mines account for roughly 10% of total electricity consumption in Yukon.



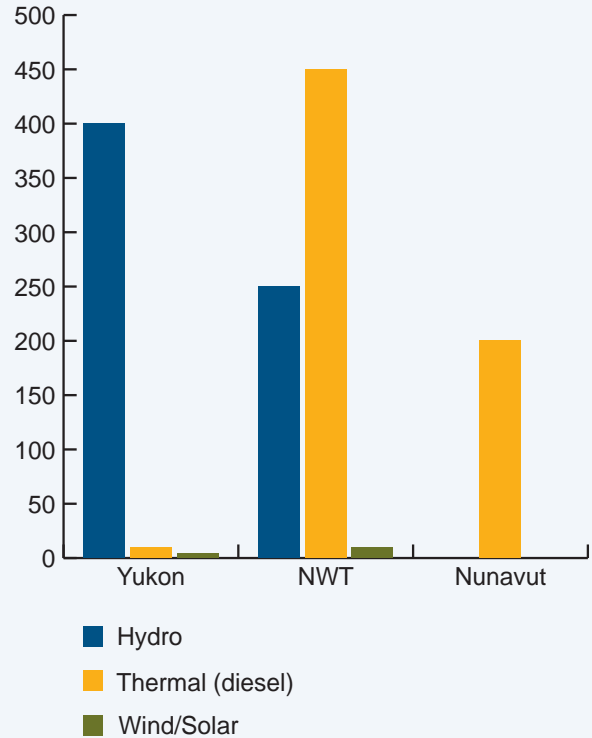
Figure 6 – Territorial Electricity Generation by Electric Utilities (GW/h) 2013



Note: GW/h equals Gigawatt per hour.

Source: Figure prepared by the Library of Parliament using data obtained from Statistics Canada, Table 127-0007, "Electric power generation, by class of electricity producer, annual (megawatt hour)," CANSIM (database).

Figure 7 – Territorial Electricity Generation by Electric Utilities & the Industrial Sector (GW/h) 2013



Note: GW/h equals Gigawatt per hour.

Source: Figure prepared by the Library of Parliament using data obtained from Statistics Canada, Table 127-0007, "Electric power generation, by class of electricity producer, annual (megawatt hour)," CANSIM (database); Nunavut includes an estimate of Agnico Eagle Mines Ltd's Meadowbank mine electricity output from [2011 Corporate Social Responsibility Report](#).

In 2013, NWT electricity mix was 75.6% hydro, 24.3% thermal (mostly diesel) and a small amount of solar. NWT's industrial sector (mostly mining and some oil and gas) produces its own electricity for off grid sites. In 2013, NWT's industrial sector produced significant power loads; in fact more electrical output was produced by this sector than the combined loads of every community in NWT. Nearly 4% of NWT's industrial sector's electricity was fuelled by wind power and 96% was powered by diesel and a small amount of natural gas.

Nunavut's utility produces the least amount of power and relies solely on diesel generation equal to 98.3 GW/h in 2013. Nunavut mining operations produced an estimated 125.4 GW/h of power from diesel.



Electricity Rates

Residential electricity rates in NWT and Nunavut are high compared to the rest of Canada while rates in Yukon are in line with southern provinces. The residential rate, in most places in Yukon, including Whitehorse is 12.14 cents per kWh applied on the first 1,000 kWh consumed per month and it is equivalent to the national average of 12.13 cents per kWh. The Yukon rate increases slightly as consumption increases. For example, for monthly electricity consumption between 1,001 and 2,500 kWh, the rate is 12.82 cents per kWh and for consumption over 2,500 kWh per month, it is 13.99 cents per kWh (see table 3).

In NWT, electricity rates vary widely. Generally, rates differ depending on whether a community is a hydro community or a thermal community (powered by diesel/natural gas). However, rates can vary within each community category of “hydro” and “thermal”. For hydro communities, residential rates range from 21 to 34 cents per kWh. In Yellowknife, a hydro community, the rate is 28.53 cents per kWh and this rate is used as a benchmark for the rate subsidy for all communities. This means that for all NWT communities, they receive the 28.53 cents per kWh residential rate on the first 1,000 kWh in winter. A resident’s consumption above this amount is subject to a non-subsidized rate. For most thermal communities it is 60.83 cents per kWh. The subsidy consumption threshold in the summer is 600 kWh (see table 4).²³

Table 3 – Yukon – Residential Rates 2015

For the first 1,000 kWh	12.14 ¢ per kWh
Between 1,001 -2,500 kWh	12.14 ¢ per kWh
Over 2,500 kWh	13.99 ¢ per kWh

Source: Yukon Energy Corporation, [Rate Schedules \(1160\)](#)

Table 4 – NWT – Residential Rates 2015

Hydro Communities	21 to 34 ¢ per kWh
For Most Thermal Communities	
Between September 1 and March 31	
For the first 1,000 kWh	28.53¢ per kWh
Above 1,000 kWh	60.83¢ per kWh
Between April 1 and August 31	
For the first 600 kWh	28.53¢ per kWh
Above 600 kWh	60.83¢ per kWh

Note: All communities are subsidized to 28.53 cents per kWh on first 1,000 kWh in winter and first 600 kWh in summer.

Source: Northwest Territories Power Corporation, [Residential Electrical Rates, excludes the 1.17 cents per kWh NWT Stabilization Fund Rider.](#)



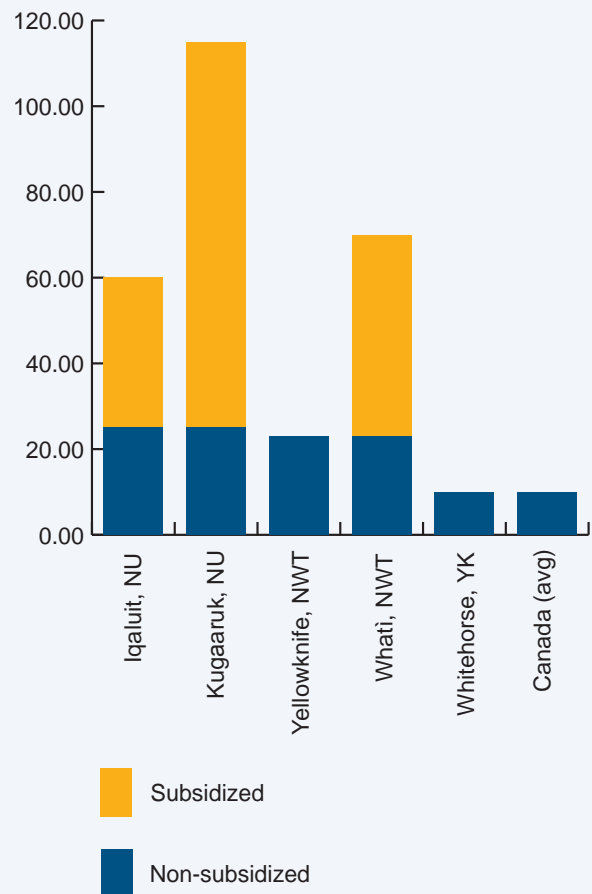
In Nunavut, all communities are subsidized to 30.15 cents per kW/h on the first 1,000 kWh per month in the winter or the first 700 kWh per kW/h per month in the summer. If consumption exceeds the threshold amounts, the full cost of servicing a community is reflected in its rate, thus unsubsidized rates vary for each community. The lowest non-subsidized rate is Iqaluit at 60.29 cents per k/Wh and the highest non-subsidized is Kugaaruk at 114.16 cents per KW/h (table 5).

Table 5 – Nunavut – Residential Rates 2015

	Iqaluit	Kugaaruk
Between October 1 and March 31		
For the first 1,000 kWh	30.15¢ per kWh	30.15¢ per kWh
Above 1,000 kWh	60.29¢ per kWh	114.16¢ per kWh
Between April 1 and September 30		
For the first 700 kWh	30.15¢ per kWh	30.15¢ per kWh
Above 700 kWh	60.29 ¢ per kWh	114.16¢ per kWh

Source: Qulliq Energy Corporation, [Billings Centre](#)

Figure 8 – Residential Electricity Rates, Cents per kWh 2015



Note: Based on the first 1,000 kWh consumed in winter; Canada's rate is based on Hydro Quebec calculations –it is an average of 2014 rates from 10 Canadian cities.

Source: Figure prepared by the Library of Parliament using data obtained from [Yukon Energy](#), [Northwest Territories Power Corporation](#), [Qulliq Energy Corporation](#), and [Hydro Quebec](#).



B. Heating the Territories

Winters are longer in the territories resulting in far more days requiring space heating than the average Canadian household. Nearly every home and building in the territories is heated by burning furnace oil (diesel). It provides a reliable source of heat but it is relatively expensive and it emits GHGs and other air pollutants. In 2011, northerners consumed 219 million litres of diesel (and some propane) for heating. To put this figure in perspective, in the same year, 76 million litres of diesel were consumed for power generation²⁴.

The second largest heating source in Yukon and NWT is firewood used in conventional woodstoves. Nunavut has limited access to wood and therefore it is not an option for Nunavummiut households. In recent years, wood pellets have emerged as a rapidly growing alternative heating source, mostly in NWT, due in large part to government strategies to advance biomass in the region. Yukon recently released a draft biomass energy strategy for public discussion.²⁵

Wood Pellets

Wood pellets are small hard cylinders of compressed wood made mostly from sawdust derived from sawmills or wood products manufacturers. Pellets usually cost much less than oil or propane per unit of heat produced. They are carbon neutral if the wood in the pellets is harvested sustainably.

Both small and large scale biomass energy technologies have significantly improved over the last decade. Wood pellet boilers have the advantage of being carbon neutral, less costly and less polluting than diesel. It also has the potential to create a biomass economy through the harvesting of local wood supplies. In NWT, many commercial buildings and some homeowners have installed wood pellet heating systems. Also in NWT, wood pellet heating systems have been installed in schools, government buildings and health centres. A correctional facility in Whitehorse, Yukon has recently installed a biomass wood pellet boiler. Some of these projects have utilized district heating systems where a boiler system heats several adjacent buildings. Typically, biomass is better utilized for heating but it can also be used for power generation, mostly in combined heat and power systems.



Wood pellets

Courtesy of: Government of the Northwest Territories



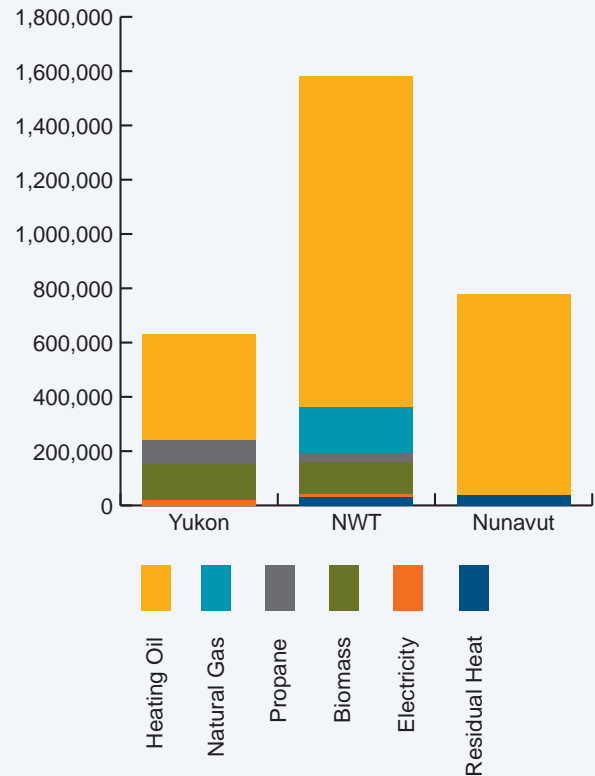
Currently, Inuvik, NWT is the only community in the territories that relies on natural gas for heating. Some propane is used for heating in Yukon and only minimally used in NWT. Yukon's lower electricity rates allow some households to install electric heating systems. All three territories have systems that capture waste heat from power generation (diesel) to heat nearby buildings though it is more prevalent in NWT and Nunavut.

C. Cold Climate Energy Innovation and Technologies

Northern Canada's harsh climate can be unforgiving on energy technologies where winter temperatures can remain below -40° C for prolonged periods. Existing technologies that operate cost-effectively in the South may not easily transfer to northern climates. Other considerations, such as permafrost, pose challenges to installing and operating otherwise proven energy technologies. Also, maintenance procedures and materials necessary to operate the technology must be sensitive to the realities of the territories where specialized skills and resources may not be in abundant supply.

Nonetheless, new technology is an enabler. It creates new possibilities. Emerging technologies designed for the northern climates can widen options many communities face in the territories. The committee heard from a number of witnesses about emerging technologies.

Figure 9 – Heat Generation by Source, 2010 MW/h



Source: Figure prepared by the Library of Parliament using data obtained from [Renewable Energy Inventory](#).



<p>Waste biomass gasification</p>	<p>Converts solid waste into a gaseous fuel that is fed into diesel generators to produce heat and electricity. It would reduce diesel use in northern communities and help address municipal waste problems. One advantage is that it can be adapted into existing diesel generators. Canmet ENERGY, the federal government's science and technology research agency housed within Natural Resources Canada, is working on understanding the tars produced from biomass gasification and its long term effect on energy systems.²⁶</p>
<p>Northern modular homes</p>	<p>Canmet ENERGY is working on a rapidly deployable northern housing prototype. The goal is to help alleviate housing shortages in the North while employing leading energy efficiency technologies.²⁷ The prototype consists of a 1,000 square-foot modular structure that can be flattened for ease of transport and assembled by untrained labourers without specialty tools. The insulation value of the prototype is reported to be 20 times greater per inch than conventional insulation.</p>
<p>Geo-exchange heat pumps</p>	<p>Earth-energy systems that use ground source heat pumps have had limited application in northern climates. Cold ground temperatures in the bedrock of the Canadian Shield and permafrost are considered major limitations.²⁸ However, researchers are exploring the use of ground source heat pumps in the North to help maintain permafrost to provide continued support to existing buildings. Heat pumps would be used to cool the soil by extracting heat that would otherwise melt permafrost while that same heat would be used to heat the building.²⁹</p>
<p>Nuclear battery</p>	<p>Micro nuclear power plants (6 MW) could provide substantial electricity and heat to remote communities and mining sites. The committee was told that entirely modular reactors can be designed that do not use on-site waste storage and that can operate for 20 years without refuelling.³⁰ However, the implementation of a new type of nuclear technology in the territories would face sizable regulatory barriers. Also, reactors are required to be placed deep underground which would be a problem in permafrost regions.³¹</p>
<p>Ocean current and tidal energy</p>	<p>Nunavut is home to some of the most abundant sources of ocean current and tidal energy resources in the world. However, there are significant economic and technical challenges related to servicing isolated sites, cost of transmission connections, the challenges of sea-ice and overall harsh environment for installation, maintenance and repair.</p>
<p>Transforming plastic to synthetic diesel</p>	<p>During its fact finding trip in the territories in May 2014, committee members were informed of a technology that transforms waste plastic into synthetic diesel. The synthetic diesel required additives when used in temperatures below 10°C.</p>



D. Oil and Natural Gas

Canada's territories are estimated to contain vast onshore and offshore oil and natural gas resources but are almost entirely untapped. Most prospects have occurred along the northern extension of the Western Canada Sedimentary Basin through the Mackenzie Valley to the Beaufort Sea.³² Major oil companies have filed extensive drilling proposals for the Beaufort Sea and recently there has been exploration activity for shale oil and natural gas in the Sahtu region within the central Mackenzie Valley area.³³

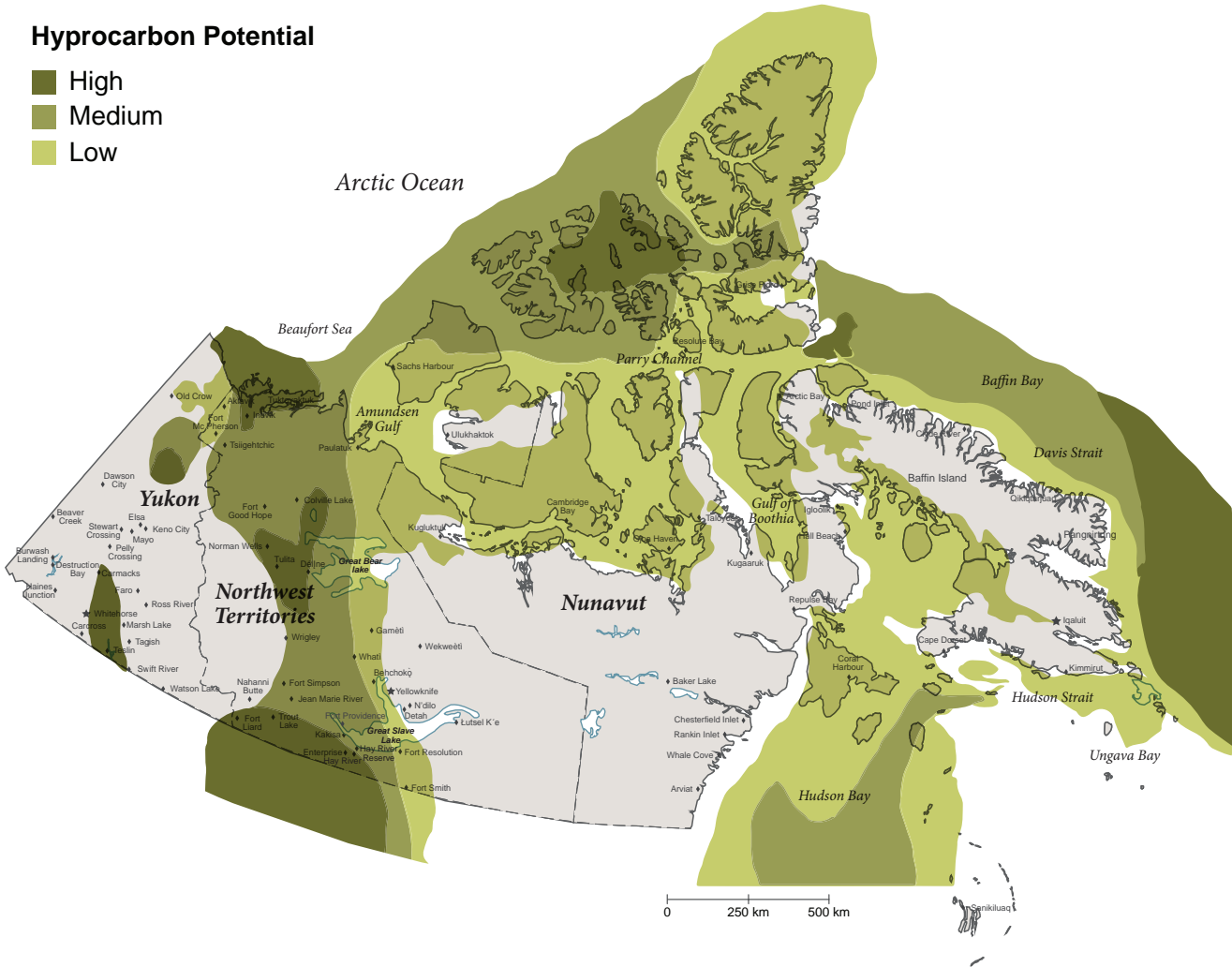
Yukon's petroleum sedimentary basins are located near and around Whitehorse, in the northern region of the territory, and within the Beaufort Sea. The Liard Basin, located in the most south-easterly region of the territory, has produced natural gas for many decades. Today, it is being newly considered for shale oil and natural gas development. There have been several major gas discoveries uncovering large petroliferous basins in the Arctic Islands, Canada's most northerly region. The eastern Arctic holds much promise for petroleum resources. However, most of the hydrocarbon activity in Nunavut is in its early phase of exploration.

Energy Jurisdiction

The Government of Canada has regulatory authority over natural resources (including petroleum resources) within offshore areas and on federal and frontier lands which includes Nunavut. Through devolution, Yukon and, more recently, as of April 1, 2014, NWT have gained responsibilities over management of onshore natural resources. Devolution discussions with Nunavut are on-going.



Figure 10 – Petroleum Resources in Canada’s Territories



Source: Map prepared by the Library of Parliament using graphic obtained from Aboriginal Affairs and Northern Development Canada submission to the Standing Senate Committee on Energy, the Environment and Natural Resources.

NWT is the only petroleum producing region North of 60°; most of the oil and gas production is situated at Norman Wells, located in the Western part of the territory, and is transported via pipeline to Alberta. Some oil is produced in Cameron Hills in south-western NWT and is also transported to Alberta. Both sites are in production declines.³⁴ Norman Wells and Cameron Hills also produce natural gas. The only other producing natural gas site is Inuvik which is located in the north-western region of the territory. Overall, natural gas production has been declining.



Developing home-grown supplies of petroleum resources in Canada's territories provides opportunities to fuel communities with fuel produced in the region. This has been achieved in a few communities in NWT that are near producing wells. The growth of natural gas generation in the territories may open additional possibilities of sourcing and developing indigenous supply chains within the territories.

VI. ENERGY OPPORTUNITIES AND CHALLENGES

Energy is at the forefront of policy discussions in the territories. Many witnesses tied the territories' economic future with the need to address its energy challenges. In fact, addressing energy challenges is what territorial premiers identified in 2014 as one of four pillars for a vision of a prosperous North.³⁵

The following section provides a closer look at the energy strategies, opportunities and major energy initiatives designed to address each territory's energy challenges.

YUKON

In 2009, the Government of Yukon introduced a ten year *Energy Strategy for Yukon*. The strategy focused on four priorities: 1) energy conservation and efficiency; 2) increasing the supply and use of renewable energy; 3) meeting current and future electricity needs; and 4) managing responsible oil and gas development.³⁶

Key actions included:

- Increase energy efficiency in Yukon by 20% by 2020
- Increase renewable energy supply by 20% by 2020
- Create strategic opportunities to replace imported diesel fuel with Yukon's oil and gas resources
- Develop a competitive and comprehensive oil and gas regulatory regime emphasizing performance-based compliance

Yukon has released two progress reports on its energy strategy. In its latest progress report in 2012, the government stated that increased hydro generation capacity completed in 2011 has helped Yukon exceed its 20% renewable energy target and that it is on course to achieving its energy efficiency targets. Yukon is continuing its legislative work to modernize its oil and gas regulations and has developed related guidelines and directives.

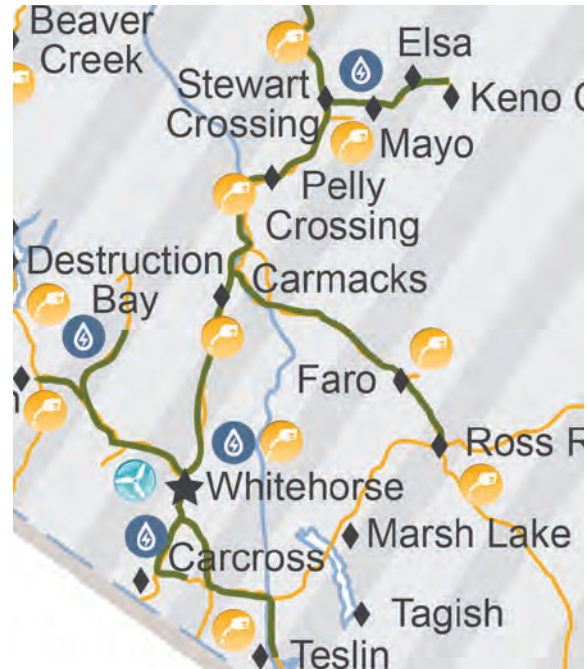


Opportunities, Initiatives and Projects

A. Next Generation of Hydro

Yukon's existing electricity system relies on four hydro facilities with back-up diesel generation which are all connected to an electricity grid.

- Whitehorse Rapids plant (40 MW) located in Whitehorse on the Yukon River. In the winter, when the flow in the Yukon River is reduced, the plant produces roughly 25 MW.
- Aishihik Hydro Facility (37 MW) located 110 km northwest of Whitehorse. Its turbines are buried 110 metres underground.
- Mayo facilities [Mayo A (5 MW) and Mayo B (10 MW)] located about 400 km north of Whitehorse.
- Fish Lake hydro facility (1.3 MW) located south of Whitehorse. The facility is owned and operated by ATCO Electric Yukon, a private utility.



The committee was informed that Yukon's electricity system is operating at close to full capacity. As such, Yukon is considering options for future hydro projects. Yukon Energy Corporation's (YEC) parent corporation, the Yukon Development Corporation, is studying options for "Next Generation Hydro" to meet the long term energy needs of Yukon, 20 to 50 years into the future. The goal is to narrow the options to "one or two hydro developments with supporting renewable power and adequate transmission infrastructure."³⁷



Repairs to hydro turbine, Yukon

Courtesy of: Yukon Energy Corporation



Yukon is also exploring smaller-scale hydro projects with pump storage. A pumped storage hydro system is one in which energy in the form of water is stored. When electricity demands are low, water is pumped from a lower elevation reservoir. This stores the energy and, during higher demand periods, the water is released to generate electricity. Storage options would allow YEC to store hydro resources which are currently wasted during the summer period when load demand is at its lowest. Currently, the Aishihik (37 MW) facility is the only hydro facility in Yukon that can store energy in the summer when demand is low and release it in winter when demand is high.³⁸ YEC is also considering buying power from the Taku River Tlingit's hydro facility in Atlin, British Columbia near the Yukon border. The facility currently has about one megawatt of excess power.³⁹

B. Natural Gas Generation

At this time, there are no natural gas generators operating in Yukon. However, several natural gas projects are being advanced. YEC is now constructing a facility to house three LNG generators in Whitehorse. The units would replace two aging diesel generators used for back-up power.

The Western Copper and Gold mining company is planning to install natural gas turbines to serve as the main generating station at its proposed Casino mining project located 380 km northwest of Whitehorse.⁴⁰

C. Wind Generation

Yukon has two utility-scale wind turbines on Haeckel Hill near Whitehorse with a combined installed capacity of 800 kilowatts (kW). The committee heard that YEC was completing wind resource monitoring and feasibility assessments of wind farms at two potential sites in Yukon: 1) Mount Sumanik near Whitehorse; and 2) Tehcho (formerly Ferry Hill) near Stewart Crossing. The project sizes are between 5-20 MW of installed capacity.



Haeckel Hill wind turbines, Whitehorse, Yukon
Courtesy of: Yukon Energy Corporation



D. Independent Power Producers

Yukon is expected to release the final version of an Independent Power Producers (IPP) policy in 2015.⁴¹ This would allow Yukon utilities to purchase electricity from non-utility power producers to help the territory meet its future power needs. The goal is to support the expansion of environmentally sound and affordable electrical supply while respecting the integrity of the existing electrical system.

Any additional IPP supply to the hydro grid system is limited to local renewable sources such as wind, hydro, geothermal, biomass and solar. Natural gas is included as a supply option for diesel powered communities. There will be restrictions on the size of IPP to reflect the technical limitations of Yukon's isolated electrical system to minimize the financial risk to Yukon's power customers.⁴²

E. Biomass for Heating

On April 27, 2015, the Yukon government released a draft biomass strategy for public feedback. The intent of the strategy is to reduce Yukon's dependence on imported fossil fuels by optimizing the use of Yukon-harvested wood to meet the territory's heating needs through modern biomass technologies. The goal is to reduce heating costs for Yukoners, create jobs in the local forest and heating industries, reduce GHGs, and move towards renewable energy sources and greater energy self-sufficiency.⁴³

F. Energy Efficiency, Conservation and Small Scale Renewable

The Energy Solutions Centre (the Centre), a branch of the Yukon government's Department of Energy, Mines and Resources, plays a leading role in promoting energy efficiency, conservation and small scale renewable energy. The Centre administers several programs and services including financial rebates for home and commercial retrofits, energy efficiency appliances and heating systems. It administers the micro-generation program which provides financial incentives to individuals who produce electricity from renewable sources and sell surplus power to the grid.⁴⁴

Yukon Energy Corporation partnered with ATCO Electric Yukon and the Yukon government to develop *inCharge*, a formal electricity conservation plan for the territory. The program provides rebates for LED lighting and block-heater timers, offers giveaways of other low costs energy efficient products and advice on how to conserve energy.

G. Transmission Connection with Alaska

In 2014, the Governments of Yukon and Alaska jointly issued a Request for Proposals (RFP) to assess the feasibility of developing electrical and telecommunication connections between Yukon and southeast Alaska. There is an opportunity to coordinate different peak loads since Yukon has more demand in the winter and Skagway, Alaska, has higher demand in the summer due to the cruise ship industry.



H. Shale Oil and Gas Development

Yukon's Department of Energy, Mines and Resources advised the committee that existing territorial natural gas resources could meet the energy needs of Yukoners for many decades and be a major contributor to the economy.⁴⁵

Yukon has eight onshore sedimentary basins, four of which have a high potential for shale oil and/or gas, but only the Liard and Eagle Plain basins have active dispositions. Shale gas is currently being produced on the British Columbia portion of the Liard Basin.

The Government of Yukon is proposing to allow hydraulic fracturing activity only in the Liard Basin pending support from affected First Nations. In response to a report tabled in January 2015 by the Yukon Legislature's Select Committee Regarding the Risks and Benefits of Hydraulic Fracturing, the government committed to continued public consultation. It also committed to conducting an economic study, expanding groundwater monitoring and seismic baseline data, and examining the regulatory processes to ensure human health and the environment are protected.⁴⁶

NORTHWEST TERRITORIES

In December 2013, the Government of NWT introduced the *Northwest Territories Energy Action Plan* (Energy Plan) in conjunction with *A Vision for the NWT Power System Plan* (PSP), developed by the NWT Energy Corporation, a Crown corporation that has since been consolidated within the Government of Northwest Territories (GNWT). The Energy Plan outlines short term action items and funding commitments to reduce NWT's high cost of energy and the impact of fossil fuel consumption has on the environment.⁴⁷ The Energy Plan builds from targeted strategies already introduced for biomass and solar energy. The PSP maps out energy priorities and short, medium and long term options available to NWT's electricity system.

Both the Energy Plan and PSP were advanced with the help of an "energy charrette" hosted by the GNWT in 2012. A charrette is a technique for consulting and work-shopping problems among a group of stakeholders; in this case, the energy charrette tackled the territory's future energy options. A second energy charrette was organized in November 2014 to assist the GNWT in reconsidering energy planning options in light of high capital cost estimates in implementing the PSP and reduced generation capacity in the hydro-electricity system.



Liard Oil and Gas Basin

Source: Figure prepared by Library of Parliament using data obtained from [Renewable Energy Inventory](#).



The second charrette report identified energy affordability as the number one energy policy objective. It also emphasized a decentralized approach to energy planning that leverages each community’s attributes.⁴⁸

The Energy Plan focusses on the territory’s electricity system, biomass energy for heating and energy efficiency and conservation. The government is concerned about high energy costs and its reliance on non-renewable energy sources.⁴⁹ GNWT is also developing an oil and gas strategy into unlocking the potential of its extensive petroleum resources.⁵⁰

Opportunities, Initiatives and Projects

A. Hydro Challenge and Increasing Connectivity

Most communities in NWT rely on thermal generation (predominantly diesel) but most of NWT’s population is located in the southern region (for example Yellowknife) and is served by hydro power. There are two multi-community grids: the Snare grid and the Taltson grid. Both grids are located along the Great Slave Lake but they are not linked to each other. The Snare grid serves Yellowknife and surrounding communities north of the lake with hydropower from the Snare Hydro System⁵¹ (30.2MW) and the Bluefish Hydro plant (7.5 MW). The Taltson grid located south of the lake is served by power from the Taltson Hydro plant (18 MW).⁵²

The lack of connectivity between NWT’s two grids and the absence of a link with the continental grid leads to costly and inefficient outcomes. Both grid systems produce the most electricity when water levels are high in the summer but when load demand is at its lowest.

Conversely, during winter months when the population draws the most power, the water levels are low. The President and CEO of NTPC, Emanuel Da Rosa, told the committee that this mismatch results in roughly 30 to 50% of “spilled” water every year.⁵³ The hydro plants have limited ability to hold back water since they are run-of-river facilities without significant reservoirs. A spill occurs when water that may have been used to generate electricity is diverted away from the turbines and is not used to generate electricity due to either low electricity demands or excess water flow.





Snare Rapids hydro, NWT

Courtesy of: Government of the Northwest Territories

The Snare Hydro System increasingly relies on diesel back-up power to achieve peak load requirements which adds to the cost of servicing consumer demand. In fact, the territorial government intervened in 2014 with a \$20 million contribution to the NTPC when water reached low levels at the Snare system, to prevent electricity rate increases.⁵⁴

Mr. Da Rosa explained that the current NWT hydro systems increase the risk of triggering an outage if there is a problem at one of the generation stations. Yellowknife's outage rate is roughly four times that of the rest of the country.⁵⁵ To address this problem, the NTPC is examining if large batteries can be a cost effective means to store excess energy during low load times to be used at a later time during peak demand. The committee was told that such an investment would cost approximately \$10 million. Batteries can store energy for short periods of time; they could not feasibly be used to carry the excess energy from the summer into winter.



B. Transmission Connection

Many problems with NWT’s hydro system could be addressed if both grid systems were connected as well as linked to mines and to the continental grid, most likely via Saskatchewan, the closest connecting point.

The advantages of NWT’s transmission expansion:

- NWT would have a reliable supply of energy in the event of outages (planned or unplanned).
- NWT could better balance and manage its loads between the two territorial grids and sell excess power to the continental grid.
- Mining companies would have reliable access to non-emitting power that could serve to extend the productive life of mines and encourage new investment. It would also reduce the consumption of diesel.
- New generation projects could be scaled based on economic efficiency instead of being constrained to incremental additions to generation based solely on regional customer demand.
- It would increase the feasibility of further expansion of the grid to connect isolated thermal communities.

High capital cost is the single biggest obstacle facing this project, as the cost of the build-out of the transmission grid is beyond the financial capacity of the territory. Mr. Da Rosa explained that the total estimated cost of the project is \$1.2 billion. The transmission link to Saskatchewan with the Taltson grid system is \$200 million but the bulk of the load and capacity is located in the Snare grid system serving Yellowknife. To make the project worthwhile, both grids would have to be connected. Linking the two existing grids is \$750 to 800 million and tying in nearby diamond mines would cost \$200 million – mining companies would fund this interconnection.

The committee was told that to keep power rates at current levels, the government would have to contribute \$400 million. The committee learned that NWT considered funding the project because of the many positive larger benefits to the economy and environment but the project was ultimately shelved because it exceeded GNWT’s borrowing capacity.

Table 6 – Estimated cost of NWT Transmission Expansion and Intertie with Continental Grid (\$millions)

Transmission link from Taltson grid to Saskatchewan	\$200
Connecting the Taltson and Snare grids	\$800
Transmission links to nearby diamond mines	\$200
Total	\$1,200

Source: Table prepared by Library of Parliament based on testimony. (See endnote 55)



C. Solar

“ ...one of the largest opportunities for the NWT really exists in solar ”

Emanuel Da Rosa,
President and CEO, NTPC

It may seem surprising but the GNWT is emphasizing the use of solar energy as a means to displace diesel generation. According to NWT's Energy Plan, small diesel powered communities that have the least efficient diesel systems and consequently high fuel costs are being targeted for solar installations.⁵⁶

There are numerous small-scale solar installations in the territory. Fort Simpson is the site of NWT's first large installed solar photovoltaic (PV) facility at 104 kW. It generates roughly 1.5 % of the community's annual electricity generation. The panels span the size of a football field and the project was nearly entirely subsidized by the government of NWT to remain on par, in terms of cost, with diesel generation.⁵⁷ Batteries are being considered, which would have a dramatic effect on energy output, raising the solar facility's contribution to 30% of the community's annual electricity needs.



Solar array in Nahanni Butte, NWT

Courtesy of: Government of the Northwest Territories

The latest large solar project is located in Colville Lake, which is expected to have an installed capacity of 135 kW and generate 30% of the community's annual electricity needs with the help of batteries. The batteries were purchased with funding assistance from the federal government's ecoENERGY for Aboriginal and Northern Communities Program. The panels would allow the local diesel plant to shut down during most of the summer. The committee was informed that solar generation still required territorial government support to keep energy costs in line with diesel.⁵⁸ However, the committee heard that cost of installing solar energy dropped 30% in the three year span between the Fort Simpson and Colville Lake projects.⁵⁹



D. Natural Gas Generation

There are two communities in the territories that rely on natural gas generation: Norman Wells and Inuvik and both of them are located in NWT.

Norman Wells	This community relies on purchased electricity from a natural gas powered oil facility operated by Imperial Oil Resources Limited.
Inuvik	In 2013, NWT installed the first LNG generation facility in the North in Inuvik. ⁶⁰ Its installation was hastened by the need to provide generation to the community which had previously relied on natural gas sourced from nearby production wells that stopped flowing in 2012. LNG is transported by truck from southern B.C.. However, there are potential opportunities to source LNG from Northern B.C. such as Spectra Energy in Fort Nelson.

The territory is exploring the potential of expanding LNG generation to other communities that have year round road access.⁶¹ Existing diesel plants can be converted so that electricity can be produced by either diesel or natural gas. Essentially, NWT is exploring means to exploit the LNG supply chain created by the LNG plant in Inuvik.

E. Wind

The territory’s first large scale wind facility became operational in September 2012. The hybrid-diesel facility was entirely funded and operated by the private sector to supplement diesel generation at a remote mine site. The facility is located at the Diavik Diamond Mine Inc. site 400 km north east of Yellowknife.⁶² It consists of four ENERCON wind turbines that have a combined installed capacity of 9.2 MW. In 2014, it supplied 10.5% of the mine’s power needs, displacing 4.9 million litres of diesel fuel.⁶³

The mine is only accessible for eight weeks of the year by a seasonal winter road. Representatives from Diavik Diamond Mine Inc. told the committee that the wind turbines result in savings of \$6 million a year in fuel purchase, transportation and storage costs.⁶⁴

The company worked with the wind turbine manufacturer to adjust maintenance and operating procedures in adapting the wind farm to the extreme Arctic climate. Diavik Diamond Mine Inc. is sharing its knowledge and lessons learned with the GNWT and others including proponents of the Raglan Mine project in northern Quebec which is contemplating wind turbines to displace diesel consumption.



Wind turbine at Diavik Diamond Mine, NWT
 Courtesy of: Diavik Diamond Mine (2012) Inc.



Despite the success of the wind turbines at Diavik Diamond Mine, wind energy plays a minor role in supplying electricity to NWT communities. The government is investigating certain regions with favourable wind resources but the committee was told that for the most part NWT does not have good wind resources.⁶⁵ Thus, there are only a few places that show promise, with the biggest potential in the Beaufort Delta area near Inuvik.⁶⁶

Low electricity loads in most communities are a challenge due to the intermittency of wind power, since most communities cannot optimize its wind resources to make it economically viable. In contrast, Diavik Mine's load was equivalent to all of Yellowknife's electricity needs. Therefore, if the wind is blowing hard, the mine can fully optimize its wind power. Other challenges include the cost of constructing transmission lines that connect wind resources to the nearest community power connection.

F. Advancing Biomass for Heat and Power

NWT has strongly supported biomass heating systems as a substitute for oil-fired heating. As of 2014, wood pellet supply was available in 14 communities and multiple wood pellet heating systems have been installed in residential, commercial and institutional buildings. The committee members were told that biomass heating can provide 30-50% in savings compared to oil furnaces and the energy source is carbon neutral.



Wood pellet boiler installation at Chief Jimmy Bruneau School in Behchoko, NWT

Courtesy of: Government of the Northwest Territories

Pellets sold in NWT come from Canadian manufacturers mostly located in British Columbia, but some pellets are also shipped from Alberta.⁶⁷ Wood pellets are derived from wood manufacturing waste and are competitively priced which makes it difficult to nurture local supply sources. The government is exploring ways to encourage local production, including harvesting residue biomass from road building and maintenance, forest thinning, forest fire burn areas, cardboard, paper or construction and demolition waste and fast growing willow or deciduous trees.⁶⁸



Jan Larsson, Founder of Energy North, a biomass wood pellet heating company in NWT, told the committee that there were several barriers to the biomass energy installations in NWT.⁶⁹ The committee heard that existing regulations, standards and certification regimes were not keeping pace with advances in biomass technologies. Also, Mr. Larsson told the committee that homeowners who install wood pellet boilers face punitive home insurance rates in Canada compared to those who have installed diesel furnaces.

Biomass Cogeneration

The main use of biomass is for space heating and not electricity generation because much of the energy is lost during the conversion to electricity. However, it is typically cost effective to use biomass heat loads to produce electricity as a by-product. Mr. Da Rosa told the committee that utility scale biomass generation options were generally more costly than diesel or LNG generation but that there may be larger environmental, social and economic benefits to communities that might warrant government support for biomass generation.⁷⁰

Jeff Philipp, President and CEO of SSi Micro Ltd., explained that an opportunity exists for a biomass co-generation facility in his community of Fort Providence, NWT. Mr. Philipp is also the owner and operator of the Snowshoe Inn which has earned international attention for cost-effectively operating an on-site diesel electricity and heat co-generation system.⁷¹

Mr. Philipp believes that the Snowshoe Inn's success can be transferred to a community-wide project. He proposes to install a biomass co-generation (heat and electricity) facility using locally harvested woodchips. The electricity generated would be sold into the local grid while a district heating system would supply heat to nearby buildings. The goal is to create a not-for-profit community foundation owned by Aboriginal partners that would operate the facility.⁷²

G. Energy Efficiency, Conservation and Small Scale Renewable

NWT promotes energy efficiency, conservation and alternative renewable energy generation through the Arctic Energy Alliance (AEA). AEA is a non-profit society originally established by the NWT government in 1997 to consolidate the activities of NWT departments and agencies that have an interest in energy related matters.

The AEA offers a variety of services and programs, including financial rebates for the purchase of eligible energy efficiency appliances, residential insulation, air sealing and energy efficiency upgrades of commercial buildings. AEA also promotes and helps fund alternative energy technologies such as solar, wind, wood pellet heating, biofuel/synthetic gas and ground source heat pumps.



Louie Azzolini, Executive Director of the AEA, told the committee that AEA's highest priority was promoting energy efficiency. He pointed out that all its programs were oversubscribed. He believed that AEA's strength lies with its local front-line approach -its staff are spread across many regions of the territory.⁷³

Not all energy related programs are managed by the AEA. For example, the Department of Environment and Natural Resources administers the Energy Conservation Program which helps community-funded departments, boards and agencies and non-profit organization reduce their use of electrical and heat energy and water by upgrading existing lighting, heating, ventilation, water and electrical systems.⁷⁴

NUNAVUT

In 2007, Nunavut released its energy strategy, *Ikummatiit*. It is intended to guide Nunavut's energy policies and related government programs and activities until 2020. The main objective is to reduce Nunavut's dependency on fossil fuels. The strategy's policy actions are outlined into four themes:

- Energy conservation and efficiency
- Alternative energy, including the development of hydroelectricity
- Better management practices
- Oil, gas and uranium development

Nunavut's Energy Secretariat, housed within the Department of Economic Development and Transportation, is responsible for the development, coordination and delivery of Nunavut's energy strategy.⁷⁵

The Government of Nunavut (GN) pays, directly or indirectly, almost 80 per cent of all Nunavut's energy costs –this includes subsidies to keep the cost of energy affordable. Nunavut currently has no incentives or programs supporting renewable energy or energy efficiency technologies.⁷⁶

The GN purchases, transports, stores, and distributes all petroleum products in Nunavut except for two communities (Iqaluit & Cambridge Bay) where the distribution and inventory management is outsourced. In the remaining locations, the GN uses local contractors to provide the required services.⁷⁷

Nunavut's petroleum fuel needs including fuel for electricity generation are forecasted then purchased annually in bulk by the government. The fuel can only be transported by marine shipping during the summer months and it is stored in tanks in every community.



Opportunities, Initiatives and Projects

A. Aging Diesel Generation Infrastructure

Electricity in Nunavut is entirely fuelled by diesel generators. Qulliq Energy Corporation (QEC) generates and distributes electricity through the operation of 26 stand-alone diesel plants in 25 communities. QEC also supplies residual heat through district heating systems connected to ten diesel plants.⁷⁸ This was financed in part with funding from the federal government’s ecoENERGY for Aboriginal and Northern Communities Program.⁷⁹



Arctic Bay, Nunavut

Courtesy of: Qulliq Energy Corporation



Communities are considerably dispersed throughout a massive area. There is no territorial electricity grid nor is there inter-community road access. Electricity systems in Nunavut are isolated and must be planned and operated independently. As of 2014, there were approximately 17 generating plants that had reached the end of their designed service life. Many of the diesel plants were once owned by the federal government via the Northern Canada Power Corporation. The territory anticipates that plant decommissioning will result in sizable environmental remediation costs.

In most communities, diesel generation is the only viable option for reliable base load power and will likely continue to be so for some time. That being said, having such a large fleet of diesel facilities operating past their life expectancy requires QEC to commit large portions of capital spending to replacing components and making upgrades to extend operating parameters.⁸⁰ Acquiring parts for these plants is a constant challenge. An aging facility increases the risk of power outages and, if a winter outage occurs, extensive damage can result due to freezing.

Table 3: Nunavut Electricity Plant Life Expectancies

Plant Name	Constructed	Remaining Life
Grise Fiord	1963	0
Qikiqtarjuaq	1936	0
Cape Dorset	1964	0
Cambridge Bay	1967	0
Kugluktuk	1968	0
Arviat	1971	0
Pangnirtung*	1971	0
Resolute Bay	1971	0
Taloyoak	1972	0
Rankin Inlet	1973	0
Arctic Bay	1974	0
Hall Beach	1974	0
Igloolik	1974	0
Kugaaruk	1974	0
Chesterfield Inlet	1975	1
Gjoa Haven	1977	3
Coral Harbour	1988	14
Whale Cove	1991	17
Kimmirut	1992	18
Pond Inlet	1992	18
Clyde River	1999	25
Naujaat	2000	26
Sanikiluaq	2001	27
Baker Lake	2003	29
Iqaluit	2014	40

* There was a fire at this facility in April 2015.

While facilities may have reached the end of their operations design, this does not mean diesel generators in each facility have reached the end of their operating life.

Source: QEC's Energy Development in Nunavut, *Information Pamphlet* submitted to the Committee May 2014; table prepared by Library of Parliament.



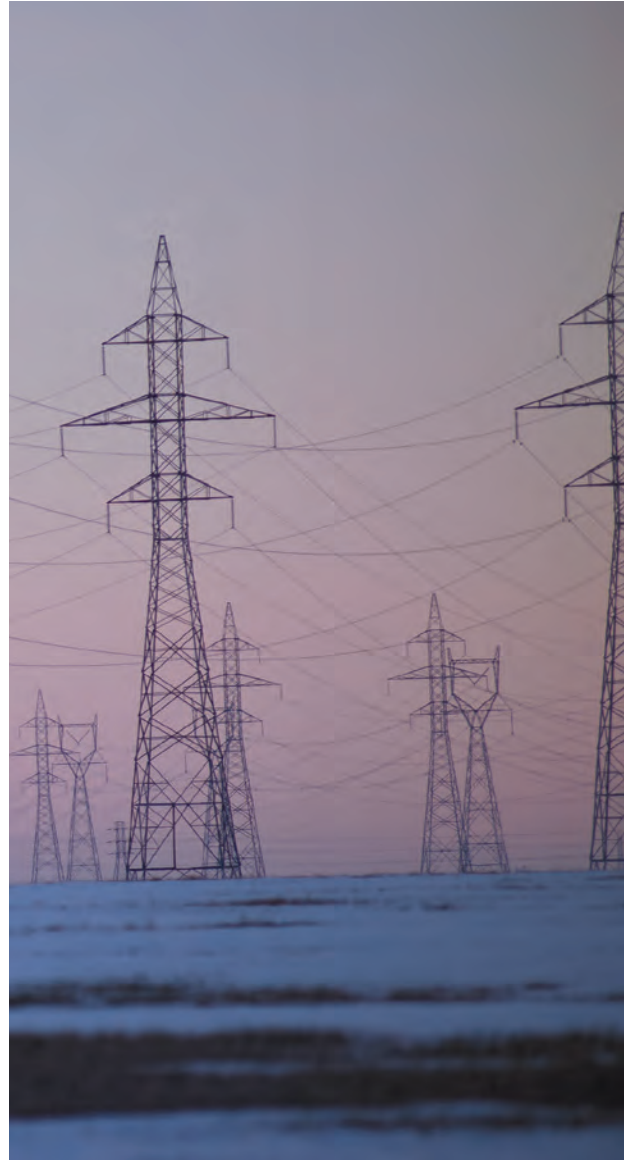
B. Transmission Connection with Manitoba

There has been a long standing desire to establish a transmission link between Churchill, Manitoba and the mineral rich Kivalliq region of Nunavut. This link would connect Nunavut to the North American electricity grid, providing access to lower-priced hydroelectric power from Manitoba and serving to reduce diesel consumption, diesel shipping and storage, GHGs emissions, as well as spur mining investment in the region.

A Hudson Bay Regional Roundtable Energy Options Working Group has been established to examine the viability of extending the transmission grid. In May 2014, committee members were in Rankin Inlet to discuss the progress of this project with key stakeholders including the Kivalliq Inuit Association, municipal leaders and the Government of Nunavut.

Committee members were also given a tour of the Agnico Eagle Meliadine pre-production mine located near Rankin Inlet. Agnico Eagle representatives expressed enthusiasm for the proposed transmission link, underscoring the fact that high energy costs are a major obstacle for mining projects.

QEC is currently in discussion with Inuit development corporations who have expressed interest in partnering on the project. The transmission link is described within the context of a nation-building effort since it could unlock enormous mining resources and may enable the territory to be a net contributor to the economic wealth of Canada.



Transmission lines in snow, Manitoba
Courtesy of Manitoba Hydro



C. Hydro Power Options

QEC highlighted two potential hydroelectricity sites to help reduce the territory’s dependence on diesel generation.⁸¹ First, the Iqaluit Hydro Project, which has been considered for a number of years, has already been subject to several studies including baseline environmental and feasibility reports. The site is attractive because Iqaluit consumes roughly one third of all diesel burned in the territory. The project proposes two sites: 1) the Qikiqjjaarvik (Jaynes Inlet) site with an installed capacity of 10 to 14.6 MW; and 2) the Tungatalik (Armshow South) with an installed capacity of 6 to 8.8 MW. It was anticipated that both plants would be connected to the same transmission line. The Qikiqjjaarvik (Jaynes Inlet) plant was expected to be built first.⁸²

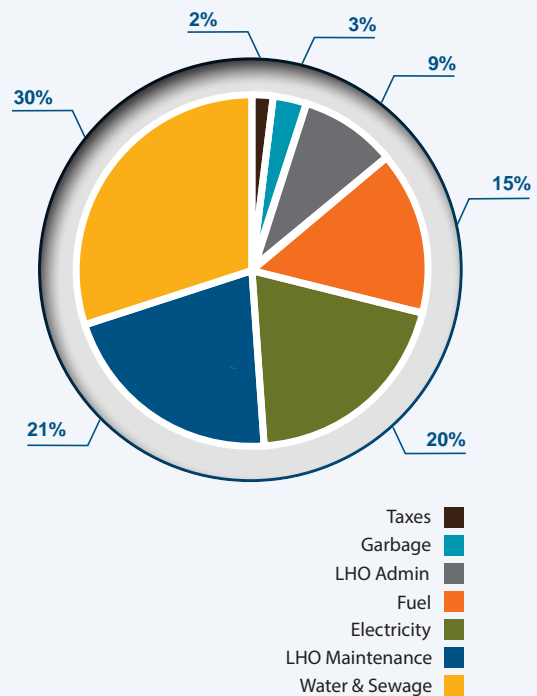
The committee was told the Iqaluit hydro project required \$6 million in further feasibility studies and that the Government of Nunavut decided to postpone the project and instead focus its limited resources on replacing, upgrading and maintaining existing diesel generation across the territory.⁸³

The second hydro site is in the Kivalliq region where several rivers could potentially serve nearby communities such as Baker Lake and Rankin Inlet, although it was also recognized that transmission costs would be extensive. The committee was told both projects would pay for themselves in the long term, but that capital costs were too prohibitive for the territory to be funded on its own.⁸⁴

D. Housing and Energy Efficiency

Unlike its territorial counterparts, most of Nunavut’s housing stock is owned or leased by a public agency, the Nunavut Housing Corporation (NHC). This means that NHC has a unique influence on energy consumption in Nunavut’s residential sector. NHC provides approximately 70% of the housing across the territory. Nearly 55% of housing stock is social housing while 15% is considered staff housing for Government of Nunavut employees. The committee was told that there is a serious housing shortage and much of the existing stock is overcrowded and needs repair.

Figure 11 – Breakdown of Public Housing Operation Cost, Nunavut 2013-14



Note: LHO is Local Housing Organization.

Source: Figure prepared by the Library of Parliament using data obtained from the Nunavut Housing Corporation, [Annual Report 2013–2014](#).



Expenses such as heat, water, sewage and maintenance are nearly entirely paid by NHC. The average annual operating cost per unit is \$24,800, of which electricity accounts for 20% and heating fuel (diesel), is 15%, of total cost per unit. Water and sewage account for 30% of total housing expenses.

NHC's social housing clients pay 6 cents per kWh, a highly subsidized rate for electricity. Lori Kimball, President and CEO of NHC, told the committee that this rate was not enough to influence energy efficiency or conservation behaviour. Also, many NHC clients are on social assistance and, therefore, the government ultimately pays the power bill.⁸⁵ NHC is looking into providing incentives to improve energy conservation but acknowledges the challenges in advancing this objective. The Corporation is working with QEC to streamline the highly administrative process in providing energy subsidies.

In terms of space heating, Ms. Kimball explained that one of the challenges was that the units have become so energy efficient and air tight that if clients turn off the air exchange systems, the unit becomes stuffy and uncomfortable.⁸⁶ This leads to doors freezing or mold issues, so they open windows. In some cases, the tenants find air exchange systems noisy or they place objects in front of the vents, particularly when there is overcrowding. The Corporation is working to raise awareness and provide incentives to prevent shutting down the air exchange systems.

VII. NATIONAL PRIORITIES FOR THE TERRITORIES

Introduced in 2009, the federal government's Northern Strategy shapes the country's national priorities in the North. The Strategy expresses a northern vision based on four pillars: 1) exercising Arctic sovereignty; 2) protecting the environment; 3) promoting social and economic development; and 4) improving and devolving Northern governance.⁸⁷ The Strategy builds from the Canadian identity and heritage as a northern country and reinforces the idea that the North's potential is strongly tied to the existing and future wealth of the nation.

The committee believes getting energy right in the territories is woven into every aspect of Canada's vision for the North. After over a year of examining territorial energy issues, it is clear that existing energy systems require change. In many communities energy costs are high and rising. There is heavy reliance on imported diesel and much of the territories' energy assets are at capacity, aging and underperforming, threatening the reliable supply of energy to northerners. These factors strain public resources and limit economic growth and prosperity. That being said, the committee also observed that territorial governments are advancing plans to diversify their energy mix through renewable generation, biomass and LNG and have placed a focus on promoting and funding energy efficiency and conservation programs. While it is still at its early stage, petroleum deposits hold promise for increased territorial energy self-sufficiency particularly in Yukon and NWT.



Nunavut's Energy Challenges

Energy challenges facing the Government of Nunavut stood apart from its territorial counterparts. Nunavut communities are more widely dispersed and isolated across an immense territory with very limited transportation access. Its climate is colder and its terrain is entirely above the tree line. There has been virtually no penetration of renewable energy technologies. The territory relies entirely on diesel power plants which are old and in need of immediate upgrading and/or replacement. The GN pays roughly 80% of all energy costs in the territory, much of this through direct and indirect energy subsidies.

Nunavut is faced with housing shortages and most of the homes in the territory are owned and managed by the Nunavut Housing Corporation. For those in social housing, there appears to be no meaningful pricing or financial incentive to encourage energy efficiency and conservation behaviour. Nunavut is also challenged by unemployment that is twice the national rate⁸⁸ and substantial reliance on social assistance. Territorial statistics indicate that 41% of Nunavut's population received some form of social assistance in 2013.⁸⁹

High dependency on social assistance conflicts with the strong sense of values, resilience and resourcefulness that have endured with Nunavummiut for centuries. Today, the lack of education, skills and mobility continues to unravel the social and economic fabric of the territory. It is the committee's view that the territorial government must address the wide gap between job requirements and available skills and, if necessary, encourage employment mobility.



Exercising Sovereignty

“ Canada would be wise to ensure that the footprints it places in the snow are deep and visible. ”

Louie Azzolini,
Executive Director, Arctic Energy Alliance

The integrity of Canada’s northern borders is not disputed internationally. However, over the foreseeable future, climate change and the global drive to supply mineral and petroleum resources will result in increased attention to the region. For example, diminishing sea ice caused by climate change is making the Northwest Passage, a waterway through the Canadian Arctic that connects the Pacific and Atlantic Oceans, more navigable. The Government of Canada considers this transit route to be within Canadian internal waters, a claim not shared among other nations.

Canada’s territories are sparsely populated by only 116,700 inhabitants while its landmass would rank as the seventh largest in the world if it were its own country. Many witnesses felt that Canada’s exercise of sovereignty would be reinforced if the northern communities prospered and Canadians maintained a strong presence in the territories. They saw increased federal funding and programming to the territories and its communities as intrinsically linked to Canada’s goal of exercising Arctic sovereignty.



Coast Guard patrol in Nunavut

Courtesy of: Fisheries and Oceans Canada



Committee Recommendations

While the federal government does not play a direct role in providing heating or electrical generation in the territories, the committee believes the federal government has a supporting role to play in helping to address territorial energy challenges, as well as its opportunities, especially in Nunavut.

The following section outlines the committee's recommendations:

A. Promote Energy Efficiency and Conservation

The committee believes that energy efficiency and conservation is the single most important method to reduce energy costs and the territorial dependency on imported diesel while meeting environmental objectives. Through the adoption of energy efficiency practices and technologies, it is possible to consume less energy while maintaining the same level of energy services. It is “low hanging fruit” when it comes to comparing available energy options.

While energy savings can be significant, there are often barriers associated with improving energy efficiency for businesses or households. They include: 1) the absence of an appropriate energy price signal; 2) the lack of information of the long term benefits of energy efficiency; 3) the lack of ability to finance energy efficiency investment/purchases; and 4) in some cases, there is a lack of access to energy savings products.

In order to address some of these barriers, both Yukon and NWT have introduced programs that provide financial incentives to purchase high efficiency appliances and furnaces and to undertake energy efficient retrofits on buildings and homes. Yukon has set a target of a 20% increase in energy efficiency by 2020, in its 2009 Energy Strategy. All territories have taken steps, through regulation and codes, to increase energy efficiency in homes and buildings.

Currently, the federal government plays a minor role in improving energy efficiency in the territories. For example, Natural Resources Canada's Office of Energy Efficiency does not administer initiatives or programs targeted for the territories. The committee believes the federal government should play a larger role in addressing barriers to energy supply and efficiency investment in the territories.

Recommendation I

That the federal government develop a strategic plan to actively improve energy efficiency and conservation in the territories.

B. Federal Funding for Communities

In addressing territorial energy challenges, witnesses emphasized that there is no single bullet solution. Some solutions may work for one community but not for another, depending on the attributes of each community and the availability of energy resources.

Territorial electricity utilities highlighted the challenges of balancing the desire to adopt renewable technologies with the often high costs and technical challenges associated with integrating them with the existing grid. However, it was also recognized that the project cost of renewable energy investments were decreasing. Additionally, most projects were seen not only through an energy or environmental lens but as a local job creator.



The federal government supports territorial communities in adopting renewable energy projects to reduce greenhouse gas emissions from electricity and heat generation through its ecoENERGY for Aboriginal and Northern Communities program. Typically, project support averages at around \$100,000. Past projects have included residual/district heating systems, advancing small hydroelectricity projects, wind, solar, biomass and geothermal technologies as well as community energy plans. Over a nine year period, a total of \$18.2 million has been spent on the ecoENERGY for Aboriginal and Northern Communities program and only 18% or \$3.2 million has been invested in territorial communities.⁹⁰ The remaining funds were distributed to aboriginal and northern communities outside of the territories. The committee believes that the program should be renewed, expanded and a larger share should be assigned to the territories.

Recommendation II

That the federal government significantly increase funding to the ecoENERGY for Aboriginal and Northern Communities Program with the objective of reducing the consumption of carbon-intensive fuels, increasing energy efficiency and enhancing community economic viability.

C. Coordinating Federal Resources for the Territories

There are numerous federal departments and agencies with mandates that impact, to varying degrees, energy circumstances in the territories. The committee is concerned that this may lead to a lack of cohesion and inefficiencies in policies, programs and resources related to energy in the territories.

The following is a list of federal departments and agencies that have responsibilities in the territories:

- Aboriginal Affairs and Northern Development Canada
- Canadian Northern Economic Development Agency
- Natural Resources Canada
- National Energy Board
- Environment Canada
- Canadian Polar Commission (to merge with the Canadian High Arctic Research Station (CHARS) to create a single large research hub for scientific research in Canada's high Arctic)
- Canada Mortgage and Housing Corporation
- Foreign Affairs, Trade and Development Canada
- Industry Canada
- Transport Canada

The committee believes that existing federal government resources for the territories should be coordinated under a single access and delivery point. It was felt that the extensive resources and expertise on energy policy and programs, aboriginal community support, research and development, energy technology assessments, mapping renewable energy potential, energy literacy and awareness, building codes and other regulatory regimes, infrastructure funding and environmental initiatives could be better coordinated within and among each department and agency via a federal energy resource and knowledge hub for the territories.



A federal resource and knowledge hub should build from the pan-territorial collaboration that currently exists in seeking solutions to shared energy challenges. It could compile best practices adopted across Canadian communities and in other northern countries and directly assist in case-by-case assessments of territorial communities' energy efficiency, conservation and energy resource potential.

The committee was informed of collaborations between Canada and the United States on northern energy issues particularly off-grid communities but felt that more can be done in partnership with other northern countries to share ideas and best practices.

Recommendation III

That the federal government create a federal resource and knowledge hub to focus on territorial energy issues and conditions, in supporting energy supply and technology evaluations, economic and environmental modelling and energy resource planning and assessments.

D. Federal Legacy Responsibilities in the Territories

Many of the existing electricity facilities operating today were once owned and operated by the federal government through the Northern Canada Power Commission (NCPC) before being transferred to the territories in the 1980s. Many of these are diesel powered generating facilities of which many have reached the end of their useful lives.

The committee was surprised to learn 17 of the 25 existing diesel facilities operating in Nunavut are operating beyond their design parameters. These aging facilities increase the risk of power outages posing a risk to public safety and resulting in costly repairs.ⁱⁱ

For example, on April 2, 2015, the diesel facility in the Hamlet of Pangnirtung stopped operating because it caught fire.⁹¹ This facility is nearly 45 years old and was operating beyond its life expectancy. The power outage resulted in a local state of emergency for the community that lasted a month. In order to restore reliable power to the community, four generators had to be airlifted using specialized Russian aircrafts: a large cargo aircraft and a specialized 70 foot-long twin engine helicopter.⁹² The cost of the operation (not including the cost of the generators) was roughly \$3 million.⁹³

The committee believes that this is an unsustainable situation. Also, it is clear that for many remote off-grid communities, especially in Nunavut, diesel is the only viable option for electricity generation. The committee holds the view that replacing existing generator systems with newer systems will allow more effective and efficient operation of the plant facilities avoiding costly and disruptive outages. Also, the committee believes there is a shared responsibility between the federal and territorial governments to address the challenges posed by aging diesel facilities which were a legacy of the Northern Canada Power Commission.

ⁱⁱ It should be noted that this does not mean the diesel generators housed within the facility have reached the end of their operating design.



Recommendation IV

That the federal government assist in the acquisition, upgrading and installation of diesel generating facilities in remote off-grid northern communities.

E. Energy Infrastructure Funding

All territorial governments underscored opportunities for large hydroelectricity projects and/or the benefits of connecting to the North American electricity grid in which they were financially constrained in advancing. Connecting electricity grids provides a means to share resources with southern neighbours and to access lower cost energy that could spur new mining investment and extend the lives of existing mines. Many witnesses framed these projects as nation building in scope and stated the need for federal funding.

The committee considered whether the Government of Canada commitment to provide a loan guarantee for the Lower Churchill projects in 2011 could be a model for major territorial energy projects.ⁱⁱⁱ The three conditions for the federal loan guarantee was that the projects have regional and national significance, economic and financial merit and significantly reduce greenhouse gas emissions in Canada. Federal officials with Natural Resources Canada told the committee that the federal government is open to discussing similar arrangements with territorial proponents if proposed projects carried similar characteristics.⁹⁴

The loan guarantee for the Lower Churchill projects has further terms and conditions requiring the provinces to put in place regulatory regimes that would recover project costs from electricity ratepayers, thus servicing the debt that was guaranteed. While this may limit some major project proposals in the territories due to small rate bases, the committee believes that terms and conditions for federal loan guarantees must ultimately have financial merit and be paid by ratepayers.

In response to territorial requests, the federal Budget 2015-16 announced proposed increases to the borrowing limits for NWT from \$800 million to \$1.3 billion and Nunavut from \$400 to \$650 million. The committee supports the federal government's announced changes to the territorial debt caps since the committee heard from territorial governments and utilities that low borrowing limits were an obstacle in advancing many energy projects.

The committee holds a view that the federal government should contribute, in some way, to help advance territorial energy projects. This could take the form of a federal infrastructure funding program for qualified territorial energy projects that promote cleaner air and reduce greenhouse gas emissions.

Recommendation V

That the federal government support infrastructure investment in qualified territorial energy projects.

ⁱⁱⁱ The Lower Churchill project consists of an 824 MW Muskrat Falls hydro generating station on Labrador Island, a transmission link to the Newfoundland and Labrador's electricity grid and linking to Nova Scotia's grid via underwater cables.



VIII. CONCLUSION

Much of the territories' existing energy assets and the design of its energy systems are a legacy of decisions made many decades ago. Many hydro facilities were built to power an emerging northern mining sector. Communities were equipped with diesel powered plants because it was the most reliable and affordable way to ensure energy is available when called upon. It is true that for most territorial communities, diesel is what warms the living rooms and keeps the lights on, and it is also true that diesel will likely continue to play an important role in powering the territory's future. However, many territorial energy systems are showing their age; energy assets including diesel generators are old and need to be upgraded or replaced.

At the same time, new ways of fuelling the territories are emerging. Renewable energy technologies such as solar and wind are integrating with diesel generation systems and are becoming less expensive. Biomass energy is creating cost effective alternatives to diesel heating, reducing carbon emissions and fostering biomass economies that create local jobs. Natural gas is beginning to show promise as a fuel capable of reducing diesel dominance in territorial communities and in the mining sector. In many areas of the territories, there are vast untapped hydro resources that can provide legacy assets for the next generation.

The next decade will likely be a pivotal time for the territories and its communities. The committee believes the federal government can play a pivotal role in helping the territories address their energy challenges while harnessing its energy opportunities from a stronger and more prosperous North.



Husky dog team on Baffin Island, Nunavut



APPENDIX A: WITNESSES

Meeting of May 7, 2015

Jan Larsson, Founder (Energy North)

Meeting of May 5, 2015

Sara Fisher-Goad, Executive Director (Alaska Energy Authority)

Floyd Roland, Mayor (Town of Inuvik, Northwest Territories)

Sean Skaling, Director, Energy Programs and Evaluations (Alaska Energy Authority)

Meeting of April 23, 2015

Dean Haslip, Director General, CanmetENERGY-Ottawa, Innovation and Energy Technology Sector (Natural Resources Canada)

Anoop Kapoor, Director, Renewable and Electrical Division (Natural Resources Canada)

Drew Leyburne, Director General, Energy Policy Branch, Energy Sector (Natural Resources Canada)

Laura Oleson, Director, Demand Policy and Analysis, Office of Energy Efficiency, Energy Sector (Natural Resources Canada)

Meeting of April 21, 2015

Chris Bertoli, Superintendent, Power Distribution and Surface Electrical (Diavik Diamond Mines Inc.)

Corey McLachlan, Manager, Communities and External Relations (Diavik Diamond Mines Inc.)

Meeting of April 2, 2015

Stephen Hooley, Acting Chief Operating Officer (Nunavut Housing Corporation)

Lori Kimball, President and CEO (Nunavut Housing Corporation)

Bernie MacIsaac, Assistant Deputy Minister, Department of Economic Development & Transportation (Government of Nunavut)

Arif Sayani, Senior Advisor, Energy Secretariat, Department of Economic Development & Transportation (Government of Nunavut)

Meeting of March 31, 2015

Jeff Philipp, President and CEO (SSi Micro Ltd.)

Meeting of March 26, 2015

Louie Azzolini, Executive Director (Arctic Energy Alliance)

David Morrison (As an Individual)

Meeting of February 17, 2015

Brendan Marshall, Director, Economic Affairs (Mining Association of Canada)

Meeting of November 20, 2014

Alain Barriault, President and Chief Executive Officer (Qulliq Energy Corporation)

William Mackay, Assistant Deputy Minister, Intergovernmental Affairs (Government of Nunavut)

Denis Tanguay, President and Chief Executive Officer (Canadian GeoExchange Coalition)



Meeting of October 30, 2014

Tim Weis, Alberta Regional Director (Canadian Wind Energy Association) John Gorman, President and CEO (Canadian Solar Industries Association)

Meeting of October 28, 2014

Brendan Marshall, Director, Economic Affairs (Mining Association of Canada)

Meeting of October 21, 2014

Peter Lang, President (Dunedin Energy Systems Ltd.)

Meeting of June 12, 2014

Rick Whittaker, Vice President, Investments and Chief Technology Officer (Sustainable Development Technology Canada)

Meeting of May 27, 2014

Jim R. Burpee, President and CEO (Canadian Electricity Association)
Doug Tenney, Vice President, Aboriginal and Government Relations (ATCO Power)

Meeting of May 8, 2014

Paul Cheliak, Director, Market Development (Canadian Gas Association)
Paula Dunlop, Director, Public Affairs and Strategy (Canadian Gas Association)

Meeting of May 1, 2014

Mark Cauchi, Executive Director, Oil, Gas and Alternative Energy (Environment Canada) Jim Fox, Business Leader, Strategy and Analysis (National Energy Board)
Susan Harper, Director General, Economic Development (Foreign Affairs and International Trade Canada)
Sandra LaFortune, Director General, Policy and Planning (Canadian Northern Economic Development Agency)
Shelley Milutinovic, Chief Economist (National Energy Board)
Lynne Patenaude, Manager, Natural Gas and Crude Oil (Environment Canada)
Matthew Spence, Director General, Northern Projects Management Office (Canadian Northern Economic Development Agency)
Marc Tessier, Head, Energy Secretariat and Deputy Director, Circumpolar Affairs and Energy Division (Foreign Affairs and International Trade Canada)

Meeting of April 29, 2014

Michel Chénier, Director, Petroleum and Mineral Resources Directorate (Aboriginal Affairs and Northern Development Canada)
Catherine Conrad, Director, Environment and Renewable Resources (Aboriginal Affairs and Northern Development Canada)
Terence Hubbard, Director General, Petroleum Resources Branch, Energy Sector (Natural Resources Canada)

Meeting of April 3, 2014

Harold Calla, Executive Chair (First Nations Financial Management Board) Niilo Edwards, Advisor (First Nations Financial Management Board)



APPENDIX B: ENDNOTES

- ¹ Senate, Standing Committee on Energy, the Environment and Natural Resources, [Evidence](#), 2nd Session, 41st Parliament, 29 April, 2014 (Catherine Conrad, Director, Environment and Renewable Resources, Aboriginal Affairs and Northern Development Canada).
- ² Environment Canada, Canadian Climate Normals, [1981-2010 Climate Normals & Averages](#).
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- ⁵ Aboriginal Affairs and Northern Development Canada, [Travel in the Northwest Territories and Nunavut](#).
- ⁶ Statistics Canada, Gross domestic product (GDP) at basic prices, [Cansim Table 379-0030](#).
- ⁷ The Conference Board of Canada, [Territorial Outlook 2014](#).
- ⁸ Senate, Standing Committee on Energy, the Environment and Natural Resources, [Evidence](#), 2nd Session, 41st Parliament, 17 February, 2015 (Brendan Marshall, Director, Economic Affairs, Mining Association of Canada).
- ⁹ The Mining association of Canada, [Facts & Figures of the Canadian Mining Industry](#), Figure 4, 2014.
- ¹⁰ The Conference Board of Canada, [Territorial Outlook 2014](#).
- ¹¹ Ibid.
- ¹² Ibid.
- ¹³ Ibid.
- ¹⁴ Nunavut Bureau of Statistics, [Population Estimates](#).
- ¹⁵ Finance Canada, [Territorial Borrowing Limits](#).
- ¹⁶ Government of Canada, [Budget 2015](#), 21 April, 2015.
- ¹⁷ Senate, Standing Committee on Energy, the Environment and Natural Resources, [Evidence](#), 2nd Session, 41st Parliament, 29 April, 2014 (Catherine Conrad, Director, Environment and Renewable Resources, Aboriginal Affairs and Northern Development Canada).
- ¹⁸ Andrew Hall, President and CEO of Yukon Energy Corporation, submission to the Standing Senate Committee on Energy, the Environment and Natural Resources.



- ¹⁹ Government of Northwest Territories, Department of Industry, Tourism and Investment, [A Vision for the NWT Power System Plan –December 2013](#).
- ²⁰ Senate, Standing Committee on Energy, the Environment and Natural Resources, [Evidence](#), 2nd Session, 41st Parliament, 30 October, 2014 (John Gorman, President and CEO, Canadian Solar Industries Association).
- ²¹ Northwest Territories Power Corporation, [Corporate Structure](#).
- ²² Northland Utilities owns and maintains power poles, power lines, insulators, transformers and streetlights within its distribution system. Northland Utilities also supplies electricity via diesel generators to four communities of Wekweètì.
- ²³ The Yukon Interim Electrical Rebate (which replaced an earlier subsidy), was introduced in July, 2009. It provides residential customers with a maximum rebate of \$26.62 per month for the first 1,000 kilowatt hours of power used.
- ²⁴ Senate, Standing Committee on Energy, the Environment and Natural Resources, [Evidence](#), 2nd Session, 41st Parliament, 29 April, 2014 (Catherine Conrad, Director, Environment and Renewable Resources, Aboriginal Affairs and Northern Development Canada).
- ²⁵ Yukon Government, Department of Energy, Mines and Resources, [Biomass Energy Strategy](#).
- ²⁶ Senate, Standing Committee on Energy, the Environment and Natural Resources, [Evidence](#), 2nd Session, 41st Parliament, 23 April, 2015 (Dean Haslip, Director General, CanmetENERGY-Ottawa, Innovation and Energy Technology Sector, Natural Resources Canada Canadian).
- ²⁷ Ibid.
- ²⁸ Northern Premiers Forum, A Northern Vision: Building a Better North, Renewable Energy Inventory, [Geothermal](#).
- ²⁹ Senate, Standing Committee on Energy, the Environment and Natural Resources, [Evidence](#), 2nd Session, 41st Parliament, 20 November, 2014 (Denis Tanguay, CEO, Canadian GeoExchange Coalition).
- ³⁰ Senate, Standing Committee on Energy, the Environment and Natural Resources, [Evidence](#), 2nd Session, 41st Parliament, 21 October, 2014 (Peter Lang, President, Dunedin Energy Systems Ltd.).
- ³¹ Senate, Standing Committee on Energy, the Environment and Natural Resources, [Evidence](#), 2nd Session, 41st Parliament, 20 November, 2014 (Alain Barriault, President and CEO, Qulliq Energy Corporation).
- ³² Aboriginal Affairs and Northern Development Canada, [Northern Oil & Gas Annual Report 2013](#), May 2014.
- ³³ Senate, Standing Committee on Energy, the Environment and Natural Resources, [Evidence](#), 2nd Session, 41st Parliament, 29 April, 2014 (Michel Chénier, Director, Petroleum and Mineral Resources Directorate, Aboriginal Affairs and Northern Development Canada).
- ³⁴ NWT Bureau of Statistics, [Oil and Gas](#).



- ³⁵ Northern Premiers' Forum, [A Northern Vision: Building a Better North](#), 4 September, 2014.
- ³⁶ Yukon Government, Energy Solutions Centre, [Energy Strategy](#).
- ³⁷ Yukon Government, [Hydroelectric Power Planning Directive Work Plan](#), May 2014.
- ³⁸ Andrew Hall, President and CEO of Yukon Energy Corporation, submission to the Standing Senate Committee on Energy, the Environment and Natural Resources.
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- ⁴⁰ M3 Engineering & Technology Corporation, [Casino Project Form 43-101F1 Technical Report Feasibility Study](#), 25 January 2013.
- ⁴¹ Government of Yukon, Department of Yukon Energy, Mines and Resources, [Energy Strategy for Yukon, Independent Power Production Policy](#), 20 May, 2014.
- ⁴² Ibid.
- ⁴³ Government of Yukon, Department of Yukon Energy, Mines and Resources, [Yukon Biomass Energy Strategy](#), Draft for Public Consultation, April 2015.
- ⁴⁴ Yukon Government, Department of Energy, Mines and Resources, Energy Solutions Centre, [Programs](#).
- ⁴⁵ Manno Moreau, Acting Assistant Deputy Minister, Yukon Department of Energy, Mines and Resources, submission to the Standing Senate Committee on Energy, the Environment and Natural Resources.
- ⁴⁶ Government of Yukon, [Yukon government accepts all 21 recommendations of the Select Committee Regarding the Risks and Benefits of Hydraulic Facturing; announces position on shale gas development](#), 9 April 2015.
- ⁴⁷ Government of Northwest Territories, Department of Industry, Tourism and Investment, [Northwest Territories Energy Action Plan](#), December 2013.
- ⁴⁸ Charrette Final Report, [2014 Northwest Territories Energy Charrette](#), 22 December 2014.
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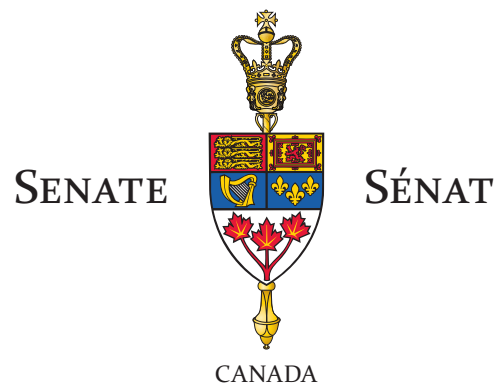
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