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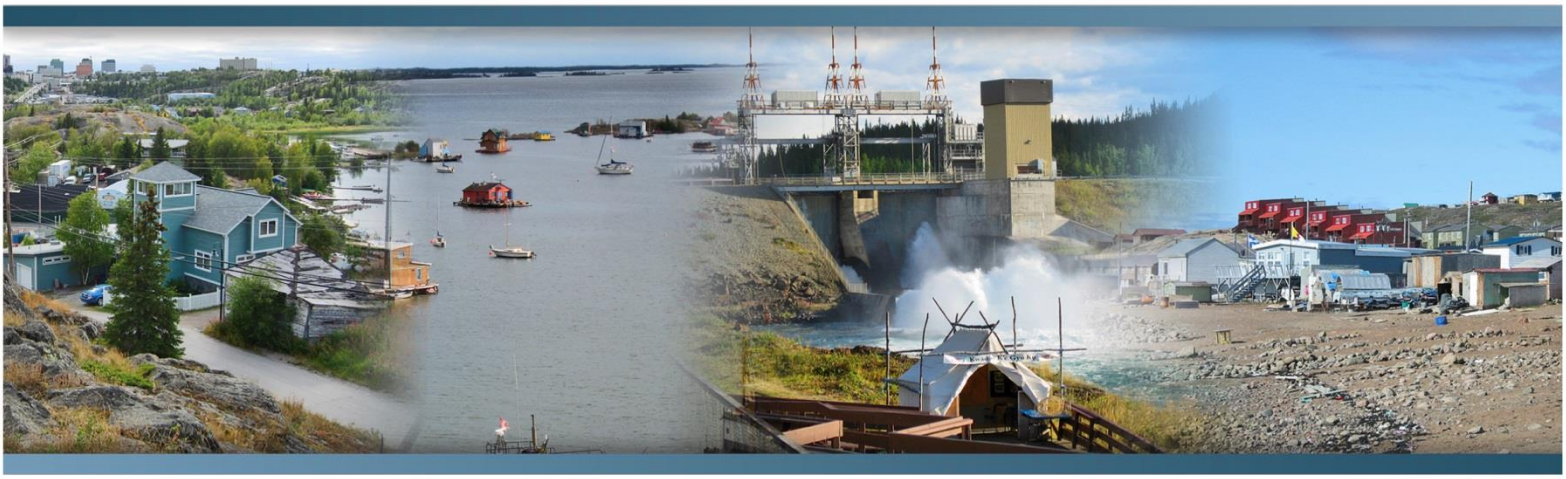
Energy Policy Context and Market Characterization for the Development of a Northern Communities Energy Technology Intervention Strategy



CanmetENERGY – Varennes, September 2015

Canada

EXECUTIVE SUMMARY

This document provides the policy context and the market characterization for the purpose of developing and implementing a Northern Communities Energy Intervention Strategy.

Canada's Northern Strategy[1] speaks about "remote and isolated communities". Essentially, the Strategy refers to the three territories plus the community of Churchill in Manitoba, the communities located in Nunavik in Northern Québec, and a few remote locations in Labrador (Nunatsiavut). This report refers to this definition of the North.

Most communities in the North are small – which could be seen as a handy comparative factor – but their situations are not necessarily homogeneous, and neither are their community structures and priorities. As a consequence, there is no one-size-fits-all solution to improve energy efficiency and conservation. Although many communities also share the goal of reducing their reliance on diesel not only for electricity generation but also for heating, the approach to introduce or deploy new technologies and Demand Side Management (DSM) solutions and options will vary.

For historical reasons, the federal government is present in many aspects of territorial life while communities are also quite independent from one another. Economic diversity of the territories is somewhat limited. Their internal economy is relatively small with little industrial and manufacturing capacity. This means the tax base is relatively modest – hence the lack of capacity to finance initiatives and projects – and their borrowing capacity is controlled by the federal government. Finally, every community ought to maintain modern services: this is not always economically viable and somewhat unrealistic to achieve and then maintain.

Devolution is a game changer, but it comes at a time when the national and international markets for natural resources have seriously declined due to lower demand and increased national and international supply. Just looking at the mining industry, it will take years before measurable benefits start accruing significantly enough to make a difference. Combined with a depressed market for natural resources, devolution will not generate sufficient revenues for the territories in the short term.

Most communities in the North are small but their situations are not necessarily homogenous, and neither are their community structures and priorities. With a population of just over 100,000 dispersed over 3.5 million square kilometers, the costs and logistics of energy distribution are major issues. Yukon has over 4,000 kilometers of highway, while Nunavut has no permanent highways. The North is also characterized by a relatively low share of industrial fuel use and a very high share of government/institution use in the commercial sector.

In Yukon, most communities have year-round road access and the vast majority of the population has access to relatively cheap hydroelectricity at rates lower than those in Ontario and most Canadian provinces. In the Northwest Territories (NWT), 16 communities out of 33 do not have all-weather access roads and four do not even have winter access roads. In the latter cases, supply is either flown in year-round or delivered via marine re-supply facilities. One community has neither road nor marine access. In Nunavut, there is no road system between communities and most of them receive their supplies via air transportation or by boats. This is also the case for Nunavik, in northern Quebec, and for Nunatsiavut, in Labrador.

[1] "Canada's Northern Strategy – Our North, Our Heritage, Our Future." Government of Canada, 2009.

End-use energy demand shows important differences between the three territories. In Yukon, the split between transportation, industrial, commercial and residential is in the 20-30% range. Industrial applications account for 55% in the NWT, and for 63.6% in Nunavut. Despite these significant figures, industrial demand is noticeably influenced by the opening and closing of large, scattered industrial operations mainly in the mining industry.[2] Although many communities also share the goal of reducing their reliance on diesel for electricity generation but also for heating, the approach to introduce or deploy new technologies and Demand Side Management (DSM) solutions and options will vary.

The electricity production profiles of the three territories show major differences in natural resources endowments as well as production facilities. Yukon boosts a very high level of hydroelectricity at 94.7% of electricity supply in the territory. Other than hydroelectricity, there is currently very little renewable energy in the North. Yellowknife alone accounts for 46% of distributed electricity in the NWT and is supplied with hydroelectricity. There are 23 communities out of 33 in the NWT which rely exclusively on diesel production and 2 others which rely on a combination of natural gas (trucked-in LNG) and diesel. Nunavut is 100% diesel.

Not surprisingly, with its large hydro-based supply, Yukon has the lowest electricity rates of the three territories. Nunavik and Nunatsiavut are special cases: their rates are highly subsidized (as a provincial policy) by the large customer bases in Quebec and Newfoundland & Labrador. Nunavut, relying entirely on diesel for electricity generation, has high rates in all communities, sometimes over $1/kWh.

Many misperceptions regarding the North were found in the abundant literature reviewed for this study. Among these false notions, three related to energy are worth noting:

- Energy is expensive… ***yes, but not everywhere.***
- Energy supply is all based on imported fuel… ***for the most part, but not everywhere.***
- Revenues generated by energy supply and demand flow out of the territory… ***often the case, but not always.***

In the three territories, while the discussion about energy issues is broad, there are two overarching concerns which are common to all communities: electricity supply and use, and fossil fuel for heating. In the three territories, the notion of remote community is also core and central to energy policies because all of them are considered isolated from the North American electricity grid. Reliability of electricity supply is a major issue that goes over strict economic considerations and pre-set financial formulas. These concerns are addressed in detailed territorial energy plans much more so than through the mechanics of rate case hearings and general work performed by public utility boards.

In 2011, the three territorial governments published a joint document discussing the energy situation in the North: ***Paths to a Renewable North – A Pan-Territorial Renewable Energy Inventory.***[3] This document was prepared following the 2009 Northern Premiers' Forum where the three territorial Premiers committed to developing an inventory of current and future renewable energy resources. The driving force behind this initiative was the clear desire to address the issue of the three territories' dependence on imported fossil fuels.

[2] "Energy Use in Canada's North: An Overview of Yukon, Northwest Territories, and Nunavut." Energy Facts, National Energy Board, March 2011.

[3] "Paths to a Renewable North – A Pan-Territorial Renewable Energy Inventory." This document is part of: "A Northern Vision: building a Better North". A collaboration of the Government of the Northwest Territories, the Government of Nunavut and the Government of Yukon. 2011.

In recent years, all three territories – Yukon, the Northwest Territories and Nunavut – have adopted a number of energy policies, energy plans, greenhouse gas (GHG) strategies, energy strategies, renewable energy programs, and so on. Clearly, territorial governments and local stakeholders have been very active. With varying electricity rates and resources endowment, accessibility and reliability of energy supply at reasonable cost, the three governments are pursuing both short-term and longer-term objectives.

Yukon and the Northwest Territories have adopted net billing/metering policies to facilitate the supply and use of renewable energy. The Northwest Territories have shown a great interest in locally produced biomass as a means of displacing fossil fuel heating in public and private buildings. They have also adopted a solar energy strategy to accelerate the deployment of photovoltaic installations. Yukon just released a draft biomass energy strategy and is geared to pursue the displacement of imported heating oil with locally produced biomass. In Nunavut, the government introduced the Nunavut Energy Management Program to improve energy efficiency in its owned and leased buildings. After a successful pilot project on 40 buildings in Iqaluit under the performance based contracting formula, a full scale project has been deployed for 89 buildings in 7 other communities.

> *"Dependence on imported fossil fuels puts us at an economic disadvantage; the three territories are vulnerable to high costs, price volatility and supply disruptions. The burning of these fuels also emits greenhouse gases that contribute to the changing climate that is affecting the North."*
>
> ***Paths to a Renewable North – A Pan-Territorial Renewable Energy Inventory***

The energy needs are great and this is reflected in the territorial strategies as well as in the actions taken so far. However, many of the territorial strategies and plans are aging and will shortly be due for major revisions. Nunavut's strategy was written in 2007. The Yukon Energy Plan was released in 2009, and a progress report is due in 2015. The NWT's three-year energy action plan was released in 2013 and has reached its midlife stage. Seeing as the NWT faces a major energy crisis with the drought in the Snare River system, short-term actions are currently being sought.

This situation presents a strategic opportunity to participate in the upcoming review/update process and provide technical assistance, particularly on renewable energy discussions and energy efficient equipment and technologies. In many cases – despite existing territorial energy plans and strategies – programs and projects within communities may not necessarily meet specific concerns formulated at the local government level. Needs expressed by communities are opportunities for project implementation, but their replication will depend on their alignment with territorial or provincial priorities and programs.

In some other cases, there could be a need to scale down the territorial governments' expectations for future energy supply, and consider (or re-consider) micro needs and relevant options at the community level. For example, the NWT recently renounced building power lines to connect with the Alberta electricity grid. While the Nunavut government is seriously looking into the hydro power option, this may not be feasible (technically and financially) except perhaps in and around Iqaluit. This will not be of value for the 24 other communities in Nunavut for which other options must be explored.

Most communities do not own diesel plants – utilities do. These can be privately owned or publicly owned. For electricity production

facilities, the latter is the norm. So if communities start owning electricity production equipment, they will need to learn new management and technical skills. Potential alternative energy projects are, in general, more complex to manage and operate than diesel engines. Furthermore, because of mismatches between electricity supply and demand, deploying more complex energy systems will require electricity supply and use to be increasingly coordinated through time of use strategies, unit sequencing, grid connectivity, and so on.

Diesel plants throughout the North are aging. This is particularly true in Nunavut where they are the only source of electricity generation. The issue of replacing or upgrading these systems is complex as there is no one single alternative. Also, whatever that choice of alternative might be, there will be a need for back-up supply (because of seasonality of renewable resources – solar and wind regime), which will most likely remain fossil fuel based. This will add significant capital costs as well as stand-by charges by utilities.

Solar energy has significant seasonal limitations. Hydro is expensive to develop. Geothermal energy – both high temperature and ground source heat pumps – is limited. As renewable energy is limited, a new focus is placed on local supply. The NWT have a strong bias towards increased use of biomass in government buildings and have adopted a strategy in this regards. Yukon is also exploring this avenue and has already published a draft biomass strategy. Although heat recovery can be considered in some communities, it does not resolve the power supply issues. Combined heat and power (CHP) generation is generally a good option for the winter season, but will generate excess heat during the summer. Technology solutions must be carefully selected and targeted because of the wide-ranging electricity rates. Like anywhere else in the world, the deployment of efficient solutions must follow sound economic considerations and make sense economically.

Because of subsidies in the residential sector, the target audience is not necessarily the end-user or the building occupant. The best stakeholder is often the local housing corporation. The departments of public services also own and operate a relatively large public buildings portfolio. The private sector also owns a significant number of energy-intensive buildings such as grocery stores, hotels and restaurants.

Concomitantly, demand side management (DSM) could be difficult in some areas because communities are not tax-based. Working on the supply side might be more efficient, particularly for electricity loads which do not appear to be very different than in non-hydro based provinces. In Nunavut, there are no building inspectors and standard-based efficiency is therefore limited. The focus tends to be more on incentivization. The preferred strategy is to provide financial incentives to upgrade rather than regulate since regulation requires inspectors.

For some technologies, a multi-stakeholder approach is necessary. A good example of this is the cold chain: sometimes, the potential technology adopters will be the communities themselves with their community freezers. Other times, adopters will come from various private sectors with their groceries, restaurants, hotels and other privately-owned commercial buildings. In both cases, however, the local utility could get involved.

There are important networks in the North including territorial departments, housing corporations, associations, utilities and colleges. All these stakeholders have a solid knowledge of their communities and their needs. They also have ideas to move the energy R&D agenda further and in sync with local priorities. Clearly, these stakeholders need to be consulted and included in the development and deployment of any energy technology intervention strategy aimed at providing solutions to *their* needs.

Seeing as there are several different needs, responses – strategy and specific ensuing actions – must be adapted. There exists no one-size-fits-all approach, particularly when energy supply (and resource availability) is highly different from one area to the other, and when consequent fossil fuel prices and electricity rates show significant differential factors, sometimes up to tenfold.

Finally, Nunavik and Nunatsiavut can rely on the extensive resources – both financial and technical – of Quebec and Newfoundland & Labrador. Concerns about energy supply and demand and energy efficiency within the communities are dealt with by utilities in the two provinces. These utilities can rely on their extensive customer base to finance and provide energy efficient solutions to their communities. Nevertheless, energy solutions developed for a northern environment can be adapted to these communities and vice-versa. The latter point should be reflected in the strategy and shared priorities considered in specific actions.

With these conclusions in mind, the development of a cohesive technology intervention strategy should minimally reflect the following guidelines:

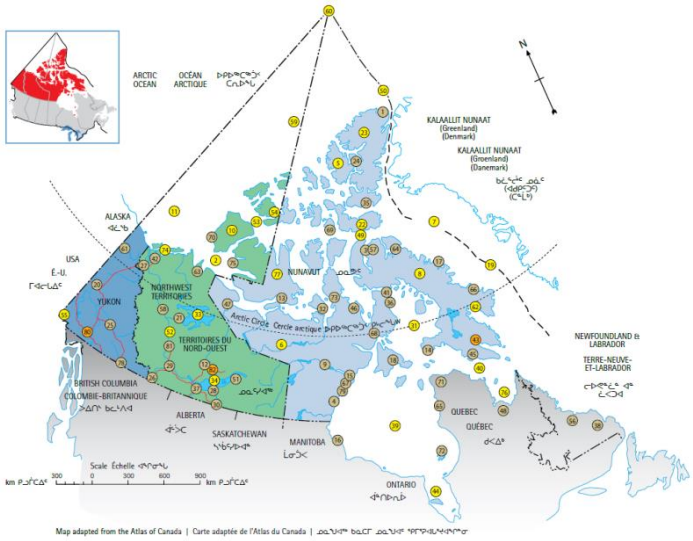
- Alignment with territorial energy strategies bearing in mind potential solutions will not be equally applicable everywhere.
- Reflecting locally identified priorities and capacity of the host community to ensure project sustainability.
- Consulting with local stakeholders such as colleges, associations, utilities and local governments since they know their specific needs. This will eventually facilitate and speed up the deployment of technologies and acceptance by communities.
- Energy technology options should ideally address the needs of small, medium and large communities (in other words, technologies and projects must be scalable).
- Solutions requesting input and participation from local workforce will receive more attention from territorial governments and communities and are more likely to succeed in the long term. Projects must be replicable by local stakeholders.
- Mini-Mega projects are good for large industrial applications but usually inadequate for most of the communities located far away from the industrial operation sites.

Northern communities are eager for solutions to remedy their dependence on fossil fuel for electricity generation and heating. Despite the scope of initiatives deployed thus far, the local governments and communities sometimes need technical assistance in implementing their strategies, particularly when deeper technical knowledge is required but lacking locally. By leveraging local talent (colleges, industry associations, territorial government departments, community staff, etc.), it is possible to accelerate the adaptation of existing technologies and the development of new systems through targeted R&D. The deployment of renewable energy technologies in the North would therefore be possible on a larger scale. Targeted and sensible actions inspired by local priorities and facilitated by local stakeholders will contribute to keeping significant financial resources in the North – which are currently flowing down South for the purchase of expensive fossil fuel and, at times, misfit technologies for northern applications.

CLARIFICATION ON TERMINOLOGY

There is ample confusion in the general literature and in policy documents regarding the appropriate terminology for "northern and remote" communities. Federal, provincial and territorial documents and reports from the private sector each seem to adopt a specific term or definition that best fits the need of the moment.

Canada's Northern Strategy speaks about "remote and isolated communities". Essentially, the Strategy refers to the three Canadian territories plus the community of Churchill in Manitoba, the communities located in Nunavik in Northern Quebec, and a few remote locations in Labrador. Map 1 (right) shows the areas and locations of the communities considered in Canada's Northern Strategy.



Map 1. North – Canada's Northern Strategy

For the purpose of the ***Government of Canada Program for the International Polar Year***[4], the North was defined as the three territories along with the northern regions of some provinces that fall north of the isolated permafrost limit.

The seven provinces included in the definition are British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec and Newfoundland and Labrador. Altogether, the three territories and the northern portions of these provinces represent a little less than two-thirds of Canada's landmass. The North is roughly defined as the area located above the dark line in Map 2 (right).

Map 2. North – Northern Development Ministers Forum

The ***Northern Development Ministers Forum***[5], for its part, defines the North as the three territories and the northern extent of seven provinces: British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, and Newfoundland and Labrador. Unfortunately, the Forum does not have a

[4] "The Government of Canada Program for International Polar Year – Highlights and Achievements." AANDC, 2011.

[5] http://www.focusnorth.ca/english/about_us.php

map showing the referenced areas, but the definition appears to include vast areas below the permanent frost line.

The ***Centre for the North***[6], a Research Centre within the Northern and Aboriginal Policy knowledge area at the Conference Board of Canada, defines the North as including the three territories and the northern extents of seven provinces. In their approach, they claim that the North/South boundary line was selected based on Statistics Canada's defined economic regions and census division. According to them, the resulting line shown in Map 3 (right), corresponds closely to the definition of the North used by the Northern Development Ministers Forum. This definition of the North is much broader than the one contained in Canada's Northern Strategy as it includes about 60% of the province of British Columbia, 50% of Alberta and Saskatchewan, 75% of Manitoba, almost all of Ontario, 80% of Quebec and all of Labrador.

Map 3. North – Centre for the North

Aboriginal Affairs and Northern Development Canada (AANDC) and ***Natural Resources Canada*** (NRCan) once referred interchangeably to "off-grid community" and "remote community" in reference to "any community not currently connected to the North-American electrical grid nor to the piped natural gas network; and is a permanent or long-term (5 years or more) settlement with at least 10 dwellings."[7] The study includes all the communities in the three territories plus about 200 other communities in 7 provinces (British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, and Newfoundland and Labrador). This concept is broader than what is considered under Canada's Northern Strategy but not as extensive as what is included by the Centre for the North.

When referencing the North, we are clearly faced with a moving target depending on the policy or program under consideration. Even within the same department, over the years, there has been no continuity of thought in this regard. The following terms are those that are most frequently used:

- Remote community
- Isolated community
- Northern community
- Arctic community
- Off-grid community
- Aboriginal and northern community

[6] http://www.conferenceboard.ca/networks/cfn/default.aspx

[7] "Status of Remote/Off-Grid Communities in Canada – August 2011", M154-71/2013E-PDF 978-1-100-22428-2.

- Aboriginal and isolated community
- Aboriginal and remote community
- Etc.

Combinations of the above terminologies are also found in various documents – each used to characterize a specific situation or reflect a particular concern or issue.

For the purpose of this report, we have elected to retain the definition set in Canada's Northern Strategy. Essentially, the Strategy refers to Yukon, the NWT, Nunavut, the community of Churchill in Manitoba, Nunavik (part of Northern Québec) and Nunatsiavut (part of Labrador) as a definition of the North.

We could even further divide these five regions into two subgroups:

1. Nunavik and Nunatsiavut (which are regions within their respective provinces of Quebec and Newfoundland & Labrador), and
2. Yukon, the NWT and Nunavut (which are more dependent on federal transfers for their social and economic organization).

Nunavik and Nunatsiavut can rely on the extensive resources – both financial and technical – of Quebec and Newfoundland & Labrador. Concerns about energy supply and demand and energy efficiency within the communities are dealt with by utilities in the two provinces. These utilities can rely on their extensive customer base to finance and provide energy efficient solutions to their communities.

The situation is different in Yukon, the NWT and Nunavut where resources – again, both financial and technical – are scarce and overall capacity is limited. Therefore, in order to better characterize the markets for the development of a Northern Communities Energy Technology Intervention Strategy, the core of this document focuses on the second group. A short presentation of Nunavik and Nunatsiavut is nevertheless provided, but mainly for comparative purposes.

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INTRODUCTION

Most communities in the North are small – which could be seen as a handy comparative factor – but their situations are not necessarily homogeneous, and neither are their community structures and priorities. As a consequence, there is no one-size-fits-all solution to improve energy efficiency and conservation. Although many communities also share the goal of reducing their reliance on diesel not only for electricity generation but also for heating, the approach to introduce or deploy new technologies and Demand Side Management (DSM) solutions and options will vary.

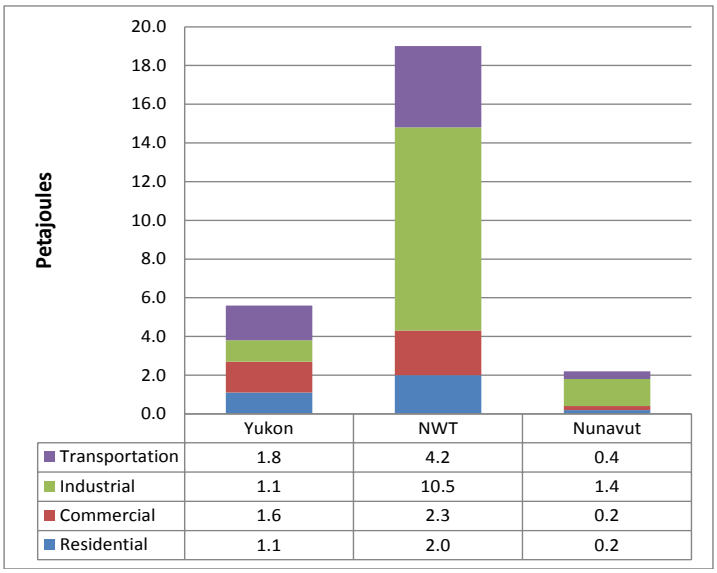
For example, energy efficiency solutions in housing will not necessarily be deployed in the same manner in privately owned houses or in rented private or public housing. Incentives to adopt energy efficient measures could depend on who owns the house (when investment in infrastructure is required – e.g. insulation) or on who pays the energy bills. A split incentive approach could be explored in many cases. This strategy is not different than what could be done in other regions in Canada except that in some northern communities, the proportion of rented houses is much higher than in others, potentially leaving room for more strategic and organized interventions. And obviously, territorial housing corporations are important stakeholders who must be consulted and formal cooperation must be established prior to attempting to deploy any specific technology.

Technology deployment in support of energy production infrastructures and DSM measures will also depend on a variety of technical factors but also on energy supply options (local resources availability). Electricity rates are also a key factor to consider for the introduction of most measures, as we will see later in this report. Since many communities are not connected to electricity grids (mostly in the NWT and Nunavut), the motivations to adopt renewable energy technologies such as solar, wind or biomass will largely depend on specific situations – often at the community level rather than territorial – although targeted energy policies are essential. The existence (or not) of a feed-in-tariff, net metering or net billing policies and programs will also influence the interest towards various types of renewable energy.

In Yukon, most communities have year-round road access and the vast majority of the population has access to relatively cheap hydroelectricity at rates lower than those in Ontario and most Canadian provinces. In the NWT, 16 communities out of 33 do not have all-weather access roads and four do not even have winter access roads. In the latter cases, supply is either flown in year-round or delivered via marine re-supply facilities. One community has neither road nor marine access. In Nunavut, there is no road system between communities and most of them receive their supplies via air transportation or by boats. This is also the case in Nunavik, in northern Quebec, and for Nunatsiavut, in Labrador.

Generally speaking, aggregate basic information comparing the three territories is available through Statistics Canada. Information for Nunavik and Nunatsiavut is more scattered. Nunavik and Nunatsiavut are regional governments within the global governance of their respective province (i.e. Quebec and Newfoundland & Labrador). Specific regional figures are not produced by Statistics Canada. Furthermore, energy supply considerations are very small subsets of broader provincial resources management programs. However, their reliance on diesel for electricity generation is a common characteristic of other isolated communities which are mostly found in the NWT and in Nunavut. In this context, some analytical parallels do exist.

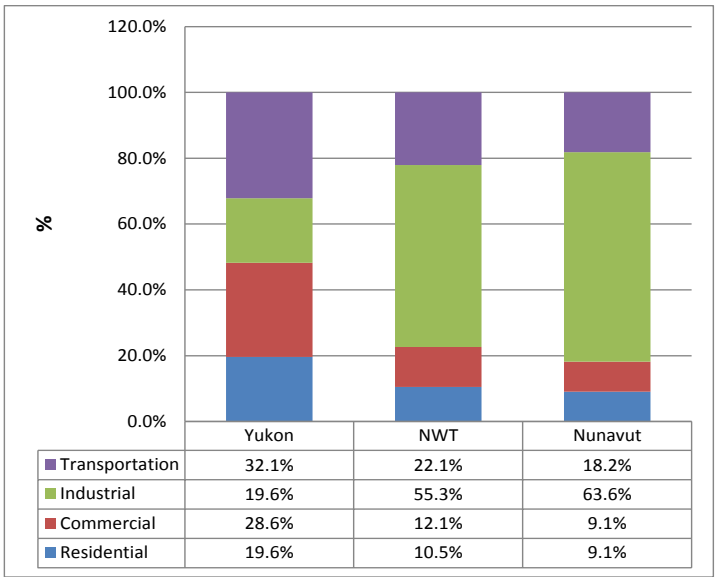
End-use energy demand[8] shows important differences between the three territories. In Yukon, the split between transportation, industrial, commercial and residential is in the 20-30% range. Industrial applications account for 55% in the NWT and for 64% in Nunavut. These figures must however be interpreted with great care. For instance, the closing or the opening of a single mine in these regions could create important swings (up and down) in energy demand from one year to the next. It is therefore imperative to have a good knowledge of what drives the demand, and whether this demand will be sustained (or not) over time. It is indeed pointless to consider R&D to address specific energy needs if these needs are likely to disappear after only a few years.



	Yukon	NWT	Nunavut
Transportation	1.8	4.2	0.4
Industrial	1.1	10.5	1.4
Commercial	1.6	2.3	0.2
Residential	1.1	2.0	0.2

Figure 1. End-Use Energy Demand (PJ) – 2013

The electricity production profiles of the three territories show major differences in natural resources endowments as well as in the types of production facilities.[9] Yukon boosts a very high level of hydroelectricity at 94.7% of electricity supply in the territory. Other than hydroelectricity, there is currently very little renewable energy in the North. Wind power is just emerging in Yukon with a tiny production of 277 MWh in 2013. This technology is more developed in the NWT with a production of 19,854 MWh in 2014, although it was essentially generated by one unit installed at the Diavik mine. Solar is emerging slowly in the NWT with about 112 MWh produced in 2013. Nunavut was 100% diesel in 2014, but some solar devices have since been installed.



	Yukon	NWT	Nunavut
Transportation	32.1%	22.1%	18.2%
Industrial	19.6%	55.3%	63.6%
Commercial	28.6%	12.1%	9.1%
Residential	19.6%	10.5%	9.1%

Figure 2. End-Use Energy Demand (%) – 2013

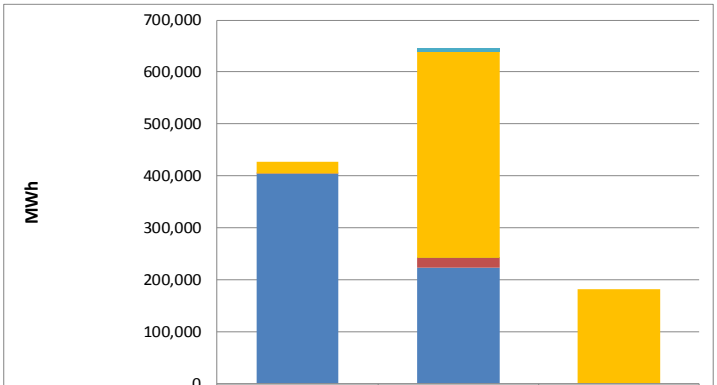
These global electricity production figures need to be interpreted while taking the context into consideration. For instance, at first glance Yukon may seem blessed with abundant hydroelectric supply available for its citizens, yet – in reality – some communities still rely exclusively on diesel. The expansion of transmission lines in absence of a

[8] "Canada's Energy Future 2013 - Energy Supply and Demand Projections to 2035 - Appendices." National Energy Board. https://www.neb-one.gc.ca/nrg/ntgrtd/ftr/2013/ppndcs/ppndcs-eng.html. Site consulted on May 6, 2015.

[9] http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=1270002. Consulted May 6, 2015. According to the Canadian Wind Energy Association (http://canwea.ca/wind-energy/installed-capacity/). Solar generation figures for the NWT are for 2013. Yukon has 0.8 MW of installed wind capacity and the Northwest Territories 9.2 MW. The NWT has some solar electricity production but data is not available at this time. Wind production for Yukon come from: Yukon Bureau of Statistics, Yukon Energy Facts 2013.

major industrial customer is often cost prohibitive and these communities need to fall back on other individual or integrated energy/electricity options.

Figure 3 presents total electricity supply including self-produced electricity by industrial and mining facilities. For the NWT, taking into consideration distributed electricity only, we find that 68% comes from hydraulic sources and 32% from thermal sources. However, Yellowknife alone accounts for 46% of distributed electricity in the NWT and is supplied with hydroelectricity. In the NWT, 23 out of 33 communities rely exclusively on diesel production, while 2 others on a combination of natural gas (trucked-in LNG) and diesel. These 25 communities represent about 32% of the population spread in communities of 500 individuals on average.



	Yukon	NWT	Nunavut
Combustion Turbine	0	6,196	0
Internal Combustion	22,601	396,727	181,280
Solar	0	112	0
Wind	277	19,854	0
Hydraulic	404,937	222,982	0

Figure 3. Electricity Production – 2014

Different resources endowment – and their economic accessibility – is directly reflected in electricity rates. Table 1 illustrates the situation for basic residential electricity supply in various distribution areas in the North.

Table 1. Sample Electricity Rates in Northern Canada[10]

		Residential Electricity Rate ($ / kWh)		
		Tier 1	Tier 2	Tier 3
	Monthly Charge	Up to 1000 kWh / month *	1000 to 2500 kWh / month	Over 2500 kWh / month
Yukon	$16.25	$0.1087	$0.1442	$0.1572
NWT - NTPC - Diesel **	$18.00	$0.2853	$0.5728	$0.5728
NWT - NTPC - Hydro	$18.00	$0.1977	$0.1977	$0.1977
NWT - NUL - Hydro - T	$18.00	$0.2721	$0.2721	$0.2721
NWT - NUL - Hydro - S	$18.00	$0.2372	$0.2372	$0.2372
NWT - NUL - Diesel	$18.00	$0.6710	$0.6710	$0.6710
Nunavut ***	$18.00	$0.8444	$0.8444	$0.8444
Nunavik	$12.19	$0.0557	$0.3364	$0.3364
Nunatsiavut	$7.15	$0.0328	$0.1604	$0.1604

(*) In Nunavik, 900 kWh / month (30 kWh / day / month)

In Nunatsiavut, Tier 1 is set between 700 and 1000 kWh / month depending on the seasons.

(**) In the NWT, there are some additional local variations in places like Norman Wells and Yellowknife.

(***) Average rate for all communities. Prices range from $0.6029 in Iqaluit to $1.1416 in Kugaaruk.

[10] Data compiled by CanmetENERGY-Varennes from rate schedules from Yukon Energy Corporation, Northwest Territories Power Corporation, Northland Utilities (NWT), Qulliq Energy Corporation, Hydro-Québec and Newfoundland & Labrador Hydro.

Not surprisingly, with its large hydro-based supply, Yukon has the lowest rates of the three territories. Nunavik and Nunatsiavut are special cases: their rates are highly subsidized (as a provincial policy) and supported by the large customer bases in Quebec and Newfoundland & Labrador. As we will see later in this report, Nunavut, relying entirely on diesel for electricity generation, has high rates in all communities, sometimes over $1/kWh. Given the context – and considering the wide-ranging electricity rates – some technologies that would not make economic sense in Yukon could well be attractive in some communities in the NWT and most of Nunavut.

As mentioned earlier, comparisons between territories or between communities within the same territory are not linear and as such, the energy and technology solutions will not be linear either. Hence the necessity to look at some key market characteristics which are essential to designing and building a differentiated framework for the purpose of developing an energy technology intervention strategy that will apply to all the concerned communities – not just capital cities or grid-connected communities.

As an initial effort to better understand territorial priorities and challenges, we reviewed all the territorial energy strategies and plans of the past ten years or so. Key components are summarized for every territory at the end of each section discussing individual territorial situations. The report then reviews parameters such as community profiles, electricity production, electricity distribution and rates, status of renewable energy, labour force capacity building, education and regional R&DD, status of the mining industry as well as telecommunication connectivity and access. Although not comprehensive, a careful analysis of these parameters is minimally required to define a framework that will reflect the future energy markets in the North.

I. YUKON

1. ENERGY POLICY CONTEXT

Energy Strategy for Yukon was released in 2009[11]. A summary of the current energy strategy is presented at the end of this section. Its intent is to complement and be coordinated with the government's ***Climate Change Strategy and Action Plan***[12], also released in 2009. The Energy Strategy focuses on four priorities:

- Conserving energy and using it more efficiently
- Increasing the supply and use of renewable energy
- Meeting current and future electricity needs
- Managing responsible oil and gas development

Since the adoption of its Energy Strategy, the Yukon has implemented a comprehensive but relatively traditional suite of energy efficiency programs as showed in a strategy status report published in 2012.[13] It has worked with the two electric utilities to develop a DSM strategy for homeowners and businesses with the goal of generating 8.5 GWh/year in electricity savings by 2018. These programs are supported by pilot projects and energy efficiency awareness initiatives. The Energy Solutions Centre, Yukon Housing and Yukon College's Yukon Research Centre continue to work with federal, territorial and provincial partners to research energy efficient technologies for houses in cold climates.

> *"On January 6, 2015, Yukon broke the all-time record in Yukon for electricity consumed at any one time. They were generating with 83.69 megawatts capacity at that point. This broke the previous record of 83.43 megawatts set on December 18th, 2013. Of that 83.69 megawatts produced, 12.4 was with diesel."*
>
> ***Yukon Energy press release – January 5, 2015***

2. ENERGY AND ELECTRICITY MARKETS

Electricity rates in Yukon are relatively low compared to the NWT and Nunavut. In fact, homeowners are essentially subject to electricity rates comparable to what they would pay in New Brunswick or Newfoundland. For homeowners, since their electricity rates are relatively low and fully harmonized in all communities, energy efficiency concerns (incentive to conserve energy and payback) are comparable to what they are in some Canadian provinces in the South. However, isolated homes located outside the territorial electrical grid or outside the remote communities' microgrids must generate their electricity with diesel and therefore, owners have a strong incentive to find cheaper, cleaner – but at the same time comparatively reliable – alternative technologies. The number of such isolated homes is not known at this time, but the number of isolated communities is small compared to the NWT and Nunavut, and

[11] "Energy Strategy for Yukon." Government of Yukon, January 2009.

[12] "Yukon Government Climate Change Action Plan." Government of Yukon, February 2009.

[13] "Energy Strategy for Yukon – Progress Report 2012." Government of Yukon, 2012. A new progress report on the strategy is expected sometimes in 2015. The publication of the progress report will be an opportunity to review what was accomplished and assess what remains to be done.

also Nunavik and Nunatsiavut. However, the situation still represents a significant territorial-wide policy concern.

This being said, there exists a strong incentive for the electricity generator/distributor to find alternatives to diesel-based electricity production. Although the direct costs related to such production are rolled into the overall territorial rate base – and the costs passed on to all consumers – savings could potentially be rewarded by reducing the marginal acquisition or production electricity costs. Technologies meant to optimize diesel electricity production or facilitate their integration with alternative energy could be deployed more broadly by working with both Yukon Energy and Yukon Electrical.[14]

Yukon Energy is a wholly-owned subsidiary of the Yukon Development Corporation (YDC), a territorial Crown Corporation. It produces and transmits most of Yukon's electricity. It also sells power directly to some retail customers. ATCO Electric Yukon buys electricity from Yukon Energy and then sells it to customers. ATCO Electric Yukon is a privately-owned company and a subsidiary of the ATCO Corporation in Alberta.

Established in 1987, Yukon Energy operates as a business, at arm's length from the Yukon Government. Yukon Energy directly serves about 1,700 customers, most of whom live in and around Dawson City, Mayo and Faro.

Yukon Energy has the capacity to generate approximately 132 MW of power. Of that total, 92 MW are provided by hydro facilities in Whitehorse, Mayo and Aishihik Lake (40 MW at Whitehorse, 37 MW at Aishihik and 15 MW at Mayo), 39 MW by diesel generators (which are currently only use as back-up) and 0.8 MW by two wind turbines located on Haeckel Hill near Whitehorse.

ATCO Electric Yukon has been providing electrical service to Yukoners for over a century. Since then, ATCO Electric Yukon has grown to serve over 17,000 customers in 19 communities from south of the Yukon border to north of the Arctic Circle.

ATCO Electric Yukon generates and distributes its own electricity in Old Crow, Beaver Creek, Destruction Bay, Burwash Landing, Upper Liard, Lower Post, Watson Lake and Swift River. In addition to the fossil fuel-fired generation plants, ATCO Electric Yukon also owns and operates the Fish Lake Hydro plant on the outskirts of Whitehorse. Built in 1950, the 1.3 MW Fish Lake hydro

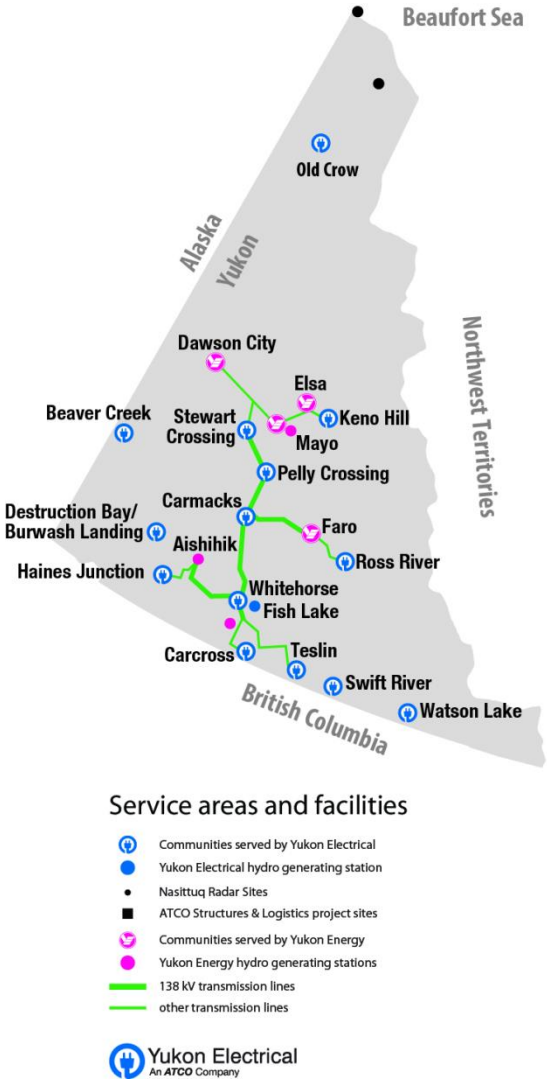


Figure 4. Electricity Distribution Network - Yukon

[14] Section I.3 of this report provides key parameters on micro-generation policy as well as independent power production policy in Yukon.

plant remains a steady contributor of power to the Yukon Interconnected System. ATCO Electric Yukon purchases power from Yukon Energy Corporation for distribution to its customers in Whitehorse, Marsh Lake, Tagish, Teslin, Haines Junction, Carmacks, Stewart Crossing, Pelly Crossing, Carcross, Keno, and Ross River. Other ATCO Electric Yukon service areas include Canyon Creek, Deep Creek, Takhini River Crossing as well as a variety of rural areas north, south, and west of Whitehorse.

The electrical grid in Yukon is composed of one larger hydro-based grid called the Yukon Integrated System, one medium-sized diesel-based grid serving Watson Lake and four smaller isolated sites with diesel generation (Old Crow, Beaver Creek, Destruction Bay – Burwash Landing, and Swift River). The Yukon grids are not connected to the North American grid.

Electricity rates throughout Yukon are regulated and approved by the Yukon Public Utilities Board. As illustrated in Table 2 at the end of this section, residential non-government rates are fully harmonized in all communities – with the exception of Old Crow where rates are about twice as high as those of other communities (for every kWh consumed over 2,500 kWh per month).

3. RENEWABLE ENERGY

Over 95% of Yukon's electricity is produced by means of renewable energy (mainly hydro), while 20% of the heating demand is met by renewable wood-based heating. Yukon Energy Corporation is evaluating the economic viability of other renewable energy technologies, including wind, solar, biomass and geothermal energy. The economic viability of these technologies must be proven to the Yukon Utilities Board before proceeding with project development.[15]

Growing demand for electricity in the residential, commercial and industrial sectors has prompted the expansion of a major dam in Yukon and the connection of the two existing grids to further supplement the extensive hydroelectric regime. However, there appears to be flexibility and room for alternative supply.

The 2009 strategy called for the development of policy to allow private citizens, First Nation communities, municipalities and businesses to contribute to adding new forms of clean electrical generation to the grid through the development of net metering and independent power production policies. The Government of Yukon issued a Micro-Generation Policy[16], in October 2013, and an Independent Power Production Policy[17], in May 2014.

The Micro-Generation Policy (MGP) states that eligible energy sources are limited to renewable technologies, which generally include wind power, micro-hydro, biomass, and solar systems. The capacity of the projects is limited to 5 kW for customers on a shared transformer, and less than 25 kW for customers on a single transformer. Generation capacity between 25 kW and 50 kW will be considered on a case-by-case basis. The program will reimburse customers for the amount of electricity exported to the grid at a rate reflective of the avoided cost of new generation in the territory. At the

[15] In all Territories, utilities must comply with their respective energy board requirements. This restriction adds a layer of complexity for the federal government in the promotion of alternative energy and technologies. Any pilot project, if financed by a local utility, must be "approved" by the energy board since the costs will ultimately be reflected in the rate base. In this context, a good understanding of local priorities is crucial and input into the rate hearing processes necessary in most cases.

[16] "Energy Strategy for Yukon – Micro-Generation Policy." Yukon Energy, Mines and Resources, October 23, 2013.

[17] "Energy Strategy for Yukon – Independent Power Production Policy." Yukon Energy, Mines and Resources, May 20, 2014.

time the program was released, the incentive rate for electricity exported to the grid was set to $0.21/kWh on the Yukon's Integrated System (YIS), and to $0.30/kWh in electrically-isolated communities powered by diesel generation. Electricity produced for self-consumption will not receive the incentive – only the electricity exported to the grid will receive a production incentive.

The Independent Power Production Policy (IPPP) is meant to facilitate the purchase of electricity from independent power producers, and calls for the replacement of imported diesel fuel with Yukon's oil and gas resources. The IPPP does not apply to customers covered under the MGP. The IPPP is divided in two tiers. Tier 1 is for smaller projects that will fall under a Standing Offer Program envelope. Projects are limited to 2 MW in the Yukon Integrated System grid and to 300 kW in the Watson Lake grid. Tier 2 applies to projects larger than the limits set for tier 1 or any systems installed in the four isolated communities. Tier 2 projects will be assessed on a case-by-case basis by the utilities and an Agreement to Purchase Power will require approval by the Yukon Utilities Board. Under Tier 1, eligible energy sources projects are limited to local renewable sources which generally include wind, hydro, geothermal, biomass, and solar. Tier 2 projects are limited to the same local renewable as set for Tier 1 or diesel off-setting sources such as natural gas.

New technologies will be considered as part of the review of the policy which will occur two years from the date of the Yukon Utilities Board approval of the Tier 1 Standing Offer Program. However, electricity-generating technologies and energy sources must be proven to be reliable before being accepted for interconnection to Yukon's electrical grid. IPP rates offered for energy delivered are set to $0.30/kWh in the diesel rate zones, to $0.64/kWh in the Old Crow rate zone, and to $0.21/kWh in the hydro rate zone. In addition to these two policies that are favourable to the development of alternative and renewable electricity generation, Yukon is also pursuing the development of the wood pellet market and the consumption of locally available cordwood remains strong. As a step towards greater use of biomass in Yukon, the government recently released a draft ***Yukon Biomass Energy Strategy***[18]***.*** The draft biomass strategy suggests six key action areas:

- Using biomass energy for government infrastructure.
- Developing regulations, policies and programs for a biomass energy industry.
- Managing air quality to protect public and environmental health and safety.
- Facilitating the development of a biomass energy industry in Yukon.
- Ensuring a sustainable timber supply.
- Ensuring biomass fuel quality and security.

The document strictly focuses on biomass for heating – mainly through the increased use of pellets. There is no mention of biomass gasification. Since all the fossil fuels used in Yukon are imported, this strategy aims at reducing the reliance on heating oil for heating purposes within the territory.[19]

[18] Yukon Biomass Energy Strategy. Draft for Public Consultation. Department of Energy, Mines and Resources, Government of Yukon, April 27, 2015.

[19] "Energy Strategy for Yukon." Government of Yukon, January 2009.

4. ENERGY STRATEGY FOR YUKON

Priorities for Efficiency and Conservation

- Increase energy efficiency in Yukon by 20% by 2020.
- Reduce energy consumption in Yukon buildings.
- Reduce energy consumption for transportation in Yukon.
- Promote the use of energy efficient products by providing incentives for products that meet energy performance standards.
- Improve energy efficiency for Yukon Government operations.

Priorities for Renewable Energy

- Increase renewable energy supply in Yukon by 20% by 2020.
- Develop a policy framework for geothermal energy.
- Support and demonstrate renewable energy projects in communities off the electrical grid to reduce diesel use.
- Conduct pilot studies to assess the feasibility of renewable energy initiatives.
- Promote renewable energy sources for heating and transportation.

Priorities for Electricity

- Support strategic investments in infrastructure to increase the supply of electricity from renewable sources.
- Assess the feasibility of expanding the Yukon transmission system to connect to other communities, industrial projects or jurisdictions.
- Update and develop a policy framework for electricity that emphasizes efficiency, conservation and renewable energy.
- Develop and implement demand management programs and incentives to promote energy efficiency and conservation.
- Support research and development of technologies and policies to optimize the use of hydroelectricity.
- Consider appropriate roles, responsibilities, and corporate structure for Yukon Development Corporation and Yukon Energy Corporation to ensure effective management and operation, and optimize the efficiency and reliability of electricity generation and distribution.

Priorities for Oil and Gas

- Support strategic opportunities to replace imported diesel fuel with Yukon's oil and gas resources.
- Develop a competitive and comprehensive oil and gas regulatory regime which will emphasize performance-based compliance.
- Prepare for northern pipeline development such as the Alaska Highway Pipeline.
- Promote private sector investment in the development of Yukon's oil and gas resources.
- Finalize and implement an agreement with the federal government for sharing management and revenues for offshore oil and gas.

Table 2. Electricity Sources and Rates by Community – Yukon[20]

YUKON

				2012						Electricity Rates ($ / kWh) Residential (non-government)		
	Communities	Pop.	Electricity Source	Cost per litre ($)	Generation (MWh)	Net Heat Rate (kWh/litre)	Litres consumed	Litres per capita	Monthly Charge	up to 1000 kWh	1000 to 2500 kWh	over 2500 kWh
1	Beaver Creek	100	Small diesel	$ 1.1259	1,897	3.52	539,000	5,390	$ 16.2500	$ 0.1087	$ 0.1442	$ 0.1572
2	Burwash Landing	85	Small diesel	n/a	n/a	n/a	n/a	n/a	$ 16.2500	$ 0.1087	$ 0.1442	$ 0.1572
3	Carcross	289	Hydro	-	-	-	-	-	$ 16.2500	$ 0.1087	$ 0.1442	$ 0.1572
4	Carmacks	503	Hydro	-	-	-	-	-	$ 16.2500	$ 0.1087	$ 0.1442	$ 0.1572
5	Champagne	24	Hydro	-	-	-	-	-	$ 16.2500	$ 0.1087	$ 0.1442	$ 0.1572
6	Dawson City	2,000	Hydro	-	-	-	-	-	$ 16.2500	$ 0.1087	$ 0.1442	$ 0.1572
7	Destruction Bay	51	Small diesel	$ 1.1238	1,996	3.68	542,000	10,627	$ 16.2500	$ 0.1087	$ 0.1442	$ 0.1572
8	Elsa	336	Hydro	-	-	-	-	-	$ 16.2500	$ 0.1087	$ 0.1442	$ 0.1572
9	Faro	344	Hydro	-	-	-	-	-	$ 16.2500	$ 0.1087	$ 0.1442	$ 0.1572
10	Haines Junction	593	Hydro	-	-	-	-	-	$ 16.2500	$ 0.1087	$ 0.1442	$ 0.1572
11	Johnson's Crossing	15	Hydro	-	-	-	-	-	$ 16.2500	$ 0.1087	$ 0.1442	$ 0.1572
12	Keno	15	Hydro	-	-	-	-	-	$ 16.2500	$ 0.1087	$ 0.1442	$ 0.1572
13	Marsh Lake	620	Hydro	-	-	-	-	-	$ 16.2500	$ 0.1087	$ 0.1442	$ 0.1572
14	Mayo	226	Hydro	-	-	-	-	-	$ 16.2500	$ 0.1087	$ 0.1442	$ 0.1572
15	Old Crow Settlement	245	Hydro/Diesel	$ 2.1470	2,136	3.45	618,000	2,522	$ 16.2500	$ 0.1087	$ 0.1442	$ 0.3433
16	Pelly Crossing	291	Hydro	-	-	-	-	-	$ 16.2500	$ 0.1087	$ 0.1442	$ 0.1572
17	Ross River	352	Hydro	-	-	-	-	-	$ 16.2500	$ 0.1087	$ 0.1442	$ 0.1572
18	Stewart Crossing	25	Hydro	-	-	-	-	-	$ 16.2500	$ 0.1087	$ 0.1442	$ 0.1572
19	Swift River	14	Small diesel	$ 1.0401	233	2.77	84,000	6,000	$ 16.2500	$ 0.1087	$ 0.1442	$ 0.1572
20	Tagish	391	Hydro	-	-	-	-	-	$ 16.2500	$ 0.1087	$ 0.1442	$ 0.1572
21	Teslin	122	Hydro	-	-	-	-	-	$ 16.2500	$ 0.1087	$ 0.1442	$ 0.1572
22	Upper Liard	178	Large diesel	n/a	n/a	n/a	n/a	n/a	$ 16.2500	$ 0.1087	$ 0.1442	$ 0.1572
23	Watson Lake	802	Large diesel	$ 0.9711	15,024	3.80	3,957,000	4,934	$ 16.2500	$ 0.1087	$ 0.1442	$ 0.1572
24	Whitehorse	23,276	Hydro	-	-	-	-	-	$ 16.2500	$ 0.1087	$ 0.1442	$ 0.1572
		30,897			21,286		5,740,000					

[20] Data compiled by CanmetENERGY-Varennes from various sources including current electricity rate schedules from Yukon Energy Corporation and Yukon Electrical.

II. NORTHWEST TERRITORIES

1. ENERGY POLICY CONTEXT

The NWT approach towards energy management is articulated in a series of energy plans and greenhouse gas strategies released since 2001. Energy priorities and specific initiatives and investments are stated in the ***Northwest Territories Energy Priorities Framework*** [21].

The ***NWT Energy Priorities Framework*** was released in 2008 out of concern for the rising cost of energy, reliance on imported fuels, and exposure to world oil prices. The framework established three priorities:

- Pursue initiatives that reduce the cost of living, and in particular, energy costs
- Work proactively with residents, communities and industry on mitigation of climate change
- Advance alternative energy initiatives

A first ***NWT Greenhouse Gas Strategy*** was released in 2001. The focus of this Strategy was to identify and coordinate northern actions to begin to control greenhouse gas emissions and assist in developing and contributing a northern perspective as part of Canada's national climate change implementation strategy. A revised strategy was released in 2007, which set a target for the Government of the Northwest Territories (GNWT) to reduce by 10% greenhouse gas emissions from its own operations (below 2001 levels) by the year 2011. It also contained 39 initiatives covering all sectors in the NWT.

A Greenhouse Gas Strategy for the Northwest Territories 2011-2015 [22] was released in August, 2011. The 2011-2015 Strategy was prepared through a broad consultation including multi-stakeholder meetings and public consultations held in 12 communities. The 2011-2015 Strategy is the product of the views and values voiced by many individuals and organizations as well as lessons learned during the 10-year deployment of the previous 2 strategies.

The 2011-2015 Strategy discusses plans for increasing renewable electrical generation capacity in the NWT, including hydro, wind, solar, geothermal and biomass power. In the Strategy, the NWT's GHG emissions target was meant to stabilize emissions at 2005 levels by 2015; to limit emission increases to 66% above 2005 levels by 2020; and to bring emissions back to 2005 levels by 2030.

In conjunction with the series of GHG strategies, the GNWT also produced comprehensive energy plans. ***Energy for the Future – An Energy Plan for the Northwest Territories (2007)*** [23] builds on the previous energy plan released in 2003, and summarizes the guiding principles for future framework and specific strategies while focusing on five areas:

- NWT energy development and supply
- Energy conservation and efficiency
- Alternative energy and emerging technologies
- Energy use reduction in GNWT assets
- Energy policy and planning

[21] "Energy Priorities Framework." Government of the Northwest Territories – Ministerial Energy Coordinating Committee, October 2008.

[22] "A Greenhouse Gas Strategy for the Northwest Territories 2011-2015." Government of the Northwest Territories, 2011.

[23] "Energy for the Future – An energy Plan for the Northwest Territories." Government of the Northwest Territories, March 2007.

The last of the energy plan series, ***The Northwest Territories Energy Action Plan – A Three-Year Action Plan and a Long-Term Vision*****,** was released in December, 2013. The plan includes 33 distinct actions and expands on previous priorities in areas such as energy conservation and efficiency, hydro development, biomass, solar and wind. In addition, the new energy plan also includes actions for liquefied natural gas and innovation (including geothermal energy and alternative energy technology). A snapshot of the plan is provided at the end of this section.

In 2012, the GNWT organized the ***first NWT Energy Charrette*** to bring together NWT representatives and energy experts to discuss the territory's energy issues and identify solutions. The GNWT used the results from the 2012 Charrette to inform the development of the NWT Energy Action Plan, and the NWT Power Corporation used the input to help prepare the NWT Power System Plan, both of which were released in 2013.

> *"The same drought conditions that contributed to this being one of the worst forest fires years in history, is also responsible for low water on the Snare system. Water levels at Snare are at a 64-year low and prompted the Corporation to apply for a 3.7 cent rate rider to cover the additional 16 million litres of fuel it anticipates burning up until June 2015 – at a cost of about $20 million."*
>
> ***J. Michael Miltenberger, Report on the Northwest Territories Power Corporation, October 20, 2014***

The current extreme low-water situation on the Snare River hydro-electric system – and the upward estimated capital cost of implementing the NWT Power System Plan – led the GNWT to reconsider what else it could be doing to make the NWT's energy system more affordable and sustainable in the long term. Furthermore, several new, large mines have been constructed in the NWT in recent years. While these operations rely on diesel for heat and power, some may be potential consumers for future renewable energy projects, particularly hydro and wind. The government is also interested in pursuing the deployment of wind-diesel hybrid systems.

To address these new challenges, a Charrette was organized in November, 2014. The ***2014 NWT Energy Charrette***[24] was organized in two parts: a public event was held on November 3, and an invitational stakeholders meeting took place on November 4. Overall, "affordability" was considered the most important objective. Three other objectives – "environment", "economy" and "energy security" – were ranked fairly closely together. A number of actions for the short term and the longer term were also identified by participants.

Short-term issues focused on the concept of thermal communities, the continuation of the biomass energy efforts, and the deployment of small-scale renewable energy projects. Longer-term issues (i.e. in the 2-5 year range) focused on regulatory and policy related issues such as the implementation of the NWT *Energy Efficiency Act*, and energy supply projects at the community and regional levels. Issues also included the rationalization of energy policy to focus on clear objectives, and the incorporation of the portfolio approach that uses multiple scales and multiple energy sources and technologies.

After the Charrette, the GNWT sought additional public input on the contents of the Report and energy issues in general. After considering the options and solutions suggested in the Report, the GNWT released its Response on June 4, 2015. The NWT have now entered the third and final year of their 2013 Energy Action Plan. With little time left before the next territorial election, scheduled for the fall of 2015, the Response details short-term actions already included in the current Energy Action Plan as well as longer term, transformative projects for the consideration of the next Legislature.

[24] "2014 Northwest Territories Energy Charrette – Charrette Final Report." Prepared by R. Marshall & Associates, December 2014.

A first action already came into effect before the release of the Response. The decision to consolidate all government energy functions within the Department of Public Works and Services (PWS) was announced and became effective April 1, 2015. Energy policy and programs are now under a single Minister.

Short-term focus is placed on energy efficiency and conservation with consideration given to the following priorities:

- Releasing a discussion paper on a NWT *Energy Efficiency Act* in the fall of 2015.
- Encouraging the use of renewable energy in industrial development.
- Focusing on energy information and awareness through increased promotional and information campaigns.
- Compiling energy data to support community energy profiles.
- Releasing a discussion paper on legislative changes to allow for the use of local improvement charges to support residential energy efficiency improvements.
- Re-profiling internal funding in 2015-16 to ensure continued support for community government energy efficiency retrofits.

With solar and biomass strategies in place, the GNWT intends to continue focusing on local alternative and renewable energy. Short-term priorities include:

- Supporting the wood pellet manufacturing industry in the NWT, primarily through an agreement to purchase made-in-the-NWT wood pellets, once a NWT based project is operational.
- Amending the net metering policy to direct the Public Utilities Board to allow municipal governments to be eligible for the program.
- Confirming a $700,000 contribution to the Northwest Territories Housing Corporation in 2015-16 to install solar PV on new and existing buildings.
- Wind monitoring work in Inuvik and in the Yellowknife/Snare region.
- Addressing the issues with the Snare hydro system. In order to start doing so, analysis will be undertaken to look at a range of potential power options including an LNG generating station in Yellowknife, a capacity addition to the Bluefish hydro station, upgrades to the Jackfish diesel plant, a 10 MW battery system, biomass CHP, and wind energy from the North Slave area.

The Report also hints at some long-term options for the consideration of the next legislature. The long-term goal is to develop transformative energy projects in NWT communities that will relegate diesel generation to back-up supply status.

- ***Transformative Community Energy Projects:*** Community scale projects that fall in the 0.250 – 9 MW range that deliver clean sustainable energy to help displace diesel as the primary source of power.
- ***Transformative Projects for New Markets:*** Projects that are too substantial for all but the largest communities, that fall in the 10 – 50 MW range, and that generally require a new or emerging energy market such as an industrial customer.
- ***Emerging Energy Alternatives:*** A number of emerging technologies exist in other parts of the world that have yet to be proven in remote northern applications. These renewable energy technologies may evolve over time to become primary options for many remote communities.

If we look at this energy policy context, many of the actions identified in the various plans and strategies are to be completed by 2015. Seeing as 2015 is an election year in the NWT, it is to be expected that

new sets of priorities for 2016-2020 and beyond will emerge in the next year. The options highlighted by the government in its response will be packaged for the consideration of the 18th Legislative Assembly. This will be an opportunity to align some of NRCan's R&D work to the territorial priorities.

2. ENERGY AND ELECTRICITY MARKETS

The Northwest Territory Power Corporation (NTPC) is the main generator and transmitter of power in the NWT. NTPC provides wholesale power to Northland Utilities (YK) Ltd in Yellowknife and to Northland Utilities (NWT) in Hay River and area. It also provides industrial service to two properties in the Yellowknife area, as well as generation and distribution services to residents in most of the remaining areas of the NWT.[25]

The total electrical load is approximately 66 MW with isolated power systems having generating capacities ranging from 64 MW at Snare/Yellowknife to 230 kW at Jean Marie River. Since these systems are isolated and unconnected, each must be planned for and operated independently. Two of these systems are dominated by hydro (the Snare-Yellowknife system serving Yellowknife, Behchoko and Dettah, and the Taltson system serving Fort Smith, Fort Resolution and Hay River), while the rest are non-interconnected communities served by thermal generation (diesel or natural gas).[26] Table 5 at the end of this section provides detailed information on these systems.

Figure 5. Existing Electrical Infrastructure of the Northwest Territories

In 2010, the GNWT issued rate policy guidelines that led to substantial reductions in the rates paid by non-government customers in thermal communities, without increases to other customers. Through the new rate policy guidelines, the NWT moved from community base rates to territorial rates. The number of rate zones in the NWT was reduced from 33 to 7. Rates are therefore not fully harmonized throughout the territory.

In the thermal communities, rates were reduced by 20% to 80% (with the largest reductions occurring in the very small diesel communities), with more modest reductions occurring in most hydro communities. In addition, concurrent with the rate rebalancing changes, the GNWT amended the Territorial Power

[25] As a point of interest, the community of Hay River announced in December, 2014, that after over 60 years of doing business together, it would not be renewing its franchise agreement with Northlands Utilities to distribute power in the town. There seems to be growing concerns about rate disparity within the NWT, even after the territory moved from community base rates to territorial rates some years ago. http://www.cbc.ca/news/canada/north/hay-river-won-t-renew-northland-utilities-power-distribution-agreement-1.2880636.

[26] Figure 5 is taken from: "A Vision for the NWT Power System Plan." NT Energy, December 2013.

Subsidy Program (TPSP) program to revise eligibility, which was a material net benefit for non-government residential customers. The winter eligibility increased from 700 kWh/month to 1,000 kWh/month.[27]

Electricity rates in the NWT are the highest in Canada after Nunavut. Paradoxically, because most houses are heated with heating oil or wood, their monthly electricity consumption is relatively low and their consequent electricity bill is often lower than for consumers located elsewhere in Canada and who heat their homes with electricity – including with GSHP and ASHP. In this context, energy efficiency options are the same as in the South, but the relative payback would be shorter, hence the incentive to adopt sound DSM practices and to use energy efficient equipment.

The high electricity price environment is also expected to continue due to a number of factors. In 2012, NTPC applied to the Public Utilities Board for the first rate increase in five years and, at the time, the PUB approved a 28.4 increase over four years. Rates increased by 5.6% on April 1, 2014, and by 6.2% on April 1, 2105.[28] Furthermore, as the NWT is facing a major energy crisis with the drought in the Snare River system, short term actions will likely be sought. The drought will likely call for a drought rate rider application from NTPC to the PUB to reflect increased generation costs due to reliance on diesel to make up for the reduced hydroelectric production.

The current electricity supply situation in the NWT – coupled with high electricity prices – has all the ingredients for the adoption of alternative supply solutions. The NWT have the potential to host the deployment of many demonstration projects, and eventually the deployment of new technologies as the economics of the projects will be improved in a high price environment – much more so than in neighbouring Yukon.[29]

3. ENERGY SUBSIDIES

The Government of the NWT helps equalize the cost of power for residential consumers through a program called the Territorial Power Support Program. For customers living in a community that is not linked to the hydro system, the GNWT subsidizes the residential electricity cost. The TPSP is based on the amount of energy required each season to supply an average household. Approximately 80% of NTPC customers use less than 700 kilowatt hours of electricity each month. The TPSP helps to make up the difference between the cost of residential power in diesel powered communities and the residential rate in Yellowknife. From September to March each year, residential customers pay the Yellowknife rate for the first 1,000 kilowatt hours they use. For the remainder of the year – when there are more hours of daylight – the GNWT subsidy applies to the first 600 kilowatt hours. The example below illustrates how the subsidized rate is calculated.

[27] http://www.ntpc.com/our-community/zone-rate-system. Electricity rates reflect how electricity is generated. For example, communities that depend on diesel or gas are called thermal communities, and their rates are higher than those in communities supplied with hydroelectricity.

[28] The Public Utilities Board of the Northwest Territories. Decision 9-2013.

[29] "Sahtu seeks renewables to offset high energy costs." Northern Journal, August 11, 2014.

Example: Aklavik

Up to 1,000 kWh/month	=	0.2853 $/kWh
Yellowknife rate	=	0.2372 $/kWh
Subsidy	**=**	**0.0481 $/KWh**

Also, the Senior Home Heating Subsidy Program provides financial assistance to seniors who are 60 years of age or older, who own their own home and who meet a financial income test.[30] The table below summarizes the subsidies available according to three different heating zones.

Table 3. NWT – Senior Home Heating Subsidy Guidelines

NWT - SENIOR HOME HEATING SUBSIDY GUIDELINES

	Maximum Fuel		
Type of Fuel	**Zone 1**	**Zone 2**	**Zone 3**
Cut Wood (cords)	5	6	7
Wood Pellets (1 Skid - 2,000 Pounds)	5 skids	6 skids	7 skids
Fuel Oil (Litres)	2,400	2,800	3,200
Propane (litres)	3,200	3,600	4,000
Natural Gas (gigajoules)	90	100	110
Electricity (kWh)	6,000	7,000	8,000

Net Household Income	**Maximum Income**		
% of Subsidy	**Zone 1**	**Zone 2**	**Zone 3**
100%	$46,249	$51,249	$56,249
75%	$47,499	$52,499	$57,499
50%	$48,749	$53,749	$58,749
25%	$49,999	$54,999	$59,999
0%	$50,000 +	$55,000 +	$60,000 +

4. RENEWABLE ENERGY

There are a number of alternative and renewable energy projects in the NWT.[31] Since 2013, the community of Inuvik's gas generators are running on liquid natural gas (LNG), imported from southern Canada by truck on the Dempster Highway. This option is investigated to supply other communities on the road system with liquid natural gas in order to fuel community generators in combination with diesel. In Fort Simpson, a solar system can generate 100 kilowatts on bright days (i.e. enough to power about 17 houses). Solar power supplements the community's diesel operations. In Colville Lake, a solar/diesel/battery system is expected to shut down the diesel plant for extended periods in the summer. It is anticipated that this hybrid energy solution will significantly reduce diesel use and related emissions by supplying most of the community's needs in the summer months. In Fort Liard and in Fort

[30] Senior Home Heating Subsidy Guidelines. Northwest Territories Education, Culture and Employment. July 17, 2013.

[31] https://www.ntpc.com/smart-energy/how-to-save-energy

McPherson, residual heat from the diesel plants heats a number of community buildings. Finally, in Fort Smith, excess power from Taltson Hydro has replaced diesel-powered heat in local buildings.

In addition to the greenhouse gas strategy and the energy plan, the GNWT has stimulated growth in local wood pellet consumption in recent years by retrofitting many large public facilities with wood pellet boilers. The first ***NWT Biomass Energy Strategy*** was released in 2010. The GNWT continues to build on this work by implementing the ***Northwest Territories Biomass Energy Strategy 2012-2015***[32].

In a nutshell, the objective of the strategy is to increase the use of biomass fuels – such as cord wood, wood chips and pellets – in all segments of the NWT space heating market. In 2011, cordwood and wood pellets accounted for roughly 11% of space heating demand. The strategy looks at all aspects of biomass resources supply and demand for the NWT and is articulated by 15 specific actions. Action 15 calls for progress evaluation of the other actions at some point in 2015.

The ***Northwest Territories Solar Energy Strategy 2012-2017***[33] was released in November, 2012. The Strategy establishes a target of displacing 10% of diesel electricity generation in the NWT. The focus is on communities using diesel energy. The Strategy targets the installation of solar systems with the capability to supply up to 20% of the average load in NWT diesel communities.

The strategy recognizes the viability of battery-based solar charging systems in remote locations not connected to community power grids where hundreds of systems have been installed in homes and businesses. There are three objectives where assistance could be provided to:

- Assist public power utility companies to advance solar-diesel hybrid systems in communities
- Promote the use of battery-based solar charging systems in remote off-grid applications
- Increase the monitoring of solar energy systems to measure and access their performance

Figure 6. Solar Photovoltaic Installations in the Northwest Territories

The Strategy focuses on the challenge to incorporate solar photovoltaic into the community grid system to offset diesel generation. At the time the Strategy was released, 25 such systems were already installed.[34]

[32] "Northwest Territories Biomass Energy Strategy 2012-2015." Government of the Northwest Territories, 2012.

[33] "Northwest Territories Solar Energy Strategy 2012-2017." Government of the Northwest Territories, 2012.

[34] Figure 6 is taken from: "A Vision for the NWT Power System Plan." NT Energy, December 2013.

The GNWT released a hydro development strategy in 2008.[35] NT Energy[36] was in charge of leading the implementation of the strategy and published its vision of the NWT power system future in 2013. [37] NTPC's role is to keep the current electricity system running efficiently. NT Energy pursues new energy options and when it discovers a viable alternative energy option, they work with NTPC when feasible to integrate the project into the grid. Over the past five years, NT Energy has led and supported many renewable energy projects. Development of hydro and other renewable and alternative energy sources has been identified by the Government of the NWT as a major priority.[38]

In September 2010, the Public Utilities Board of the NWT approved a net billing pilot project for people producing electricity through solar, wind or other methods such as mini-hydro. The pilot project took place from September 1, 2010, to May 1, 2013.[39] This decision was in response to an application filed by NTPC and Northland Utilities Ltd. The purpose of the pilot project was to test the feasibility and logistics of having system-connected customers, with acceptable renewable energy generation in excess of their own needs, sell their excess energy into the grid. The total overall size of the project was capped at 50 kW with no single installation exceeding 5 kW.

In its decision, the Board stated it expected the project proponents to consider the limited certainty provided by the pilot project in designing their project and assessing their level of economic commitment and risk. In a nutshell, the Board essentially sent the message that given the size of any individual project, the proponents' motivation was expected to be a reduction of their electricity consumption from the grid rather than an opportunity for a steady revenue stream by selling into the grid.[40]

The Board's decision was somewhat an indication of what would follow. In the summer of 2013, both NTPC and NUL filed an application for a permanent net metering program. A decision was rendered by the PUB in January, 2014[41], allowing people to produce their own power through solar, wind or other methods, and to trade power to the grid in exchange for kWh credits.

For example, a home using 500 kWh of utility distributed electricity in a month and producing 100 kWh with a solar panel will only get billed for 400 kWh. If another customer produces 1000 kWh of electricity in a month yet only consumes 400 kWh, a credit of 600 kWh will be carried over and subtracted from the next utility bill. These credits can be carried over from month to month until March 31 of each year, after which any leftover credits in the bank are reset to 0. The PUB's decision also suggests that this one-to-one kWh exchange rate is not guaranteed over the long term for net metering customers in hydro-powered communities such as Yellowknife. The focus could be on thermal zones in the longer term.

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[35] Draft NWT Hydro Strategy – The Foundation for a Sustainable Energy Future. GNWT, 2008.

[36] NT Energy is funded from outside of the NWT's regulated electricity rate payers to explore ways to develop local, affordable, and ideally renewable energy projects in the NWT. It is a crown corporation. NT Energy's vision is to be a centre of excellence, leading in the development of local and renewable energy sources in the NWT for the benefit all residents, communities and Aboriginal governments. It's mandate is to plan and develop safe and environmentally responsible energy projects to serve existing and new energy requirements in the NWT. NT is the sister company of the Northwest Territories Power Corp. (NTPC). Both NT Energy and NTPC are subsidiaries of NT Hydro Corp., a Crown Corporations wholly owned by the Government of the Northwest Territories.

[37] A Vision for the NWT Power System Plan, NT Energy, December 2013.

[38] Please note that as of April 1st, 2015, the Government of the Northwest Territories has consolidated Energy Initiatives within the department of Public Works and Services.

[39] Public Utilities Board of the Northwest Territories, Decision 13-2010.

[40] This approach is qui different than in other jurisdictions where net-metering programs are clearly designed to facilitate increased supply to the grids.

[41] Public Utilities Board of the Northwest Territories, Decision 1-2014.

The NWT Public Utilities Board has approved a 20% capacity limit for intermittent renewable generation in each isolated community within the Thermal Zones. The maximum size of generation under the program would generally not exceed 5 kW. However, projects exceeding 5 kW may be accommodated as long as the serving utility recognizes that the proposed generation project would not pre-empt system access by smaller projects. In respect to hydro communities, a capacity limit will be established each year on the basis of system impacts. The net metering program also applies to GNWT and Federal Government accounts. However, the implementation for these accounts has been delayed until the utilities' next Phase II proceeding.

At the end of March 2014, the total solar capacity installed in 13 communities stood at 202 kW or roughly 8% of an estimated total solar capacity of 2607 kW.[42] Table 4[43] shows the net metering program capacity by community as of March, 2014. Roughly, a remaining potential for the deployment of 2,405 kW of solar capacity has been identified. Market size is therefore known and so is the "scalability" of the potential projects.

Thermal communities are small and may require technical assistance, although electricity distribution and grid connectivity are ensured by NTPC as part of its commitment to the Public Utilities Board. However, optimizing the production of a multitude of small solar production units below 5 kW in sync with diesel power plants is an opportunity for technology deployment.

[42] Not all of these 202 kW were installed under the net billing pilot program.

[43] http://www.ntpc.com/docs/default-source/default-document-library/net-metering-capacity-by-community-v1.pdf?sfvrsn=2

Table 4. Northwest Territories Power Corporation – Net Metering Program Capacity by Community as of March 31, 2014

	Community Average Load (kW)	Estimated Available Solar Capacity (kW)	Current Solar Capacity Installed (kW)*	Available Capacity (kW)
Wha Ti	237	47	5	42
Gamèti	170	34	5	29
Lutselk'e	216	43	0	43
Fort Smith	2,420	484	0.47	484
Fort Resolution	314	63	0	63
Fort Simpson	875	175	119	56
Fort Liard	320	64	0	64
Wrigley	80	16	0	16
Nahanni Butte	54	11	4.8	6
Jean Marie River	36	7	1.3	6
Inuvik	3,600	720	27.7	692
Norman Wells	970	194	2.86	191
Tuktoyaktuk	491	98	0	98
Fort McPherson	415	83	0	83
Aklavik	354	71	0	71
Déline	320	64	0	64
Fort Good Hope	342	68	5	63
Paulatuk	175	35	6.7	28
Sachs Harbour	114	23	4.3	19
Tsiigehtchic	86	17	0	17
Colville Lake	50	10	0	10
Ulukhaktok	240	48	0	48
Tulita	285	57	10	47
Behchoko	872	174	9.8	164
Total	**13,036**	**2,607**	**202**	**2,405**

Notes

* **Includes all solar capacity installed whether under the Net Billing Pilot Program or not.**

5. THE NORTHWEST TERRITORIES ENERGY PLAN[44]

Energy Conservation and Efficiency

- Continue to fund the Arctic Energy Alliance to ensure effective delivery of energy programs, services and information in all NWT communities. Expand AEA's presence to include an office in the South Slave.
- Continue to provide substantial funding for energy conservation and efficiency incentive programs. Undertake a comprehensive program review in 2013-14 to ensure funding is effective and impacting a broad base of NWT residents, businesses and community governments.

[44] "Northwest Territories Energy Action Plan – A three-Year Action Plan and a Long-Term Vision." Government of the Northwest Territories, December 2013.

- Implement an Electric Hot Water Heater Replacement Program in four thermal communities. The GNWT will consider extending this project to other communities in 2014-15 and beyond based on results.
- Continue to monitor NTPC's power generation facilities for future investment opportunities in residual heat projects.

Hydro

- Begin discussions with the Tłı̨chǫ Government concerning the construction of a transmission line to Whatì, and if the project can go forward, provide up to a $3-million subsidy to make the line financially viable.
- Continue to assess options to extend hydro power to Kakisa and Fort Providence while working with existing resources.
- Provide $50,000 per year for three years to monitor water flows. Continue to assess the potential for a mini-hydro project.
- Invest $500,000 in 2013-14 to investigate opportunities for large-scale transmission and further the development of NWT hydro resources, to be reflected in a Northwest Territories Power System Plan.
- The GNWT will invest $200,000 in 2014-15 to support the development of a detailed technical and economic evaluation of the hydro potential of the Great Bear River.

Biomass

- Continue to support both the Alternative Energy Technology Program with $250,000 in 2013-14, and $275,000 in fiscal years 2014-15 and 2015-16.
- Continue targeted biomass programming through the AEA, with $500,000 spread out over the next three years (2013-2016).
- The Federal Government has made a $1.4 million investment in forest resources and industry development activities in 2013-14; the GNWT will continue to discuss ongoing funding with federal partners.

Solar Energy

- Funding of $250,000 in 2013-14 and $500,000 in the following two years is dedicated to the installation of a solar array with energy storage in Colville Lake. Another project will proceed in either Nahanni Butte or Jean Marie River in 2015-16.
- Install smart meters and carry out smart-grid research in four communities over three years through funding of $125,000 per year. This work will facilitate the installation of renewable energy systems in these communities.

Wind Energy

- Install a wind monitoring tower at the Storm Hills site and complete a feasibility analysis of wind power development. An amount of $50,000 in funding is dedicated for both 2013-14 and 2014-15.
- Invest $50,000 per year over three years to continue to monitor wind speeds at various sites near communities in the NWT.

Liquefied Natural Gas

- Invest $100,000 in 2013-14 to develop a supply chain of LNG in Inuvik.
- Invest $150,000 in 2014-15 and 2015-16 to help expand the use of LNG in the NWT's thermal power plants.

Innovation

- Using existing resources, the GNWT will continue to investigate the geothermal potential of the Dehcho region.
- The GNWT will invest $300,000 annually in the Alternative Energy Technology Program to assist residents, businesses, communities, and organizations with the installation of various renewable energy systems.
- Invest $15,000 in 2014-15 and 2015-16 to lease an electric plug-in hybrid vehicle that will be tested by the Arctic Energy Alliance.

GNWT Leadership

- Invest $3.80 million over the next three years (2013-2016) to install biomass boilers in GNWT facilities.
- Dedicate $700,000 in each of the following three years to the installation of wood pellet boilers and perform other energy upgrades in multi-unit housing complexes operated by the NWT Housing Corporation.

Policy and Planning

- Issue strategic direction to NTPC and implement an accountability framework to demonstrate the corporation's alignment with priorities established by the Legislative Assembly.
- Reaffirm the role of the PUB and clarify the role of the GNWT with respect to issuing policy direction to the Board.
- The GNWT will work with the University of Calgary to develop performance indicators and measurement criteria, as well as ensure systems are in place to track and populate them with the necessary data.
- Develop a net metering renewable energy policy in 2014 to encourage and clarify the process of installing grid-connected renewable energy systems.
- A Stand-by Rate policy for renewables will be developed in 2014.
- Investigate the challenges and opportunities of implementing an *Energy Efficiency Act* in the NWT.
- The GNWT commits to using a collaborative process when developing future energy policy.
- The GNWT will direct the Arctic Energy Alliance to expand its energy literacy and outreach programs. The GNWT will also promote energy literacy through written and online media, in order to improve awareness of programs that can help them make better energy decisions.
- The GNWT will consider changes to the *City, Towns and Villages Act* to enable communities to use Local Improvement Charge legislation for the purposes of offering energy financing programs to individual property owners.
- The GNWT will allocate $700,000 annually to provide core, operational funding for the Northwest Territories Energy Corporation.

Table 5. Electricity Sources and Rates by Community – Northwest Territories[45]

NORTHWEST TERRITORIES

	Communities	Pop.	Electricity Source*	Distributor**	Activities***	2012 Cost per litre ($)	2012 Generation (MWh)	2012 Net Heat Rate (kWh/litre)	2012 Litres consumed	2012 Litres per capita	Electricity Rates ($ / kWh) Residential Monthly Charge	Residential Up to 1000 kWh	Residential Over 1000 kWh
1	Aklavik	628	Diesel	NTPC	D-G	n/a	n/a	n/a	n/a	n/a	$ 18.00	$ 0.2853	$ 0.5728
2	Behchokǫ̀ / Rae-Edzo (Dog Rib Rae)	2,004	Hydro-S	NTPC	D-G	-	-	-	-	-	$ 18.00	$ 0.2853	$ 0.2929
3	Colville Lake (Behdzi Ahda)	140	Diesel	NTPC	D-G	n/a	n/a	n/a	n/a	n/a	$ 18.00	$ 0.2853	$ 0.5728
4	Déline (Fort Franklin Settlement)	543	Diesel	NTPC	D-G	n/a	n/a	n/a	n/a	n/a	$ 18.00	$ 0.2853	$ 0.5728
5	Dettah	260	Hydro-S	NTPC	D-G	-	-	-	-	-	$ 18.00	$ 0.2853	$ 0.2929
6	Enterprise	110	Hydro-T	NUL	D	-	-	-	-	-	$ 18.00	$ 0.2721	$ 0.2721
7	Fort Good Hope (K'asho Got'ine)	564	Diesel	NTPC	D-G	n/a	n/a	n/a	n/a	n/a	$ 18.00	$ 0.2853	$ 0.5728
8	Fort Liard (Acho Dene Koe)	596	Diesel	NTPC	D-G	n/a	n/a	n/a	n/a	n/a	$ 18.00	$ 0.2853	$ 0.5728
9	Fort McPherson (Tetlit Gwich'in)	804	Diesel	NTPC	D-G	n/a	n/a	n/a	n/a	n/a	$ 18.00	$ 0.2853	$ 0.5728
10	Fort Providence (Deh Gah Gotie Dene Council)	753	Diesel	NUL	D-G	$ 0.9380	3,251	3.64	892,000	1,185	$ 18.00	$ 0.6710	$ 0.6710
11	Fort Resolution (Deninu K'ue)	485	Hydro-T	NTPC	D-G	-	-	-	-	-	$ 18.00	$ 0.1977	$ 0.1977
12	Fort Simpson (Liidlii Kue)	1,243	Diesel	NTPC	D-G	n/a	n/a	n/a	n/a	n/a	$ 18.00	$ 0.2853	$ 0.5728
13	Fort Smith (Salt River)	2,448	Hydro-T	NTPC	D-G	-	-	-	-	-	$ 18.00	$ 0.1977	$ 0.1977
14	Gamèti (Rae Lakes)	295	Diesel	NTPC	D-G	n/a	n/a	n/a	n/a	n/a	$ 18.00	$ 0.2853	$ 0.5728
15	Hay River (West Point)	3,840	Hydro-T/D	NUL	D	$ 0.9527	1,354	3.60	376,000	98	$ 18.00	$ 0.2721	$ 0.2721
16	Hay River Reserve (K'atlodeeche)	319	Hydro-T	NUL	D	incl'd	incl'd	incl'd	incl'd	incl'd	$ 18.00	$ 0.2721	$ 0.2721
17	Inuvik	3,615	Nat-Gas/Diesel	NTPC	D-G	n/a	n/a	n/a	n/a	n/a	$ 18.00	$ 0.2853	$ 0.5728
18	Jean Marie River	80	Diesel	NTPC	D-G	n/a	n/a	n/a	n/a	n/a	$ 18.00	$ 0.2853	$ 0.5728
19	Kakisa (Ka'a'gee Tu)	54	Diesel	NUL	D-G	$ 0.9431	429	3.14	137,000	2,537	$ 18.00	$ 0.6710	$ 0.6710
20	Lutsel K'e Dene Band (Snowdrift Settlement)	329	Diesel	NTPC	D-G	n/a	n/a	n/a	n/a	n/a	$ 18.00	$ 0.2853	$ 0.5728
21	Nahanni Butte (Nahanni Butte Dene / Deh Cho)	123	Diesel	NTPC	D-G	n/a	n/a	n/a	n/a	n/a	$ 18.00	$ 0.2853	$ 0.5728
22	Norman Wells	860	Nat-Gas/Diesel	NTPC	D-G	n/a	n/a	n/a	n/a	n/a	$ 18.00	$ 0.2853	$ 0.4477
23	Paulatuk	306	Diesel	NTPC	D-G	n/a	n/a	n/a	n/a	n/a	$ 18.00	$ 0.2853	$ 0.5728
24	Sachs Harbour	127	Diesel	NTPC	D-G	n/a	n/a	n/a	n/a	n/a	$ 18.00	$ 0.2853	$ 0.5728
25	Trout Lake (Sambaa K'e Dene)	95	Diesel	NUL	D-G	$ 1.0396	491	3.32	148,000	1,558	$ 18.00	$ 0.6710	$ 0.6710
26	Tsiigehtchic (Arctic Red River / Gwichya Gwich'in)	183	Diesel	NTPC	D-G	n/a	n/a	n/a	n/a	n/a	$ 18.00	$ 0.2853	$ 0.5728
27	Tuktoyaktuk	915	Diesel	NTPC	D-G	n/a	n/a	n/a	n/a	n/a	$ 18.00	$ 0.2853	$ 0.5728
28	Tulita (Tulita Dene / Fort Norman)	542	Diesel	NTPC	D-G	n/a	n/a	n/a	n/a	n/a	$ 18.00	$ 0.2853	$ 0.5728
29	Ulakhaktok (Holman)	420	Diesel	NTPC	D-G	n/a	n/a	n/a	n/a	n/a	$ 18.00	$ 0.2853	$ 0.5728
30	Wekweèti (Dechi Laot'I / Snare Lake)	143	Diesel	NUL	D-G	$ 1.1842	657	3.49	188,000	1,315	$ 18.00	$ 0.6710	$ 0.6710
31	Whatì (Tlicho / Lac La Martre)	495	Diesel	NTPC	D-G	n/a	n/a	n/a	n/a	n/a	$ 18.00	$ 0.2853	$ 0.5728
32	Wrigley (Pehdzeh Ki)	114	Diesel	NTPC	D-G	n/a	n/a	n/a	n/a	n/a	$ 18.00	$ 0.2853	$ 0.5728
33	Yellowknife (City of Yellowknife and N'dilo)	19,739	Hydro-S	NUL	D	-	-	-	-	-	$ 18.00	$ 0.2372	$ 0.2372
		43,172					6,182		1,741,000				

(*) Hydro-S = Snare River System
Hydro-T = Talston River System

(**) NTPC = Northwest Territories Power Corporation
NUL = Northland Utilities

(***) D = Distribution
G = Generation

Forecast 2012/2013					
NTPC	Snare Zone	$ 1.1300	1,200	3.64	330,000
NTPC	Talston Zone	$ 1.1300	964	3.43	281,000
NTPC	Thermal Zone	$ 1.1300	74,611	3.53	21,125,000
	TOTAL		**82,957**		**23,477,000**

[45] Data compiled by CanmetENERGY-Varennes from a variety of sources including: (1) Northwest Territories Power Corporation 2012/13 – 2013/14 General Rate Application, (2) Northland Utilities (NWT) Limited 2014-2015 General Rate Application, (3) https://www.ntpc.com/customer-service/residential-service/what-is-my-power-rate, (4) Northland Utilities (NWT) Limited, Rate Schedule (Current).

III. NUNAVUT

1. ENERGY POLICY CONTEXT

In Nunavut, the main policy driver for energy is ***Ikummatiit: The Government of Nunavut Energy Strategy***[46] released in September 2007. The focus of the energy strategy is to reduce Nunavut's dependency on fossil fuels. The strategy calls for the development of different forms of energy, such as hydro-electricity, wind power and solar power, and eventually, other "exciting and new energy sources." Since no energy strategy would be complete without some form of effort on the energy efficiency side, it seeks to streamline and strengthen the management of the territory's energy system. In addition, the strategy seeks to deploy policy actions for oil, gas and uranium development.

> *"The Government of Nunavut pays approximately 80 per cent of Nunavut's energy costs, either directly or indirectly. Energy costs are subsidized in Nunavut through subsidy programs but also through underinvestment in the replacement and upgrade of our existing capacity, much of which is near the end of its life cycle. This is clearly not sustainable."*
>
> ***Hon. Peter Taptuna, MLA, Deputy Premier and Minister responsible for Energy, GN. Testimony before the Standing Senate Committee on Energy, the Environment and Natural Resources, March 15, 2012.***

The strategy also identifies key variables which could potentially drive energy consumption: increasing Canadian presence in the Arctic, increasing mining and exploration activity, and the continuing increase in tourism and shipping. In the consultation leading to the Strategy, large energy consumers expressed an interest in developing their own electricity generation sources and selling any excess to Qulliq Energy Corporation (QEC)[47]. The Government of Nunavut (GN) asked Qulliq to consider developing and implementing an Independent Power Purchase Policy. This is expected by the end of 2015.

The Strategy covers a vast array of options including replacing inefficient diesel generators, alternative energy for heat and hot water (mainly solar options) and energy from waste. The GN has a strong focus on hydro-electricity. This is core and central to the Strategy and an issue which was reiterated publicly a number of times since the release of the Strategy.[48]

Nunavut's energy system is unique in Canada as it is the only province or territory that has no primary energy production. Nunavut relies exclusively on imported fossil fuels for its energy needs. In 2012-2013, the territory imported 180 million liters of fuel. This included 44 million liters of diesel used for electricity generation, 64 million liters of motive fuel for transportation, and 63 million liters of heating fuel.[49]

All of Nunavut's fuel is purchased and shipped in bulk during the short summer season and stored in tank facilities in each community. The Department of Community and Government Services, through

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[46] "Ikummatitt – The Government of Nunavut Energy Strategy." Government of Nunavut, September 2007.

[47] Qulliq Energy Corporation is responsible for the generation of electricity in Nunavut.

[48] Since the publication of Ikummatiit, government officials have reiterated many times their intent to develop the hydro potential in Nunavut. One of the latest declarations was made on November 20, 2014 during a testimony before the Senate Committee on Energy, the Environment and Natural Resources, by William Mackay, Acting Deputy Minister for Intergovenmental Affairs at the GN.

[49] http://nunavutenergy.ca/Nunavuts_Energy_System

their Petroleum Products Division (PPD), is responsible for supplying, delivering, and distributing all fuel products. In Iqaluit and Cambridge Bay, distribution responsibilities are outsourced to private corporations, while PPD uses local contractors in all other communities.[50] As shown in Table 6, Qulliq Energy consumed 48 million litres of diesel for electricity generation in 2012-2013, while diesel used for heating purposes represented approximately 70 million litres.

2. ENERGY AND ELECTRICITY MARKETS

Electricity in Nunavut is produced exclusively through diesel combustion. QEC maintains 26 stand-alone diesel plants in 25 communities (two plants in Iqaluit). Each community in Nunavut has its own independent electricity generation and distribution system. There is no back-up grid. QEC is the sole electricity supplier in Nunavut and also looks at heat redistribution systems, which recycle exhaust heat from electricity generation plants. A particularity in Nunavut is that the GN purchases and distributes Nunavut's annual fuel supply.

Inspired by similar policy in the NWT, in the fall of 2012, QEC began working on the Corporation's 2014/2015 General Rate Application (GRA), with plans to make a move from community base rates to territorial rates. Moving to territorial rates was authorized in the previous GRA application and was supposed to be phased in over a number of years, with limits placed on the maximum increase or decrease that customers would have experienced during one period. Rate-hikes of about 5% were planned for residential customers in six communities (including the largest communities such as Iqaluit and Rankin Inlet). Rates would have dropped by 4% in all other communities. The rate re-balancing proposal faced heated debates and the Government of Nunavut finally halted the process on March 19, 2014.[51]

Electricity rates in Nunavut are the highest in Canada. Because of the re-balancing proposal rejection, rates vary from a "low" of $0.6029/kWh, in Iqaluit, to a high of $1.1416/kWh, in Kugaaruk. Table 6 at the end of this section provides more detailed information.

3. ENERGY SUBSIDIES

In Nunavut, the Nunavut Electricity Subsidy Program is designed to provide small commercial enterprises and private residential power consumers with equitable rates for power consumption.[52] The cost differential for power consumption between Iqaluit rates and that of other Nunavut communities is paid for by this program up to specified consumption levels.

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[50] http://www.nunavutenergy.ca/Cost_of_Energy. Consulted September 17, 2015. There are some high profile PPD customers. For example, in 2012-2013, Qulliq Energy Corporation purchased approximately $42 million of fuel for electricity production. Another territorial corporation, the Nunavut Housing Corporation, spent approximately $43 million on heat and electricity. In addition to territorial corporations, the Government of Nunavut spends money to provide electricity and heat to government-owned buildings. Also in 2012-2013 the Government of Nunavut spent approximately $21.6 million for electricity, and an additional $6.7 million on fuel from PPD. In addition to this energy spending, the GN supports a number of different energy subsidies. Some of these are highly visible such as the Nunavut Electricity Subsidy Program, and the Public Housing Support Program. Others are hidden inside other programs such as electricity and heat payments from the Income Support Program. Energy subsidies are estimated to cost the GN approximately $30 million a year. Some of these subsidy programs are discussed in section (VI) of this report: HOUSEHOLDS AND COMMUNITY PROFILES.

[51] (1) "QEC starts move towards uniform Nunavut rates." NunatsiaqOnline, 2011-11-15. (2) "Nunavut power utility files 5.1 per cent rate hike scheme". NunatsiaqOnline, 2013-11-04. (3) "Okalik dumps Nunavut power utility's one-rate scheme." NunatsiaqOnline, 2014-03-19.

[52] Nunavut Electricity Subsidy Program : Contribution Policy.

For small commercial enterprises, the maximum subsidization is for the first 1000 kWh of monthly consumption. For residential consumers, during the April to September billing cycles, the first 700 kWh are billed at the subsidized rate. For the October to March billing cycles, the first 1,000 kWh used each month are billed at the subsidized rate. Any power consumed in excess of these thresholds is billed at the full rate that has been set for the community in which the customer resides.

Under the conditions outlined in the program, subsidized rates for all Nunavut communities are calculated at 50 percent of the Iqaluit rate. The following two examples illustrate how the subsidized rate is calculated.

Example: Rankin Inlet

Up to 1,000 kWh/month	=	0.6223 $/kWh
Subsidized rate @ 50% of Iqaluit rate of 0.6029	=	0.30145 $/kWh
Subsidy	**=**	**0.32085 $/KWh**

Example: Kugaaruk

Up to 1,000 kWh/month	=	1.1416 $/kWh
Subsidized rate @ 50% of Iqaluit rate of 0.6029	=	0.30145 $/kWh
Subsidy	**=**	**0.84015 $/KWh**

Nunavut also has a Senior Fuel Subsidy Program.[53] The program helps offset the cost of heating fuel for seniors who own and live in their homes. The maximum allowable subsidy is different depending on where the applicant lives. The subsidy ranges from 2,500 to 3,175 liters of fuel per home. An income assessment is done to establish whether the net income of the applicant falls within the program limits. Homeowners with a total net income up to and including $75,000 may be eligible for a 100% fuel subsidy. Homeowners with a total net income greater than $75,000 and less than or equal to $100,000 may be eligible for a 50% fuel subsidy. Homeowners with a total net income greater than $100,000 are not eligible for the fuel subsidy.

4. RENEWABLE ENERGY[54]

Limited electrical grid connectivity, limited transportation infrastructure, cold climate, limited demand, sparse population, dependency on fossil fuels and human capacity issues remain persistent deterrents to the growth of renewable energy in Nunavut.

In addition to QEC's 26 diesel generators, there is a small amount of renewable energy generation in Nunavut. This includes a 3 kW solar photovoltaic system on the Arctic College in Iqaluit, a 10 kW solar photovoltaic system on the Arviat recreation center, and a 4 kW solar photovoltaic system on the

[53] http://gov.nu.ca/family-services/information/senior-fuel-subsidy-sfs. Consulted September 17, 2015.

[54] Most of the information in this section comes from: www.nunavutenergy.ca/Renewable_Energy.

community freezer in Kugaaruk.[55] Other potential renewable energy sources include a wind turbine in Cape Dorset, and a hydroelectric project outside of Iqaluit.

Despite the current shortage of domestic energy production, the future holds considerable potential for both conventional and renewable energy resources in Nunavut. Discovered oil and gas reservoirs, for instance, are estimated to total nearly 2 billion barrels of crude oil and 27 trillion cubic feet of natural gas. Alternatively, Nunavut holds considerable solar photovoltaic potential. Several solar projects, both for electricity and air heating, are being developed across Nunavut to capitalize on the long summer days. There are plans for pilot wind projects and interest in the long-term to consider tidal energy. The development of a wind program and supporting wind-hydrogen projects is also considered. The hamlet of Chesterfield Inlet, for example, has a yearly PV potential of 1158 kWh/kW, which is greater than that of southern municipalities such as Victoria (BC) and St. John's (NL).

Locations along the Hudson Bay coast in the Kivalliq region receive the highest amount of solar energy in Nunavut. The amount of solar energy that reaches coastal areas of the Kivalliq region is comparable to the amount of solar energy that reaches southern Quebec, much of Ontario, and the Maritimes. The amount of solar energy that reaches the northern half of Nunavut is lower than any other part of Nunavut and Canada.

Solar PV applications have demonstrated success in northern jurisdictions. In particular, a PV array at the Arctic College in Iqaluit has delivered electricity since its installation in 1995. The PV array captures up to 20 hours of sunlight per day during the longest days of summer and five hours per day during the darkest days of winter.

In 2010, the GN commenced four pilot projects in Iqaluit, including the installation of a SolarWall air pre-heater at the Baffin Regional Hospital and solar domestic hot water systems at the hospital's 40-bed residence, the Baffin Correctional Centre and the Young Offenders Facility. Also, a solar thermal SolarWall project at Alaittuq High School in Rankin Inlet has operated successfully since 2002.

Three wind energy pilot projects have been attempted in Nunavut, all of which were diesel grid connected. One turbine was installed in Cambridge Bay in 1994 and operated until 1999. Two turbines operated in Kugluktuk from 1997 to 2002. One turbine in Rankin Inlet operated from 2000 to 2001. The Rankin Inlet turbine was refurbished in October 2008 but was ultimately decommissioned. The Nunavut wind projects experienced equipment malfunctions, issues with routine maintenance, and financial restrictions.

Wind speeds in Nunavut have been modeled in the Canadian Wind Energy Atlas. Cape Dorset, Arviat and Rankin Inlet are among the communities that have high wind resources (i.e. wind speed). Communities with moderate wind resources include Cambridge Bay, Kugaaruk and Resolute Bay. Iqaluit, Coral Harbour and Kugluktuk are among the communities that have the lowest wind resources. Wind monitoring towers will likely be installed at potential wind project sites before committing to a development since modeled data is not as reliable as real data. The QEC is planning to erect two wind monitoring towers in Cape Dorset and one in Arviat.

Potential hydroelectric sites have been identified in Nunavut. In particular, assessments of hydroelectric potential have been completed for various locations near Iqaluit and in the Kivalliq region. In the latter

[55] The last two projects were approved under the ecoENERGY for Aboriginal and Northern Communities Program in 2013-2014. https://www.aadnc-aandc.gc.ca/eng/1334855478224/1334856305920#yr3

region, many potential sites are far away from community centres resulting in increased developmental costs. The demand for electricity in many Nunavut communities is too low to economically justify hydroelectric development, which has left hydroelectric resources underdeveloped in Nunavut. However, if significant mining development occurs, there may be opportunities to economically develop these resources in the future. The first hydroelectric project to be developed in Nunavut would likely be in Iqaluit. The Armshow River Long and the Jaynes Inlet sites have been identified as potential hydroelectric developments.

Residual heat recovery is one type of alternative energy that is currently used by QEC in several Nunavut communities. Funding for residual heat recovery systems has been made available by various government agencies for diesel power plants in Nunavut. QEC has plans to expand existing residual heat systems and establish new residual heat systems in other Nunavut communities. QEC completed residual heat recovery projects in Rankin Inlet and Iqaluit in FY 2006-07. These new projects are displacing 2.3 million litres of heating fuel annually. QEC heat sales are summarized in Figure 7.[56]

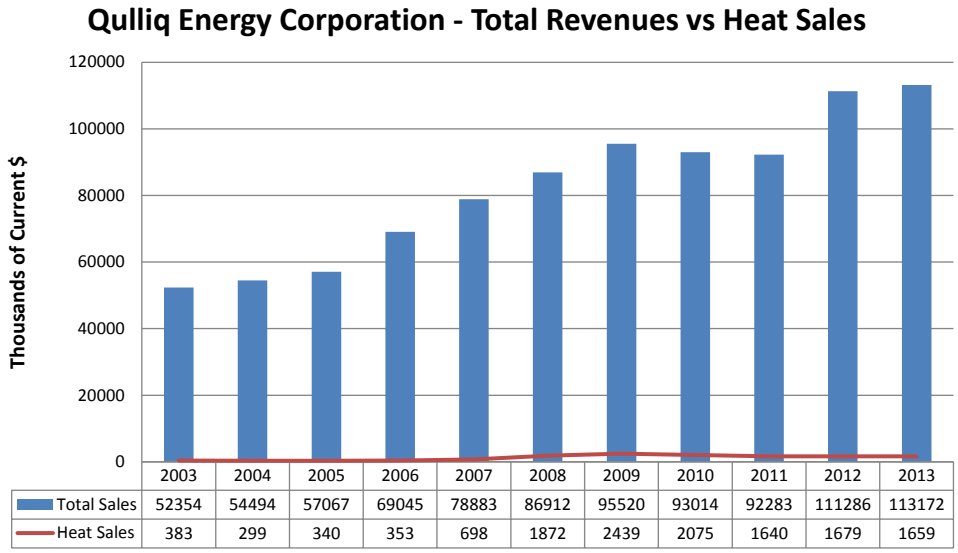


Figure 7. Qulliq Energy Corporation – Total Revenues vs Heat Sales

The GN's Energy Strategy (2007) proposes to initiate a feasibility study to identify the potential for small-scale waste-to-energy projects in Nunavut. To determine if the use of small-scale waste incinerators for heat generation is a feasible option for Nunavut, a review of Nunavut's waste management system is required. To this end, a small-scale waste incinerator was purchased in early 2014 by the City of Iqaluit, with support from the Canadian Northern Development Agency.

[56] Data compiled by CanmetENERGY-Varennes from: (1) Qulliq Energy Corporation, various annual reports, 2003 to 2013.

In addition:

- Solar Domestic Hot Water systems were installed in three buildings during the Pilot in Iqaluit. The results are monitored at the site.
- Solar air heating system (solar wall) has been installed on the older portion of the Baffin Regional Hospital.
- Exterior LEDs were also installed in 4 buildings. Results were apparently positive and the technology was extended to all buildings.
- Fifth Lighting Control System was installed in five buildings after a monitored pilot project. These are equipped with an IP address allowing complete control over the Internet. The energy manager controls the system. Savings in excess of 70% were achieved.

The primary consumer of electricity in Nunavut is the GN, including public housing, local communities and the GN-owned commercial buildings. The GN makes up 39% of Qulliq's revenues, and owns or leases more than 600 buildings in 26 communities. Due to the dependence of these communities on diesel to heat buildings and generate electricity, the GN has a high energy bill. As a result, the Nunavut Energy Management Program was developed to improve the GN's energy efficiency and reduce its greenhouse gases in its owned and leased buildings. This program is modeled on the Federal Government's Federal Buildings Initiative (FBI), and was approved by the Nunavut Legislative Assembly to enable third party implementation and savings financing on energy efficiency measures.

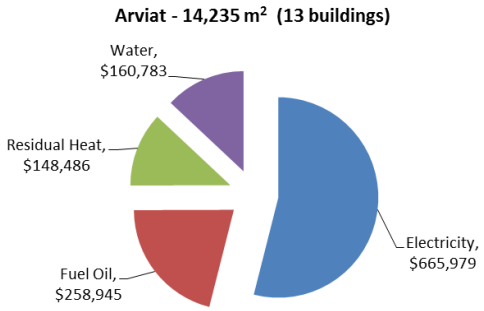
The GN initiated the program by way of a pilot project comprising all of its owned buildings in Iqaluit. The project included 40 buildings that were small or large in scale, either old or new, and that had a wide variety of uses. The combined utility bill (water, fuel oil, residual heat, and electricity) was $9.7 million in 2013. Annual savings are now in the order of $1.6 million. The third party investment was approximately $12.5 million.

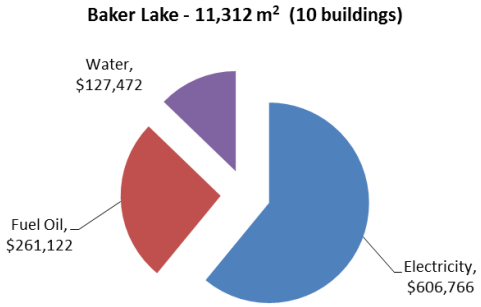
On October 31, 2014, the GN issued a request for proposal (RFP) for an energy management project in the Kivalliq Region.[57] The project will address energy and water efficiency measures, green energy and storage measures, occupant education and facility operator and manager training for 89 buildings in 7 communities. Phase 1 of the RFP consists of the investment grade feasibility studies and Phase 2 will encompass the implementation of the study results. The contract was awarded to MCW Custom Energy Solutions Ltd on January 5, 2015. One interesting fact is the relatively high share of water utility bill in some buildings/communities. It would be interesting to further investigate with the GN to see if energy related technologies could be used to reduce these charges.

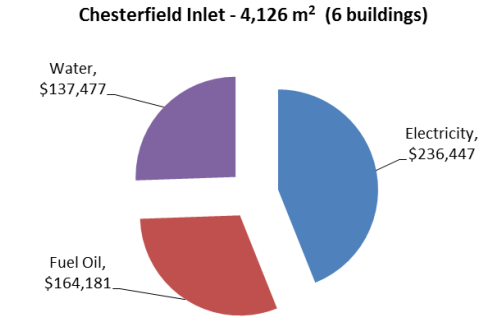
The following 7 charts show the breakdown of aggregate utility bills for the 89 buildings in the 7 communities of the Kivalliq Region.[58] There are four main accounts: electricity, fuel oil, residual heat, and water. Energy and water efficiency measures, green energy and storage measures as well as occupant education could all lead to significant energy savings.

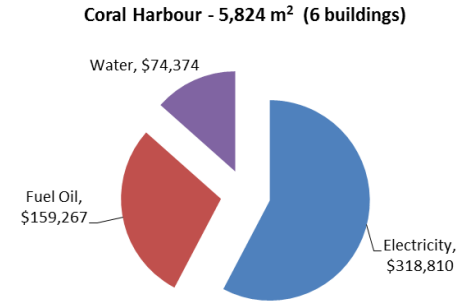
[57] Government of Nunavut. Request for Proposals. Energy Management Project: Kivalliq Region (Arviat, Baker Lake, Chesterfield Inlet, Coral Harbour, Rankin Inlet, Repulse Bay, Whale Cove). RFP # 2014-70, October 31, 2014.

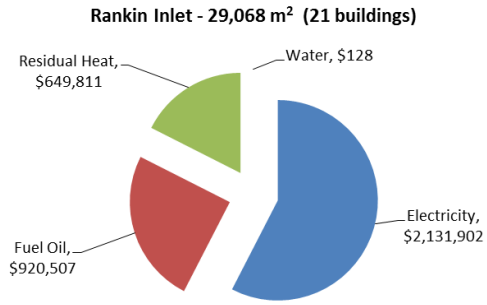
[58] Charts were created with information contained in the above mentioned RFP. Detailed information is available for all individual buildings (89) in the 7 communities.

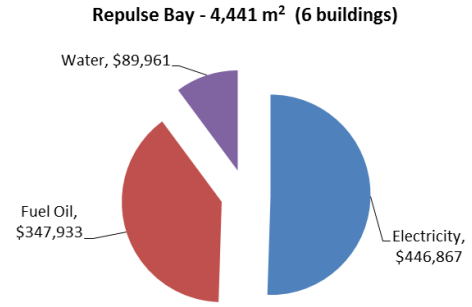












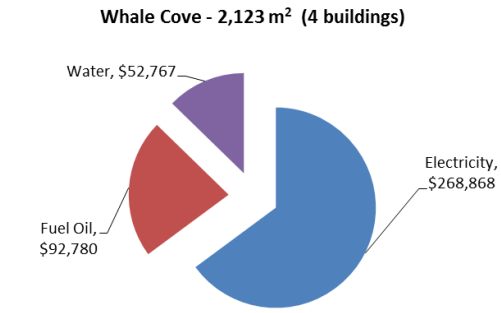


Figure 8. Aggregate Utility Bills – Kivalliq Region

IV. IKUMMATIIT – THE GOVERNMENT OF NUNAVUT ENERGY STRATEGY[59]

1. ENERGY CONSERVATION AND EFFICIENCY

The GN Energy Strategy consists in implementing a series of policy actions that encourage the adoption of energy conservation and efficiency, thereby reducing Nunavut's energy costs and its reliance on imported fossil fuel.

- Energy Awareness Initiative: The Government of Nunavut will initiate a 10-year program to raise awareness and understanding of energy efficiency and conservation.
- Energy Education Initiative: The GN will work with Nunavut Arctic College to help make Nunavummiut more aware of energy issues.
- Buildings and Equipment Initiative: The GN will encourage and motivate building owners, landlords and tenants to improve the energy efficiency of their facilities and increase the use of alternative energy.
- Transportation Energy Initiative: The GN will motivate Nunavummiut to purchase energy efficient vehicles, to maintain them, and to introduce more efficient energy-management practices.

2. FOSTERING THE ADOPTION OF ALTERNATIVE ENERGY

The Government of Nunavut will develop and implement a series of policy actions that will increase the adoption of clean, renewable, domestic energy sources to replace fossil fuels in the generation of electricity and the provision of heat and hot water.

- Policy and planning: The GN will initiate a technical and economic study to identify and quantify the various clean, alternative energy sources that are available for each of its 26 communities.
- Alternative energy for electrical generation
- Alternative energy for heat and hot water: The GN will implement a series of demonstration projects to determine the feasibility of various alternative energies for heat and hot water.
- Energy from waste: QEC and the GN will expand the use of energy from waste through the following policy actions.

3. BETTER MANAGEMENT PRACTICES

These practices are aimed at reducing Nunavut's reliance on imported fossil fuels by integrating sustainable energy policy into overall Government policy.

- Sustainable energy policies: The GN will review all of its key policies for energy impacts and modify them to encourage the adoption of energy efficiency and alternative energy.

[59] "Ikummatitt – The Government of Nunavut Energy Strategy." Government of Nunavut, September 2007.

4. URANIUM AND FOSSIL FUEL DEVELOPMENT

The GN will oversee the development of Nunavut's uranium, oil and natural gas resources to ensure that the development is environmentally and economically sustainable.

- Uranium: Nunavut's uranium reserves are attracting the attention of uranium miners. The Government of Nunavut released guiding principles for the development and mining of uranium to ensure that the process is environmentally sound and provides benefits to Nunavummiut.
- Oil and Natural Gas: Nunavut has 5% and 15%, respectively, of Canada's known reserves of oil and natural gas. High international prices are necessary to improve the possibility that developing these reserves will become economically feasible.

Table 6. Electricity Sources and Rates by Community – Nunavut[60]

NUNAVUT

				2012/2013						Electricity Rates ($ / kWh)	2012/2013	
	Communities	Pop.	Electricity Source	Cost per litre ($)	Generation (MWh)	Net Heat Rate (kWh/litre)	Litres consumed	Litres per capita	Monthly Charge	Residential - Non Government*	Diesel Used for Heating	Litres per capita
1	Arctic Bay	750	Diesel		3,009	3.60	834,696	1,113	$ 18.00	$ 0.8787	1,338,749	1,785
2	Arviat	2,508	Diesel		8,029	3.72	2,159,135	861	$ 18.00	$ 0.7914	2,974,762	1,186
3	Baker Lake	2,140	Diesel		8,938	3.87	2,312,481	1,081	$ 18.00	$ 0.7031	4,331,683	2,024
4	Cambridge Bay	1,658	Diesel		9,414	3.66	2,572,893	1,552	$ 18.00	$ 0.7606	4,662,271	2,812
5	Cape Dorset	1,491	Diesel		6,110	3.30	1,849,599	1,241	$ 18.00	$ 0.6859	1,330,493	892
6	Chesterfield Inlet	393	Diesel		2,002	3.54	565,326	1,438	$ 18.00	$ 0.9754	819,947	2,086
7	Clyde River	1,004	Diesel		3,681	3.67	1,004,173	1,000	$ 18.00	$ 0.7819	1,593,433	1,587
8	Coral Harbour	945	Diesel		3,368	3.49	966,145	1,022	$ 18.00	$ 0.9466	1,380,260	1,461
9	Gjoa Haven	1,386	Diesel		5,009	3.72	1,347,789	972	$ 18.00	$ 0.8945	2,080,186	1,501
10	Grise Fiord	157	Diesel		1,250	3.38	369,817	2,356	$ 18.00	$ 0.9209	569,154	3,625
11	Hall Beach	851	Diesel		3,258	3.60	905,836	1,064	$ 18.00	$ 0.8903	1,290,022	1,516
12	Igloolik	1,974	Diesel		6,183	3.44	1,798,376	911	$ 18.00	$ 0.6323	2,620,022	1,327
13	Iqaluit	7,177	Diesel		56,889	3.82	14,906,330	2,077	$ 18.00	$ 0.6029	22,446,151	3,128
14	Kimmirut	479	Diesel		2,063	3.45	598,730	1,250	$ 18.00	$ 1.0374	699,306	1,460
15	Kugaaruk	878	Diesel		2,654	3.63	731,527	833	$ 18.00	$ 1.1416	1,214,378	1,383
16	Kugluktuk	1,547	Diesel		5,577	3.52	1,585,171	1,025	$ 18.00	$ 0.9332	2,690,377	1,739
17	Pangnirtung	1,611	Diesel		6,477	3.66	1,769,781	1,099	$ 18.00	$ 0.6574	2,001,310	1,242
18	Pond Inlet	1,612	Diesel		5,994	3.58	1,675,787	1,040	$ 18.00	$ 0.8995	2,579,698	1,600
19	Qikiqtarjuaq	520	Diesel		2,531	3.54	715,864	1,377	$ 18.00	$ 0.7792	1,008,376	1,939
20	Rankin Inlet	2,777	Diesel		17,396	3.77	4,617,561	1,663	$ 18.00	$ 0.6223	5,598,152	2,016
21	Repulse Bay	1,040	Diesel		3,585	3.80	942,705	906	$ 18.00	$ 0.8506	1,473,913	1,417
22	Resolute Bay	225	Diesel		4,778	3.66	1,306,169	5,805	$ 18.00	$ 1.0135	1,901,999	8,453
23	Sanikiluaq	884	Diesel		3,483	3.70	941,903	1,066	$ 18.00	$ 0.8225	1,217,204	1,377
24	Taloyoak	980	Diesel		3,419	3.34	1,024,434	1,045	$ 18.00	$ 0.9836	1,416,487	1,445
25	Whale Cove	463	Diesel		1,753	3.40	515,940	1,114	$ 18.00	$ 0.9042	688,478	1,487
		35,450			176,850		48,018,168				69,926,811	

(*) Customers are entitled to a 700 kWh subsidy for each 30 day period from April 1st through September 30th.
Customers are entitled to a 1000 kWh subsidy for each 30 day period from October 1st through March 31th.

[60] Data compiled by CanmetENERGY-Varennes from different sources: (1) Qulliq Energy Corporation 2014/15 General Rate Application, November 2013, (2) http://nunavutenergy.ca/communities.

V. NUNAVIK

1. ENERGY POLICY CONTEXT

Energy policy in Nunavik is dictated by the Government of Quebec and electricity rates are set by the *Régie de l'énergie*. In practical terms, Hydro-Québec is planning the electricity supply for the Nunavik communities with the final approval by the *Régie de l'énergie*. Through its *Plan global en efficacité énergétique*, which is filed annually before the *Régie* as part of its rate case hearings, Hydro-Québec also dictates rules regarding electricity consumption in private and public buildings. For example, in order to benefit from the tier one electricity rates (see Table 6 below), it is forbidden to heat homes and buildings with electric baseboards or electric furnaces. As a consequence, buildings are heated with heating oil. Targeted energy efficiency programs are also designed by Hydro-Québec. Programs designed and deployed by the *Ministère de l'Énergie et des Ressources naturelles* such as *RénoClimat* and *LogiRénov* are also available in Nunavik.

2. ENERGY AND ELECTRICITY SUPPLY

Electricity in Nunavik is produced and distributed by Hydro-Québec. The tier 1 residential rate (consumption of up to 900 kWh per month) is the same as for all other clients in Quebec. This rate is currently set at $0.0557/kWh. Past this threshold, Nunavik homeowners are faced with a rate of $0.3364/kWh. With such a rate, there is a strong incentive to maintain electricity consumption below the threshold of 900 kWh per month.[61]

Figure 9. Communities in Nunavik

On February 2, 1994, the Makivik Corporation[62] and Hydro Quebec entered into an Electricity Supply Plan Agreement. Pursuant to the Agreement, a Protocol was signed on September 9, 1994, through which Hydro-Québec was to subsidize the cost of heating oil and propane gas and, at its own expense, provide for maintenance and repair of oil-fired furnace burners and water heaters used by its electricity commercial, industrial, institutional, and private customers in all Inuit communities. Hydro-Québec and the Makivik

[61] « Plan d'approvisionnement des réseaux autonomes – Annexe ». Hydro-Québec, Demande R-3864-2013, HQD-2, document 2, 1 novembre 2013.

[62] The Makivik Corporation is the legal representative of Quebec's Inuit people, established in 1978 under the terms of the James Bay and Northern Quebec Agreement, the agreement that established the institutions of Nunavik. Its principal responsibility is the administration of Inuit lands and the over CAN$120 million in compensation funds it has received under the terms of the James Bay and Northern Quebec Agreement of 1975 and the more recent offshore Nunavik Inuit Land Claims Agreement that came into effect in 2008. It has a mandate to use those funds to promote the economic and social development of Inuit society in Nunavik. The Makivik Corporation is also empowered to negotiate new agreements with governments on behalf of the Quebec Inuit and to represent them on bodies like the Inuit Tapiriit Kanatami and the Inuit Circumpolar Council. The corporation is run by a five-member executive committee including a president, and a 16-member board of directors. Members of both bodies are elected by the Inuit of Nunavik. The executive committee and board of directors together appoint a board of governors to act as an elders' council. Makivik's president is Jobie Tukkiapik. It is headquartered in Kuujjuaq, Quebec, and has offices in Inukjuak, Montreal, Quebec City, and Ottawa. It has roughly 100 employees. http://en.wikipedia.org/wiki/Makivik_Corporation

Corporation agreed that the administration of the Subsidy Program was to be undertaken by the Makivik Corporation.

The Protocol was renewed with the following modification that took effect on September 1, 2010: Makivik continues to administer the eligibility of the applications to the Subsidy Program and provides support to all eligible customers. The heating oil supplier administers the payment of the heating oil subsidies to all eligible customers. This means that eligible customers are not required to submit claims to Makivik for reimbursement of heating oil costs for deliveries made on September 1, 2010, and subsequently. The subsidies for heating oil are automatically applied by the supplier and therefore the customer is only being charged the difference between the heating oil price and the subsidy amount.

3. RENEWABLE ENERGY

For many years, and with the drive given by the various versions of the "Plan Nord", Hydro-Québec considered piloting the installation of a windmill in one of the seven communities that were identified as having the best wind potential in Nunavik. After years of studying the question, Hydro-Québec decided not to go ahead with the project arguing it was not profitable.[63] In the meantime, both the Federal Government and the Government of Quebec provided financial assistance to Tugliq Energy to install a wind mill and storage system at the Raglan Mine, located south east of the Community of Salluit. This is the only known renewable energy project in the region.

[63] "Hydro-Québec says Nunavik wind, underwater power projects 'not profitable'". NunatsiaqOnline 2014-10-24.

Table 7. Electricity Sources and Rates by Community – Nunavik[64]

QUEBEC (NUNAVIK)

				2012						Electricity Rates ($ / kWh) Residential		
	Communities	Pop.	Electricity Source	Cost per litre ($)	Generation (MWh)	Net Heat Rate (kWh/litre)	Litres consumed	Litres per capita	Monthly Charge*	Up to 30 kWh / day / period	Over 30 kWh / day / period	Production Costs ($/kWh)
1	Akulivik	615	Fuel No. 2		3,300	3.59	919,220	1,495	$ 12.19	$ 0.0557	$ 0.3364	$ 1.0970
2	Aupaluk	195	Fuel No. 2		1,600	3.75	426,667	2,188	$ 12.19	$ 0.0557	$ 0.3364	$ 1.1940
3	Inukjuak	1,597	Fuel No. 2		9,200	3.84	2,395,833	1,500	$ 12.19	$ 0.0557	$ 0.3364	$ 0.7770
4	Ivujivik	370	Fuel No. 2		2,100	3.35	626,866	1,694	$ 12.19	$ 0.0557	$ 0.3364	$ 1.3240
5	Kangiqsualujjuaq	874	Fuel No. 2		4,000	3.47	1,152,738	1,319	$ 12.19	$ 0.0557	$ 0.3364	$ 0.7880
6	Kangiqsujuaq	696	Fuel No. 2		4,400	3.34	1,317,365	1,893	$ 12.19	$ 0.0557	$ 0.3364	$ 0.8520
7	Kangirsuk	549	Fuel No. 2		3,400	3.48	977,011	1,780	$ 12.19	$ 0.0557	$ 0.3364	$ 0.7890
8	Kuujjuaq	2,375	Fuel No. 2		18,400	3.86	4,766,839	2,007	$ 12.19	$ 0.0557	$ 0.3364	$ 0.8600
9	Kuujjuaraapik	657	Fuel No. 2		11,000	3.63	3,030,303	4,612	$ 12.19	$ 0.0557	$ 0.3364	$ 0.7040
10	Puvirnituq	1,692	Fuel No. 2		10,200	3.76	2,712,766	1,603	$ 12.19	$ 0.0557	$ 0.3364	$ 0.6620
11	Quaqtaq	376	Fuel No. 2		2,400	3.52	681,818	1,813	$ 12.19	$ 0.0557	$ 0.3364	$ 0.9540
12	Salluit	1,347	Fuel No. 2		7,300	3.75	1,946,667	1,445	$ 12.19	$ 0.0557	$ 0.3364	$ 0.6500
13	Tasiujaq	303	Fuel No. 2		2,300	3.24	709,877	2,343	$ 12.19	$ 0.0557	$ 0.3364	$ 0.9060
14	Umiujaq	444	Fuel No. 2		2,700	3.51	769,231	1,733	$ 12.19	$ 0.0557	$ 0.3364	$ 0.9590
		12,090			82,300		22,433,201					

(*) $0.4064 / day.

[64] Data compiled by CanmetENERGY-Varennes from a variety of sources: (1) « Plan d'approvisionnement des réseaux autonomes – Annexe ». Hydro-Québec, Demande R-3864-2013, HQD-2, document 2, 1 novembre 2013. (2) Tarifs d'électricité (En vigueur le 1 avril 2015) – Chapitre 7 – Tarifs applicables aux réseaux autonomes.

VI. NUNATSIAVUT

1. ENERGY POLICY CONTEXT

Nunatsiavut is home to five communities, all found along the Northern Labrador coastline. From most northernly to southernly, these communities are Nain, Hopedale, Makkovik, Postville, and Rigolet. Each community has its own Inuit Community Government that manages the town's affairs. The Nunatsiavut Government acts as the governing body for the region, bringing all five communities together as one. The Nunatsiavut Government represents communities in areas as far-reaching as land claims negotiations, establishing mining regulations, and creating a tourism industry for the region. Each community has a population that ranges from 250 to 1,200 people. The residents of Nunatsiavut are primarily Inuits.

2. ENERGY AND ELECTRICITY SUPPLY

In Newfoundland and Labrador, the generation and distribution of electricity is provided by two utilities: Newfoundland Power (NP), an investor-owned utility and subsidiary of Fortis Inc., and Newfoundland & Labrador Hydro (Hydro), a provincial Crown corporation which has the mandate to generate and transmit electricity in the province, and to provide distribution and retail services to customers in Labrador and in areas of the island of Newfoundland not serviced by NP.

NP is the primary distributor of electricity on the island portion of the Province. NP distributes power to nearly 240,000 customers. Hydro supplies about 92% of its energy requirements and NP supplies the remainder with its 23 small hydroelectric generating plants. The majority of customers are served by the island's interconnected system. In Labrador, customers on the Labrador interconnected system are served by Hydro with power from Churchill Falls. Customers in 21 isolated systems on the coasts of Newfoundland and Labrador receive their power from diesel generators operated by Hydro.

Figure 10. Nunatsiavut Communities

In July 2007, as part of its Northern Strategic Plan for Labrador, the Provincial Government announced an annual investment for an electricity rebate to reduce the cost of basic electricity consumption for Hydro residential customers in Labrador's coastal rural isolated diesel communities as well as those in the Labrador Straits (approximately 2,600 customers). This rebate is funded by the Provincial Government and is not included in the PUB-approved rates. There is also a separate rate structure for

isolated communities where diesel generation is used. These customers receive a first block of power at the same rates as island interconnected consumers.

The rebate brings the costs of the monthly Basic Customer Charge and lifeline block of energy for Labrador rural isolated diesel and Labrador Straits residential electricity customers in line with comparable Happy Valley – Goose Bay residential electricity costs. It is intended to provide some rate assistance to residential customers. This electricity rebate applies to the Lifeline Block of electricity consumption, which is intended to represent electricity sufficient to cover basic needs, such as lighting, cooking and water heating, as well as the basic customer charge for residential customers. The average monthly electricity rebate, depending on usage, is approximately $45-$65 monthly.[65]

3. RENEWABLE ENERGY

Electricity to Northern communities in Labrador is generated and supplied by Newfoundland & Labrador Hydro. The company is investigating renewable energy sources for diesel communities in the province. It is also currently evaluating the potential for small-scale hydroelectric sites and wind generating sites to reduce these communities' reliance on diesel generation.

To support efforts of identifying alternative sources of energy for Labrador's coastal communities, the Provincial Government announced in June 2011 the start of the Coastal Labrador Wind Monitoring Program under Phase Two of the Coastal Labrador Alternative Energy study. Hydro is currently managing this project on behalf of the province.

Phase One of the study identified alternative energy sources that have the potential to provide some level of clean renewable power to residents on Labrador's coast who are currently serviced by diesel generation. The results of this initial phase provided valuable information on the region's resource potential and areas for further examination, such as wind and small-scale hydroelectricity.

In addition to the Wind Monitoring Program, Hydro is furthering investigation at the hydroelectric sites identified in Phase One of the Alternative Energy Study. Currently ongoing, the analysis includes preliminary investigations at the sites shown to be competitive against the cost of diesel fuel, and/or capable of displacing one or more diesel plants. This study includes more detailed engineering and environmental assessments, cost estimates, and detailed surveying and mapping.

Hydro's parent company, Nalcor, has built one of the first projects in the world integrating generation from wind, hydrogen and diesel in an isolated electricity system. The Wind-Hydrogen-Diesel Energy Project in Ramea is a research and development project that uses renewable energy sources to supplement the diesel requirements of the island community. The demonstration phase involves studying the operation of the facility, analyzing collected data and considering issues regarding the role this technology can play in an isolated electricity system.

[65] http://www.nr.gov.nl.ca/nr/energy/electricity

To inform the development of a provincial net metering policy in collaboration with Newfoundland and Labrador Hydro and Newfoundland Power, Navigant Consulting Limited was retained to research relevant standard industry practices and provide guidance on developing a proposed net metering policy which will allow small-scale renewable energy sources to be fed into the province's electricity grid.[66] We assume some small-scale renewable electricity in Nunatsiavut could qualify under this program to the extent electricity can be sold to Hydro in a micro-grid context. This is an area where micro-grid expertise could be deployed.

[66] "Net Metering Standard Industry Practices Study". Navigant Consulting, October 31, 2014.

Table 8. Electricity Sources and Rates by Community – Nunatsiavut

LABRADOR (NUNATSIAVUT)

	Communities	Pop.	Electricity Source	Monthly Charge	Electricity Rates ($ / kWh) Residential First Block (*)	Second Block	Thereafter
1	Black Tickle	220	Diesel	$ 7.15	$ 0.0328	$ 0.1183	$ 0.1604
2	Cartwright	550	Diesel	$ 7.15	$ 0.0328	$ 0.1183	$ 0.1604
3	Charlottetown	350	Diesel	$ 7.15	$ 0.0328	$ 0.1183	$ 0.1604
4	Hopedale	530	Diesel	$ 7.15	$ 0.0328	$ 0.1183	$ 0.1604
5	Makkovik	362	Diesel	$ 7.15	$ 0.0328	$ 0.1183	$ 0.1604
6	Mary's Harbour	417	Diesel	$ 7.15	$ 0.0328	$ 0.1183	$ 0.1604
7	Mud Lake	60	Diesel	$ 7.15	$ 0.0328	$ 0.1183	$ 0.1604
8	Mushuau	706	Diesel	$ 7.15	$ 0.0328	$ 0.1183	$ 0.1604
9	Nain	1,034	Diesel	$ 7.15	$ 0.0328	$ 0.1183	$ 0.1604
10	Norman Bay	45	Diesel	$ 7.15	$ 0.0328	$ 0.1183	$ 0.1604
11	Paradise River	14	Diesel	$ 7.15	$ 0.0328	$ 0.1183	$ 0.1604
12	Port Hope Simpson	529	Diesel	$ 7.15	$ 0.0328	$ 0.1183	$ 0.1604
13	Postville	219	Diesel	$ 7.15	$ 0.0328	$ 0.1183	$ 0.1604
14	Rigolet	269	Diesel	$ 7.15	$ 0.0328	$ 0.1183	$ 0.1604
15	St. Lewis	252	Diesel	$ 7.15	$ 0.0328	$ 0.1183	$ 0.1604
16	Williams Harbour	59	Diesel	$ 7.15	$ 0.0328	$ 0.1183	$ 0.1604
		5,616					

	First Block (kWh)	Second Block (kWh)
JAN	1000	0
FEB	1000	0
MAR	900	100
APR	900	100
MAY	800	200
JUN	800	200
JUL	700	300
AUG	700	300
SEP	700	300
OCT	800	200
NOV	900	100
DEC	1000	0

(*) With Northern Strategic Plan credit for Labrador Isolated rural residential customers

VII. COMMUNITY RELATIONS AND LOCAL NETWORKS

1. COMMUNITY RELATIONS

Working with communities in the North requires buy-in from territorial governments but also, and more importantly, from the communities. The Arctic Energy Alliance[67] has established strong partnerships with communities, self-governments, utilities, the Federal Government and agencies, and the renewable energy industry. The Alliance provides technical expertise on northern/remote technologies and community processes. The Alliance has identified the following challenges in working with northern communities[68]:

- Communities are very independent – need to be introduced
- Most have a very small population (50 to 1000)
- High unemployment rate
- Small local economy
- Challenge of getting supplies
- Shortage of qualified labour
- Energy costs

Lessons learned by the Alliance over the years:

- Patience
- Stability over the years
- Build the relationship step by step
- Be present locally through people known in the community and the region
- Hire local liaison employees for special projects
- Establish partnerships with local staff with other mandates
- Ask for community support in tangible ways
- Translations and broad consultations
- Keep plan simple
- Build long-term local capacity
- Cultural awareness very important
- Physical demonstration of proven technologies helpful

At the Sivummut IV Conference held in Iqaluit in December, 2014, there were a number of extremely enlightening comments made by participants.[69] Some expressed the concern that the Nunavut economy does not just apply to regional centers and that focus should be extended to smaller communities as well. The government should hold economic development workshops in all communities first, then

[67] The Arctic Energy Alliance is a not-for-profit organization incorporated in 1997. It currently employs 19 staff in five offices across the NWT. The Alliance is the go-to place for advice on renewable energy and energy efficiency. Its mission is to promote and facilitate the adoption of renewable energy and energy efficiency by all members of NWT society. The AEA delivers many programs for the NWT government including the Energy Efficiency Incentive Program. The AEA also provided a series of services to the Nunavut Energy Secretariat. They mainly performed yardstick energy audits, site visits and verbal advice for a half-dozen public buildings in Iqaluit and Arviat. Targeted energy audits have also been performed.

[68] Summary from : "Smart Energy Communities in Northern & Remote Canada: The Northwest Territories." Marie-Soleil Lacoursière, Operations Coordinator, Arctic Energy Alliance.

[69] Conference Notes – Sivummut IV Conference. Iqaluit, Nunavut, December 1-4, 2014.

regional, then territorial. Other participants stated that different communities have different priorities and this must be built into regional and Nunavut-wide planning – hence a bottom-up approach rather than top-down. Questioning the notions of what is a healthy community, a good life and wellness, some participants stated that " […] elders' interpretations are very different from southern definitions […] " and that " […] elders' knowledge is another local asset which is underutilized."

Participants found that high fuel, housing and other costs were challenges for community economic development. At the same time, they stated that the community economic development plan for each community must have strong community participation. In addition, there is a need to focus on projects that complement local reality. They should not be too vast and align with their strengths (e.g. cold weather testing; tidal/solar power). What transpires out of this conference is that understanding community concerns is absolutely necessary to designing energy solutions that are aligned with each community's set of priorities.

At a QUEST workshop[70], in 2013, in conjunction with the annual Energy Ministers' Conference, QUEST Canada representatives reiterated some of the key outcomes of the QUEST 2012 Roundtable on Northern and Remote Communities.[71]

- High cost of energy
- Critical reliability issues (e.g. marine fuelling one per year)
- Need to replace ageing infrastructure (e.g. diesel generator sets coming to their end of life)

During the same workshop, participants outlined a number of key messages including one specific to innovation and collaboration: "Support established partners in the North, like the Arctic Energy Alliance and the Cold Climate Technology Centre to serve as innovation and demonstration convenors." The Arctic Energy Alliance representative added that "[…] one of the key successes to overcoming reluctance to attracting investment and overcoming cultural barriers in the North is to physically demonstrate proven technologies. […] Success in the North happens because of communities and the immense social and innovative capacity that exists. "

2. NETWORKS

QUEST North is the official QUEST Canada caucus for Yukon, NWT and Nunavut. The purpose of QUEST North is to provide a high-level forum for dialogue among northern energy and community stakeholders with the aim of implementing actions to advance Smart Energy Communities across Canada's North, more specifically through advancing knowledge and innovation, identifying opportunities for collaboration, and aligning messaging for advocacy. Currently, QUEST North holds regular meetings via teleconference. To date, they have organized four special meetings to identify mutual opportunities, build partnerships, and actualize a community of practice to advance Smart Energy Communities. Executives of QUEST North include representation from the three territorial governments, the cities of Yellowknife and Whitehorse, the NWT Public Utilities Board, STDC, CanNOR, AANDC as well as half a dozen private companies.

[70] Smart Energy Communities in Northern and Remote Canada. Yellowknife City Hall, August 27, 2013.

[71] "Fuelling the North: Prosperity, Affordability and Sustainability - QUEST Roundtable on Northern and Remote Communities." November 21, 2012, QUEST 2012 International Conference & Tradeshow, Winnipeg, Manitoba.

The Energy Solutions Centre[72] is a branch of the Government of Yukon's Department of Energy, Mines and Resources. The branch's mandate is to encourage improvements in energy efficiency and the adoption of more forms of renewable energy. To accomplish this mandate, the branch participates in the design of energy policies and delivers energy programs and projects that enhance the environmental, economic and social sustainability of the territory.

The Nunavut Energy Secretariat (NES) is part of the Department of Economic Development and Transportation. The NES is responsible for the development, coordination and delivery of Nunavut's energy strategy. In this respect, the secretariat monitors energy-related issues, develops and delivers energy-related programs and services while coordinating action on energy decisions. The Energy Secretariat is the intergovernmental lead on Federal-Territorial-Provincial energy policy discussions. The Energy Secretariat is also responsible for energy and climate change mitigation awareness work. This work is aimed at increasing adoption of energy conservation practices, reducing energy waste, improving understanding of energy use, and reducing greenhouse gas emissions.

Other networking opportunities exist through local colleges and territorial associations such as the Yukon Wood Products Associations, the Northwest Territories Biomass Energy Association, the NWT & Nunavut Chamber of Mines and the Yukon Chamber of Mines. National associations such as DE Canada are active in the North and are open to pursuing cooperation in the deployment of decentralized energy options. Over the years, they have nurtured relationships with local communities and their expertise could be leveraged to help move projects forward.

[72] A significant number of energy related studies are posted on the following website: www.esc.gov.yk.ca/publications.html

VIII. HOUSEHOLDS AND COMMUNITY PROFILES

1. HOUSEHOLD EXPENDITURES AND DWELLING CHARACTERISTICS

A quick analysis of the territories' gross domestic product (GDP), based on final consumption expenditures, shows a strong proportion of government expenditures (over 50% in all three territories) while, in the rest of Canada, government expenditures account for 26.4%. Consequently, household expenditures are the main driving force of the Canadian GDP at 71.8%. In the territories, household expenditures account for 48.1%, 43.4% and 34.9% in Yukon, the NWT and Nunavut, respectively.

For household expenditures, the breakdown between goods and services is comparable – all three territories being quite close to the Canadian average. However, the proportion of expenditures between durable goods, semi-durable goods and non-durable goods shows greater variances compared to the Canadian average. This discrepancy is particularly true for Nunavut, where durable goods only account for 13.5% of goods expenditures, while the Canadian average stands at 30.7%. At the other end of the spectrum, the share of non-durable goods is much higher in Nunavut at 62.8% of expenditures.

Table 9. Gross Domestic Product, Expenditure-Based

GROSS DOMESTIC PRODUCT, EXPENDITURE-BASED

	Final Consumption Expenditure (%) *			
	Canada	**Yukon**	**NWT**	**Nunavut**
Household final consumption expenditure	71.8	48.1	43.4	34.9
Goods	45.9	42.1	46.6	47.3
Durable goods	30.7	30.4	26.5	13.5
Semi-durable goods	18.1	15.2	17.8	24.7
Non-durable goods	51.5	54.5	56.4	62.8
Services	54.1	57.9	53.5	52.7
Non-profit inst's serving households' final cons. exp.	1.9	2.0	1.6	2.6
General governments final consumption expenditure	26.4	50.0	55.0	62.8

(*) Totals may not add due to rounding

Source: Statistics Canada, CANSIM, table 384-0038.

The *Survey of Household Spending (SHS), Dwelling Characteristics and Household Equipment* [73] conducted by Statistics Canada sheds some light on the differences in household expenditures in the three territories and offers a better understanding of why such major differences can be observed (details are shown in Table 10).

In Nunavut, 79.5% of households live in rented dwellings, while this proportion stands at 34.8% in Yukon and 46% in the NWT. The survey also shows important gaps in the quality of dwellings as measured by the number of dwellings needing major repairs and minor repairs (59.5% in Nunavut vs 37.9% in Yukon). As mentioned in our introduction, the ownership structure of the housing stock and the general

[73] CANSIM Table 203-0031 - Survey of Household Spending, Dwelling Characteristics and Household Equipment.

condition of it may orient the deployment of building-related energy efficient technologies and the possibility of using split incentives.

Another interesting figure observed in the Survey is the number of households having a freezer. In Nunavut, only 36.8% of households have a freezer compared to 65% in Yukon and 57.8% in the NWT. This could potentially reflect the fact that many communities in Nunavut have community freezers – hence confirming the relevance of efforts deployed to reduce the energy used by this type of equipment.

Table 10. Survey of Household Spending, Dwelling Characteristics and Household Equipment as of December 31, 2012

	Yukon	NWT	Nunavut
		%	
Single-detached dwelling	63.7	55.4	48.6
Single-attached dwelling	12.0	13.6	32.8
Apartment	16.3	21.5	-
Other type of dwelling	-	-	-
Dwellings needing major repairs	15.9	17.8	32.1
Dwellings needing minor repairs	22.0	28.4	27.4
Dwellings needing no repairs	62.1	53.8	40.5
Owned dwelling	65.2	54.0	20.5
Rented dwelling	34.8	46.0	79.5
Dwellings with 1 to 4 rooms	31.1	34.6	35.2
Dwellings with 5 rooms	18.3	22.3	28.3
Dwellings with 6 rooms	15.9	16.6	20.4
Dwellings with 7 or more rooms	34.6	26.5	-
Dwellings with bathrooms (with a bathtub or shower)	98.2	99.6	100.0
Principal heating equipment, hot air furnace	58.0	56.4	39.4
Principal heating equipment, heating stove (including wood stove)	15.7	-	-
Principal heating equipment, electric heating (including baseboards)	17.9	-	-
Age of principal heating equipment, 5 years old and under	23.7	29.6	-
Age of principal heating equipment, 6 to 10 years old	27.7	26.0	21.1
Age of principal heating equipment, over 10 years old	48.6	44.4	61.2
Principal heating fuel, oil or other liquid fuel	59.4	59.7	94.3
Principal heating fuel, bottled gas (propane)	-	16.2	-
Principal heating fuel, electricity	18.2	-	-
Principal heating fuel, wood	15.0	-	-
Principal heating fuel for hot water, oil or other liquid fuel	13.6	35.3	80.5
Principal heating fuel for hot water, electricity	79.8	39.6	19.5
Principal heating fuel for hot water, other heating fuel or no running hot water	-	17.3	-
Principal cooking fuel, electricity	94.9	93.4	99.1
Households having a washing machine	86.8	87.1	86.7
Households having a clothes dryer	82.9	85.6	88.6
Households having a dishwasher	59.2	51.7	28.6
Households having refrigerators	99.3	100.0	100.0
Households having a freezer	65.0	57.8	36.8
Households having a microwave oven	91.4	89.7	86.1
Households having air conditioning	-	13.9	-
Households having a telephone (regular or cellular)	98.2	96.2	91.7
Households having cablevision	47.5	56.1	70.0
Households having a satellite dish	33.6	33.3	22.9
Households having a home computer	87.2	82.7	71.3
Households having Internet use from home	81.7	80.2	65.1
Households having colour televisions	94.6	99.0	98.5

Symbol legend: (-) = Too unreliable to be published.

Source: CANSIM Table 203-0031(accessed: 2015-02-25)

If we dig a little deeper into the housing sector, there are some additional features which could help better understand the decision-making process of households with regard to energy management. As noted above, rented dwellings represent a significant market share in Nunavut, but also in the NWT. The table below shows the number of dwellings administered by the housing corporations in the three territories.[74]

Table 11. Dwellings Managed by Housing Corporations

	Yukon	Northwest Territories	Nunavut
Social Units	652	2349	5123
Staff Units	168	?	1424
Total	**820**	**2349**	**6547**

These figures mirror the rented versus owned dwellings presented in Table 10. With a building stock comprised of over 10,000 units, housing corporations are definitely knowledgeable stakeholders regarding energy use patterns and profiles in the residential sector.

Table 12 shows some interesting additional facts about households in the North. The most striking one is the fact that, notwithstanding a few exceptions, household expenditure proportions in the three territories are not significantly different than the Canadian average. One clear exception is the proportion of food in Nunavut – which stands at 23.9% of total household expenditures – which is well above the proportions in the two other territories.

Not surprisingly, given the lack of roadways, transportation expenses by household are much lower in Nunavut than they are in Yukon and the NWT, or compared to the Canadian average. However, perhaps the most intriguing observation is in regards to the expenses for household operation (which include energy expenses) which follow the Canadian average in proportion of total household expenditures for all three territories.

[74] Data compiled by CanmetENERGY – Varennes. Sources: (1) Yukon Housing Corporation Annual Report – March 2014, (2) Northwest Territories Housing Corporation Annual Report 2013-2014, (3) Nunavut Housing Corporation Annual Report 2013/2014.

Table 12. Average Household Expenditures 2012 (Detailed Categories)

	Canada	%	North	%	Yukon	%	Northwest Territories	%	Nunavut	%
Total expenditure	***$79,012***	***100.0%***	***$95,107***	***100.0%***	***$86,958***	***100.0%***	***$107,641***	***100.0%***	***$86,997***	***100.0%***
Total current consumption	**$58,592**	**74.2%**	**$68,022**	**71.5%**	**$62,903**	**72.3%**	**$76,620**	**71.2%**	**$61,730**	**71.0%**
Total food	$7,980	13.6%	$11,046	16.2%	$8,678	13.8%	$11,022	14.4%	$14,744	23.9%
Total shelter	$16,387	28.0%	$17,836	26.2%	$16,443	26.1%	$21,697	28.3%	$13,610	22.0%
Total household operation	$4,328	7.4%	$5,168	7.6%	$4,706	7.5%	$5,777	7.5%	$4,877	7.9%
Total household furnishings and equipment	$849	1.4%	$2,529	3.7%	$2,477	3.9%	$2,735	3.6%	$2,269	3.7%
Total clothing	$3,550	6.1%	$3,703	5.4%	$2,914	4.6%	$4,078	5.3%	$4,305	7.0%
Total transportation	$12,041	20.6%	$12,465	18.3%	$13,344	21.2%	$15,276	19.9%	$6,466	10.5%
Total health care	$2,407	4.1%	$1,480	2.2%	$1,846	2.9%	$1,456	1.9%	$956	1.5%
Total personal care	$1,229	2.1%	$1,457	2.1%	$1,225	1.9%	$1,699	2.2%	$1,417	2.3%
Total recreation	$3,922	6.7%	$6,542	9.6%	$6,198	9.9%	$6,720	8.8%	$6,778	11.0%
Total reading materials and other printed matter	$183	0.3%	$265	0.4%	$303	0.5%	$260	0.3%	$213	0.3%
Total education	$1,518	2.6%	$785	1.2%	$1,075	1.7%	$722	0.9%	F	F
Total tobacco products and alcoholic beverages	$1,331	2.3%	$2,969	4.4%	$2,077	3.3%	$3,033	4.0%	$4,242	6.9%
Games of chance (net of winnings)	$160	0.3%	$448	0.7%	$306	0.5%	$670	0.9%	$299	0.5%
Total miscellaneous expenditures	$1,563	2.7%	$1,329	2.0%	$1,311	2.1%	$1,476	1.9%	$1,114	1.8%
Personal taxes (net of refunds)	**$13,891**	**17.6%**	**$18,838**	**19.8%**	**$16,081**	**18.5%**	**$22,228**	**20.7%**	**$17,499**	**20.1%**
Total personal insurance payments and pension contributions	**$4,562**	**5.8%**	**$5,860**	**6.2%**	**$5,814**	**6.7%**	**$6,385**	**5.9%**	**$5,064**	**5.8%**
Total gifts of money and contributions	**$1,968**	**2.5%**	**$2,387**	**2.5%**	**$2,160**	**2.5%**	**$2,408**	**2.2%**	**$2,703**	**3.1%**

Source: Statsistics Canada, Table 203-0030 Survey of household spending (SHS) for territorial data. Table 203-0021 for Canada.

2. COMMUNITY ENERGY PROFILES

The *Survey of Household Spending, Dwelling Characteristics and Household Equipment* provides aggregate information regarding energy-using equipment in households in the three territories. By cross-cutting such information at a more micro-level with specific community profiles, it is possible to draw preliminary assessments of electricity usage and identify potential areas of interest from a DSM perspective and related technology deployment.

When considering energy consumption, community profiles are essential as they provide a first rough scan of local issues and potential solutions. The three territorial governments have invested time and resources in developing community energy profiles. Although the depth of these profiles may vary from one region to the other, they are nevertheless extremely useful for the purpose of understanding energy demand profile and loads and identifying potential receptors of new energy efficient technologies. These community profiles should be carefully reviewed and analyzed prior to considering interventions and technology deployment in the North.

The Yukon community profiles provide basic socio-economic information. Of interest are the short descriptions of the economic activity and development information provided for every community.[75] There is also some readily available information on essential infrastructures within the communities.

In 2010, the Arctic Energy Alliance completed and published an energy profile for every community in the NWT. Each profile shows population figure, total energy cost and total energy used in the community. It also gives an idea of the types of energy used within the community, the efficiency of the

[75] http://www.yukoncommunities.yk.ca/

diesel production units as well as the allocation of energy use between homes, other buildings and transportation. Although not comprehensive, these profiles are very helpful for cross comparison between communities.[76]

In addition, the Northwest Territories Bureau of Statistics[77] published socio-economic profiles for each community with basic information on key infrastructure such as number of buildings or facilities for the following categories: educational, recreation, tourism, housing, health, community, municipal, business, etc. A summary of the 33 community infrastructure profiles is presented in Table 13 at the end of this section.

The Government of Nunavut also published relatively extensive community profiles. A typical profile includes community services and information and details on community businesses: accommodation and dining, retail, transportation and shipping, expediting, contracting and equipment supply, tourism and culture, technical and communications, etc. These short profiles are very useful to get a snapshot of services and commercial activities conducted in every community.[78]

Finally, Figures 11 to 14 provide some insights regarding population, employment and unemployment rates in the three territories. It is interesting to notice that, in the past five years, the working age population in Yukon and Nunavut has increased at a significant pace while the working age population in the NWT at the end of 2015 was below the 2010 levels.[79]

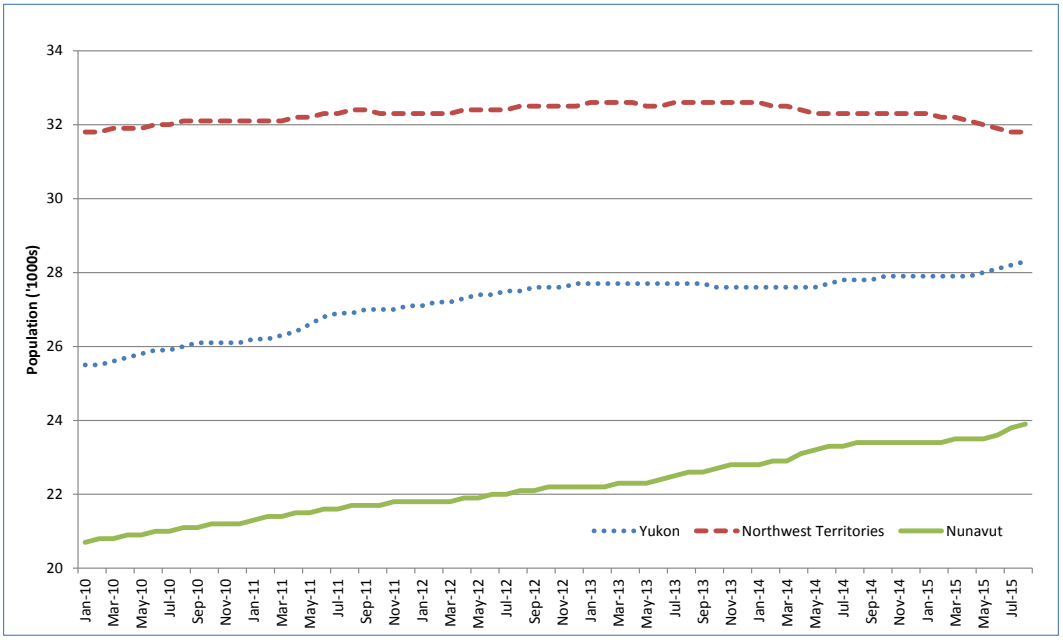


Figure 11. Territorial Working Age Population – 15 Years and Over (January 2010 – August 2015)

[76] http://aea.nt.ca/communities

[77] http://www.statsnwt.ca/community-data/index.html

[78] http://nunavutenergy.ca/communities

[79] Figures 11 to 14 were prepared by CanmetENERGY – Varennes with data from the following sources: (1) Statistics Canada Table 051-0001 Estimates of Population, by age group and sex for July 1, Canada, provinces and territories, annual. (Accessed May 28, 2015). (2) Statistics Canada Table 282-0100 Labour Force Survey estimates, by territories, sex and age group, 3-month moving average, seasonally adjusted and unadjusted, monthly. (Accessed September 9, 2015).

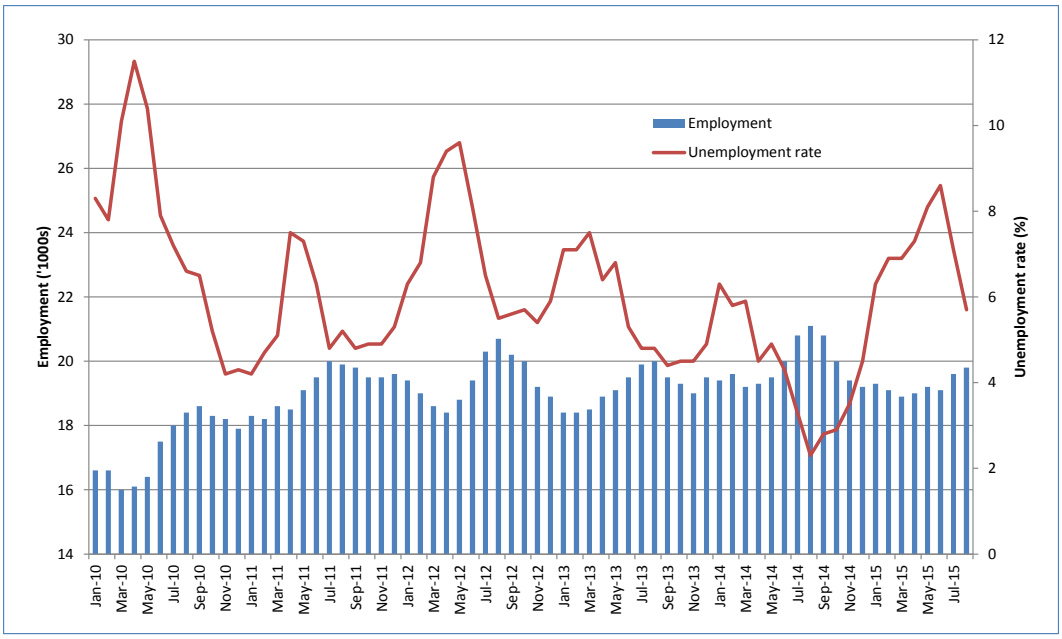


Figure 12. Yukon – Monthly Employment and Unemployment Rate (January 2010 – August 2015)

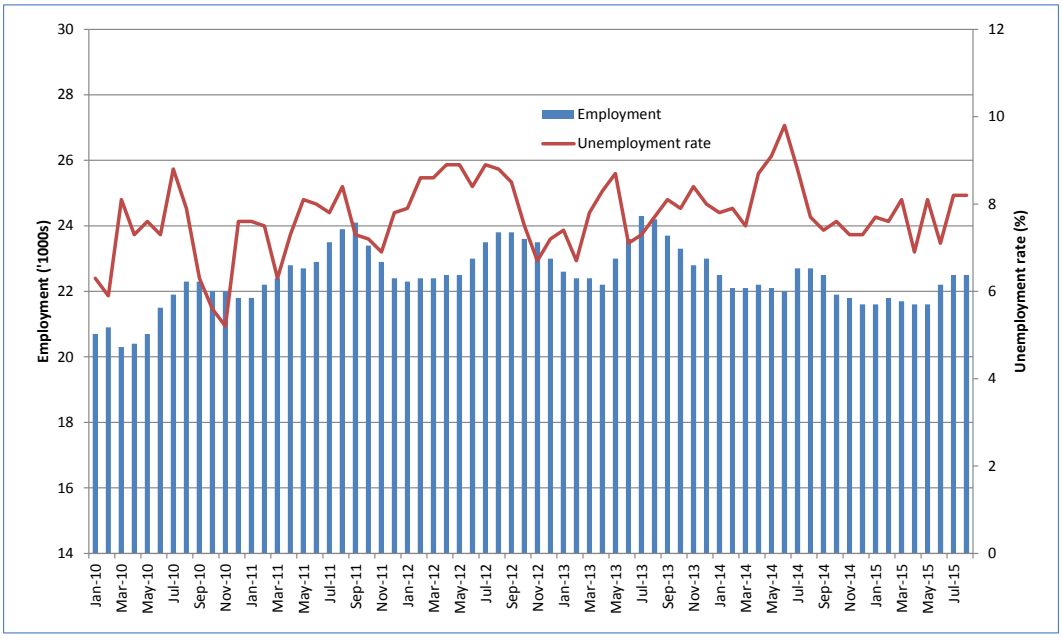


Figure 13. NWT – Monthly Employment and Unemployment Rate (January 2010 – August 2015)

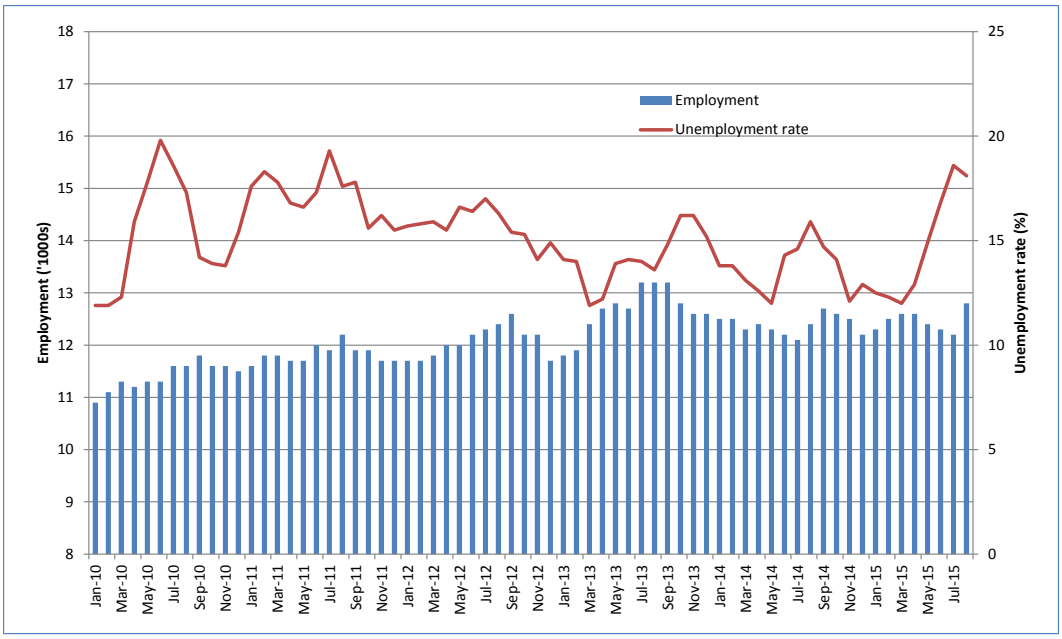


Figure 14. Nunavut – Monthly Employment and Unemployment Rate (January 2010 – August 2015)

Table 13. Northwest Territories Community Profiles Summary

	Aklavik	Behchokǫ̀ / Rae-Edzo (Dog Rib Rae)	Colville Lake (Behdzi Ahda)	Déline (Fort Franklin Settlement)	Dettah	Enterprise	Fort Good Hope (K'asho Got'ine)	Fort Liard (Acho Dene Koe)	Fort McPherson (Tetlit Gwich'in)	Fort Providence (Deh Gah Gotie Dene Council)	Fort Resolution (Deninu K'ue)	Fort Simpson (Liidlii Kue)	Fort Smith (Salt River)	Gamèti (Rae Lakes)	Hay River (West Point)	Hay River Reserve (K'atlodeeche)	Inuvik	Jean Marie River	Kakisa (Ka'a'gee Tu)	Lutsel K'e Dene Band (Snowdrift Settlement)	Nahanni Butte (Nahanni Butte Dene / Deh Cho)	Norman Wells	Paulatuk	Sachs Harbour	Trout Lake (Sambaa K'e Dene)	Tsiigehtchic (Arctic Red River / Gwichya Gwich'in)	Tuktoyaktuk	Tulita (Tulita Dene / Fort Norman)	Ulukhaktok (Holman)	Wekweètì (Dechi Laot'i / Snare Lake)	Whatì (Tlicho / Lac La Martre)	Wrigley (Pehdzeh Ki)	Yellowknife (City of Yellowknife and N'dilo)
Educational Infrastructure																																		
Community Learning Centre	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	N	N	N	Y	N	Y	N	N	N	Y	Y	Y	Y	Y	Y	N	Y
Aurora Campus	N	N	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y
Aurora Research Centre	N	N	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y
Career Centre	N	N	N	N	N	N	N	N	N	N	N	Y	Y	N	Y	N	Y	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	Y
Recreation Infrastructure																																		
Community Hall	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	1	1	1	0	0	1	1	1	1	1	0	1
Arena	1	1	0	1	0	0	1	1	1	1	1	1	1	1	1	0	1	0	0	1	0	1	1	1	0	0	1	1	1	1	1	0	3
Curling Rink	1	0	0	1	0	0	1	0	1	1	0	1	1	0	1	0	1	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	1
Gymnasium	1	3	1	1	1	1	1	1	1	1	1	3	3	2	3	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	10
Swimming Pool	1	1	0	0	0	0	0	1	1	1	1	1	1	0	1	0	1	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	1
Transportation Infrastructure																																		
All Weather Access Road	N	Y	N	N	Y	Y	N	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	N	N	N	N	N	N	Y	N	N	N	N	N	Y	Y
Winter Access Road	Y	N	Y	Y	Y	N	Y	N	N	N	N	N	N	Y	N	N	N	N	N	N	Y	Y	N	N	Y	N	Y	Y	N	N	Y	N	N
Marine Re-supply Facility	N	N	N	N	N	N	N	N	Y	N	N	Y	N	N	Y	N	Y	N	N	Y	N	Y	Y	Y	N	Y	Y	N	Y	N	N	Y	N
Airport	Y	N	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y
Air Terminal Building	Y	N	Y	Y	N	N	Y	Y	Y	N	Y	Y	Y	Y	Y	N	Y	N	N	Y	N	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y
Tourism Infrastructure																																		
Lodges|Outfitters	1	1	1	3	1	0	0	0	0	1	3	8	17	0	10	0	7	0	0	0	1	10	1	2	2	0	9	1	2	1	0	0	38
Accommodations	1	1	1	0	0	1	3	1	1	2	2	8	12	1	7	0	6	2	1	0	2	5	1	0	0	0	1	1	1	0	1	0	19
Campgrounds	0	0	0	0	0	2	0	1	1	1	1	1	1	0	2	0	3	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	3
Parks	0	1	0	0	0	3	0	1	1	2	1	1	2	0	1	0	3	1	2	0	0	1	0	0	0	0	0	0	0	0	0	0	9
Restaurants	0	0	0	1	0	1	0	0	0	1	0	3	4	0	8	0	7	0	0	0	0	3	0	0	0	0	0	0	1	0	0	0	33
Visitor Centre	0	0	0	0	0	0	0	1	1	0	0	1	2	0	1	0	1	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	2
Housing Infrastructure																																		
Private (owned)	77	251	30	64	41	28	104	102	120	118	105	243	546	47	941	64	432	13	15	60	33	117	19	14	32	28	81	65	31	23	73	31	3621
Private (rented)	11	13	1	11	3	11	17	57	16	22	7	79	182	8	218	13	458	7	2	7	1	72	8	3	0	8	9	12	7	12	10	1	2292
Public Housing (rented)	134	168	0	88	36	0	53	0	120	94	63	96	138	8	169	10	240	0	0	37	0	36	42	23	0	23	167	69	87	0	16	9	289
Staff Housing (rented)	6	35	4	10	0	0	9	11	13	8	9	23	17	7	21	6	149	0	1	7	1	81	5	7	0	1	27	11	15	0	20	1	541
Business Infrastructure																																		
Government Financing	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	3
Chartered Bank Branches	0	0	0	0	0	0	0	0	0	0	0	1	1	0	2	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	5
ATM Service	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
Grocers	2	1	1	2	0	0	2	2	2	2	1	2	3	1	2	1	4	0	0	1	1	2	1	1	1	1	2	1	2	1	1	1	5
Health Infrastructure																																		
Hospital	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y
Medical Clinic	N	N	N	N	N	N	N	N	N	N	N	N	Y	N	Y	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y
Health Centre	Y	Y	N	Y	N	N	Y	Y	Y	Y	Y	Y	N	Y	N	N	N	N	N	Y	N	Y	Y	Y	N	Y	Y	Y	Y	N	Y	N	N
Health Cabin	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	Y	N	Y	Y	N	Y	N	N	N	Y	N	N	N	Y	N	Y	N	Y
Shelter	N	N	N	N	N	N	N	N	N	N	N	N	Y	N	Y	N	Y	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	Y
Judicial Infrastructure																																		
Correctional Facility	N	N	N	N	N	N	N	N	N	N	N	N	Y	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y
Yound Offenders Facility	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y

IX. LABOUR FORCE CAPACITY BUILDING, EDUCATION AND REGIONAL R&DD

Lack of qualified labour is often mentioned as a barrier to the implementation of energy efficiency and renewable energy projects in the North. Yet, there exists a valuable and proven technical capacity in the three territorial colleges. The three colleges are:

- Yukon College in Yukon
- Aurora College in the NWT
- Nunavut Arctic College in Nunavut

All of them have developed expertise reflecting local needs and projects. Much could be learned from their experience and specific expertise and knowledge of local issues, constraints as well as their potential facilitation role. But more importantly, colleges are extensions of the local communities and have an inherent capacity to facilitate technology deployment and project implementation. They are also key players in ensuring buy-in from the communities.

1. YUKON COLLEGE

Cold Climate Innovation is focused on the development, commercialization and export of sustainable cold climate technologies and related solutions for subarctic regions around the world. It is one of seven key programs at the Yukon Research Centre (YRC) at Yukon College. The other six programs are: Biodiversity Monitoring, Northern Climate Exchange, NSERC Industrial Research Chair for Colleges in Mine Life Cycle, Technology Innovation, Science Adventures, and Resources and Sustainable Development in the Arctic. Core funding for the Yukon Research Centre is provided by Yukon Education and Yukon Economic Development.

In recent years, the College has been involved in a variety of alternative energy projects such as:

- A biogas characterization study
- The Burwash Landing and Destruction Bay wind monitoring tower
- A closed loop biomass energy control system
- The Whitehorse District Heating Study
- The Infinia stirling engine project
- The Nortwestel remote station solar / diesel hybrid power generation
- Some plastic to fuel projects
- The analysis of a vertical axis wind turbine for off-grid agriculture

Innovation funding supports applied research, development and enhancement of applications and opportunities of cold climate, and technology innovations. Cold Climate Innovation funding provides seed money to help individuals and businesses establish partnerships and leverage funding from other sources for the development of innovative cold climate as well as other technology applications.

2. AURORA RESEARCH INSTITUTE – AURORA COLLEGE

The Aurora Research Institute (ARI) operates research centres in three regions of the NWT.

- The Western Arctic Research Centre is located in Inuvik and is ARI's northernmost outpost. It is also the College's largest facility and hosts the largest number of researchers annually of all three locations.
- The South Slave Research Centre is the southernmost research centre located on Aurora College's largest student campus in Fort Smith.
- The North Slave Research Centre is at the center of it all in downtown Yellowknife. This research centre focuses on health and social sciences research.

The Department of Environment and Natural Resources (ENR) and the ARI have been conducting wind energy studies in the NWT for nearly ten years.[80] Wind monitoring programs have been established in several locations dependent on diesel generated electricity in order to provide communities with a clear picture of their local wind resources. Reports are available for each of the communities.

The Western Arctic Research Centre (WARC) in Inuvik has 10 solar panels installed on its south-facing wall. Five were installed when the WARC was built in 2011, while the other 5 were installed in partnership with Environment and Natural Resources and Arctic Energy Alliance during the summer of 2013. All 10 panels are continuously monitored to measure energy production, and all energy is fed into the WARC and used to offset the facility's energy demands. The ARI, in partnership with the Arctic Energy Alliance, continues to monitor the energy produced by the WARC solar panels to determine whether they are a feasible source of renewable energy in the Inuvik region.

The south-facing wall of the third floor of the WARC is covered with a solar wall. During April, 2013, the WARC and the ARI partnered with both Environment and Natural Resources and the Arctic Energy Alliance to install monitoring equipment and software that monitor the energy produced by the WARC solar wall. The solar wall is generally shut off in the summer, when the air temperature is too warm, and also in the winter, when direct sunlight is insufficient to power the solar wall. The solar wall at the WARC therefore produces the most energy during the "shoulder seasons" of spring and fall. During these seasonal periods, air pulled into the building via the solar wall can be up to 15°C warmer than the outside air. This means that the solar wall offsets a lot of energy use at the WARC during the shoulder seasons.

[80] Since 2005, the Aurora Research Institute has been conducting research on the potential use of wind energy in communities that are currently dependent on diesel-generated electricity. Report are available for each of the communities and regions listed at the following link: http://nwtresearch.com/projects/energy/wind-energy-potential

3. NUNAVUT ARCTIC COLLEGE

The Nunavut Research Institute (NRI) is a gateway to research and technology development initiatives underway in the territory. As part of the Nunavut Arctic College, it is the central body mandated to license research, and serves as a touchstone for broad-scale scientific activity in the territory. The NRI also acts on behalf of Nunavut residents, sharing information on research projects, providing advice on research funding programs, and assisting in the development of proposals to research funding agencies.

The NRI's mandate is to develop, facilitate and promote scientific research as a resource for the well-being of people in Nunavut. The core objectives of the Institute are to:

- Coordinate the research licensing process under the Nunavut Scientists Act;
- Support the meaningful involvement of Nunavut residents in scientific research;
- Promote the development and application of new technology to improve the quality of life of Nunavummiut;
- Help broker research projects and partnerships that meet the needs of Nunavut residents;
- Provide a clearing house of information on scientific research conducted in Nunavut;
- Organize, facilitate, and promote research training and outreach programs designed to enhance awareness and build local research capacity in Nunavut.

Staff of the NRI can also provide a range of research advisory services to support research across the territory. Support includes:

- Research regulatory advice (e.g. identification of permit requirements for field projects);
- Identification of research field support services (referrals for interpreters, field assistants, accommodation, etc);
- Organization of research presentations and outreach activities in Iqaluit;
- Advice on communication, training, and community engagement initiatives;
- Support for research development, including proposal review, brokering partnerships, and identification of project funding sources.

In 2007, the GN launched the Nunavut Energy Management Program through a pilot project aimed at implementing energy efficiency measures in all GN-owned buildings within Iqaluit. The project involved 40 buildings and was conclusive. In October 2014, the GN issued an RFP for the extension of the program to nearly 70 buildings in 7 communities in the Kivalliq region.

The Nunavut Energy Management Program has a strong training component including product training, formal training and mentoring. Formal training for building managers and operators is conducted via a partnership between the Nunavut Arctic College, the retained ESCO (MCW Custom Energy Solutions) and Seneca College in Ontario. Building operators and GN maintenance staff have been provided with energy efficiency education via the Seneca College Building Environment Systems (BES) program.

X. ECONOMIC CONTEXT

1. TERRITORIAL FORMULA FINANCING (TFF)[81]

The main federal funding to the three territorial governments is provided through the Territorial Formula Financing (TFF) transfer. This is an annual unconditional transfer from the Government of Canada to the territorial governments to enable them to provide their residents with a range of public programs and services comparable to those offered by provincial governments, at comparable levels of taxation. The formula takes into account the higher cost of providing programs and services in the North, and the TFF grant helps fund services such as hospitals, schools, roads and social services.

TFF is comprised of three separate gap-filling formulas to recognize the unique circumstances of each of the territories. Each territory's grant is based on the difference between a proxy of its expenditure needs (the Gross Expenditure Base, or GEB) and its capacity to generate revenues (eligible revenues). Each territory's GEB is adjusted annually to ensure that territorial spending can grow in line with changes in relative population growth between the territories and Canada and changes in provincial-local government spending. In 2014-2015, the TFF transfers to Yukon, to the NWT and to Nunavut were $897 million, $1.264 billion and $1.456 billion, respectively. The per capita transfers in Yukon and the NWT are comparable – at $29,032 and $29,278 – but are much higher in Nunavut, at $41,072.

Territorial governments – similarly to provincial governments – make decisions on behalf of their residents, with the exception of the administration and management of public lands, water resources, mineral resources, and oil and gas management. Natural resource revenues are not part of territorial eligible revenues for the purposes of TFF calculations. The treatment of natural resource revenues is negotiated separately with each territory as part of overall negotiations on the devolution of the federal responsibility for the administration and control of onshore natural resources to the territorial governments.

2. DEVOLUTION[82]

Devolution is the transfer of province-like responsibilities from the Federal Government to the territories. Over the last few decades, Northern governments have taken on greater responsibility for many aspects of their regional affairs including education, health care and social services. An exception among these affairs is the control over lands and resource management, which was retained by the Federal Government.

Canada owns almost all the public land and bodies of water in the three territories. In absence of devolution, the Federal Government makes the final decisions on the development of resources such as oil, gas and mines, and keeps almost all of the money companies pay to develop these resources. In those areas where authority has been delegated to a territorial government, all final decisions rest with the territorial government. Ownership of Crown land in Northern Canada is retained by the Federal Government.

[81] http://www.fin.gc.ca/fedprov/tff-eng.asp

[82] https://www.aadnc-aandc.gc.ca/eng/1100100035280/1100100035284

On April 1, 2003, Yukon became the first territory to take over land and resource management responsibilities, as the final major step in the territory's devolution process. Prior to Yukon's devolution, the Government of Canada, through the Department of Aboriginal Affairs and Northern Development, governed most natural resources in the territory. The Northwest Territories Lands and Resources Devolution Agreement was signed on June 25, 2013, and became effective on April 1, 2014. In Nunavut, a protocol for future negotiations has been signed between Canada, the territorial Government and Nunavut Tunngavik Incorporated, and work between the parties on devolution is ongoing.

In the NWT, the government keeps 50% of the revenues collected from resource development on public land, up to a maximum amount. The Government of Canada deducts its share, the remaining amount, from the GNWT's federal transfer payments. The maximum benefit is a percentage of the GNWT's annual budgetary needs, meaning that it will grow as the territory grows. These arrangements are consistent with the arrangements of provinces that also receive federal transfer payments. In August 2012, amendments were made to resource revenue sharing arrangements under the Yukon Northern Affairs Program Devolution Transfer Agreement, allowing Yukoners to benefit from arrangements similar to those agreed to as part of the NWT devolution negotiations.

After devolution, the biggest change people see in the Government of Canada's presence in the territory is with Aboriginal Affairs and Northern Development Canada. This department's role in the territory fundamentally changes, but Aboriginal Affairs and Northern Development continues to have a role in:

1. Intergovernmental relations;
2. Inuit and First Nation programs and services;
3. Management of federal obligations related to contaminated sites; and
4. Devolution does not significantly change the role the Government of Canada plays in areas such as taxation, Territorial Formula Financing and other major transfers, infrastructure, economic development, transportation and national defense.

3. TERRITORIAL BORROWING LIMITS[83]

Pursuant to subsection 20(2) of the *Northwest Territories Act*, subsection 27(2) of the *Nunavut Act*, and subsection 23(2) of the *Yukon Act*, a territorial government has the authority to borrow money for territorial, municipal or local purposes up to a specific limit. The maximum amounts that may be borrowed are set by the Governor in Council through an Order in Council for each territory. Any borrowing beyond these maximum levels requires Governor in Council approval.

Borrowing by territorial governments are charges against their own Consolidated Revenue Funds and are not supported or guaranteed by the Government of Canada. Further, the Government of Canada is not involved in territorial borrowing decisions. Within the established limits, territorial governments are fully accountable for their own borrowing decisions, which they make according to their own priorities and needs.

The Government of Canada reviews a territorial borrowing limit following formal requests from the territorial government. When a review is requested, the Government of Canada may change a territorial government's maximum borrowing amount based on an assessment of the territorial government's

[83] http://www.fin.gc.ca/fedprov/tbl-pet-eng.asp

ability to carry future debt. This assessment is based on its economic and fiscal outlook, including federal transfer support. Currently, the borrowing limits established by Orders in Council are $800 million, $400 million, and $400 million for the NWT, Yukon and Nunavut, respectively. These borrowing limits could potentially restrain territorial governments from developing renewable energy resources in their territories, or delay the decision making process, as illustrated by the following two examples.

In Nunavut, the government has a strong focus on hydro-electricity development. This is core and central to its energy strategy, adopted in 2007, and an issue which was reiterated publicly a number of times since then. A $450 million, 8.8 MW hydroelectric development project is considered for Iqaluit. This project alone goes over the territorial borrowing limit and the cost would have to be absorbed by the current relatively modest customer base which is already paying the highest electricity prices in Canada.[84]

In 2013, the NWT announced plans to expand the local power grid to reach out isolated communities, but also to connect to the continental grid through British Columbia, Alberta and Saskatchewan.[85] First thought to cost around $587 million, the project was finally abandoned less than a year after the release of the plan and after a new study showed the project cost was revised to $1.2 billion.[86] The project was deemed to be not economically viable. In the wake of this decision, the government of the NWT is negotiating with the Federal Government to raise the borrowing limit to $1.8 billion.

4. ECONOMIC DIVERSIFICATION AND GDP PROFILES

The CanNOR Northern Economic Diversification Index (NEDI)[87] – illustrated in Figure 15 – shows that the North region, with an Economic Diversification Index of 88.17 in 2012, is the least diversified region in Canada (EDI=93.04), after Newfoundland (EDI=86.91). Although the index is too recent to show progress over time, it is useful to position the territories within the Canadian context. Table 8 shows a comparative breakdown of economic sectors by percentage of GDP in Canada and the three northern territories, and illustrates how the NEDI may eventually respond to changing market conditions.

While “Public administration” and “Mining, quarrying, and oil and gas extraction” rank among the top five sectors in Canada – with percentages of 7.0% and 7.9%, respectively – they are the top two in all three territories with a total for both sectors of 40.1% in Yukon, 43.2% in the NWT, and 38.2% in Nunavut. Manufacturing activities account for 10.8% of the Canadian GDP, while this sector only makes up 1% in Yukon and a minuscule fraction in the other two territories. Generally speaking, there are no other striking major differences between the Canadian average and the three territories.

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[84] Testimony of Alain Barriault, President and Chief Executive Officer, Qulliq Energy Corporation before The Standing Senate Committee on Energy, the Environment and Natural Resources. Ottawa, Thursday, November 20, 2014. http://www.parl.gc.ca/content/sen/committee/412/ENEV/51754-E.HTM

[85] “A Vision for the NT Power System Plan.” NT Energy, December 2013.

[86] http://www.cbc.ca/news/canada/north/n-w-t-abandons-1-2b-plan-to-export-electricity-south-1.2814190

[87] In 2012-13, the Canadian Northern Economic Development Agency (CanNor) created the Northern Economic Diversification Index (NEDI). The index is an important part of the Agency's annual Report on Plans and Priorities beginning in 2013-2014 and serves as a measure of the state of economic diversity in Canada's three northern territories. It is a performance indicator of CanNor's policy, advocacy, coordination efforts, and the effectiveness of its economic development programs in support of strong, diversified and dynamic economies in the North. http://www.cannor.gc.ca/eng/1388762115125/1388762170542#chp2

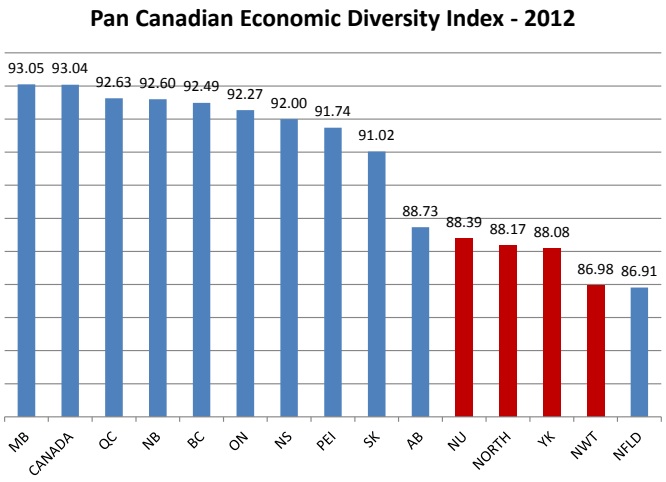

Figure 15. Pan Canadian Economic Diversity Index – 2012

Table 14[88]. N Breakdown of Economic Sectors by Percentage of GDP – 2012

	Breakdown of Economic Sectors by Percentage of GDP (2012)			
	Canada	Yukon	NWT	Nunavut
Real estate and rental and leasing	12.5	13.0	8.7	11.2
Manufacturing	10.8	1.0	0.1	0.3
Mining, quarrying, and oil and gas extraction	7.9	19.9	28.1	15.4
Construction	7.2	7.9	5.2	9.2
Public Administration	7.0	20.4	15.1	22.8
Health Care and Social Assistance	6.9	7.2	6.6	6.1
Finance and insurance	6.5	2.7	3.0	2.1
Wholesale trade	5.5	1.6	3.0	2.8
Retail trade	5.4	4.5	5.2	4.1
Educational Services	5.3	5.2	5.0	9.2
Professional, scientific and technical services	5.3	2.5	2.6	1.9
Transportation and warehousing	4.2	2.9	6.7	2.7
Information and cultural industries	3.4	2.9	2.4	2.1
Admin. and support, waste mng't and remed. services	2.6	1.4	1.9	2.4
Utilities	2.4	1.6	1.8	3.9
Accommodation and food services	2.0	3.0	1.8	1.4
Other services (except public administration)	2.0	1.5	1.2	1.4
Agriculture, forestry, fishing and hunting	1.6	0.2	0.7	0.2
Arts, entertainment and recreation	0.7	0.4	0.2	0.2
Management of companies and enterprises	0.7	0.4	0.8	0.6

Economic diversity is a great concern for stakeholders in the North as they look toward long-term development opportunities. Although the mining sector presents opportunities to develop and implement renewable energy projects and strategies (e.g. wind power at the Diavik mine), it is also an impediment to invest in energy infrastructures for the long term. For example, the NWT's plan to expand the Taltson Hydro Facility and run transmission lines up to the diamond mines was cold-

[88] http://www.cannor.gc.ca/eng/1388762115125/1388762170542

showered by the refusal of the diamond mines to sign long-term power purchasing agreements. It is therefore difficult for territorial governments to invest in major infrastructures if targeted customers are not willing to guarantee the existence of a market. This unfortunate situation could nevertheless create other opportunities and leave room for smaller renewable energy supply projects and the introduction of new technologies.

The president of Nunavut Tunngavik[89], Cathy Towntongie, speaking at the Nunavut Economic Forum in December 2014, summarized the issue in the following terms: “It worries me as an Inuit leader, because mining is ‘boom and bust’. It has a life span, and after that, it closes down. So you have to be prepared when mining leaves and the wealth of Nunavut leaves us. What type of long-term sustainable development do we want to see?”[90]

[89] Nunavut Tunngavik Incorporated (NTI) ensures that promises made under the Nunavut Land Claims Agreement (NLCA) are carried out. Inuit exchanged Aboriginal title to all their traditional land in the Nunavut Settlement Area for the rights and benefits set out in the NLCA. The management of land, water and wildlife is very important to Inuit. NTI coordinates and manages Inuit responsibilities set out in the NLCA and ensures that the federal and territorial governments fulfill their obligations.

[90] Quoted from: Peter Varga, “Future oil royalties could pay for infrastructure, Nunavut premier says.” NunatsiaqOnline, December 2, 2014. http://www.nunatsiaqonline.ca/stories/article/65674future_oil_royalties_could_pay_for_infrastructure_nunavut_premier_says/

XI. MINING ACTIVITIES[91]

Although the potential for mining development in the North remains important, exploration and development spending dropped by 22% in 2014 according to an estimate released by Natural Resources Canada in mid-January, 2015.[92] In Yukon, spending dropped by 13% to $88 million and by 43% in Nunavut to $148 million. The notable exception is the NWT, which saw a 32% increase in spending to $103 million. Nationally, spending on projects declined by 7% in 2014 compared to 2013.

The Bank of Nova Scotia's commodity price index fell to 100.9 points in January 2015, a drop of 27.9% since January, 2014. The index is at its lowest point since January 2007. The Baltic Dry Index, created in 1985 as a measure of global shipping, crumbled to a record low of 509 points in mid-February 2015.[93] Figure 17 at the end of this section provides selected commodities price charts over many years.

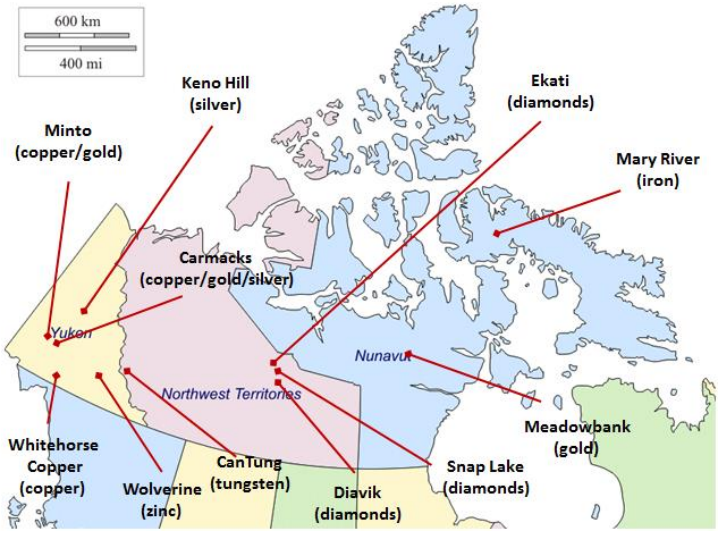

Figure 16. Existing and Potential Mining Sites in the North

While there are many mining development projects in the North, there are currently only 11 mines technically in operation in the three territories. With global commodity markets in such a global slump, many mining projects have either been scaled-down or postponed. This is particularly true for copper, gold, silver zinc, tungsten and iron. Diamond mining projects may react differently as diamond prices have not tumbled as much as other resources, but they have been on a downward trend since 2012.[94]

Mining projects in the North are especially sensitive to price changes because construction and operation costs are high in comparison to other jurisdictions. Price volatility is indeed a key factor. Talking about iron mining in the 2013 Nunavut Economic Outlook, the authors mention that "[…] most experts believe the long-term growth prospects are positive and do not expect prices to fall below

[91] Figure 16 and the descriptions in sub-sections 1, 2 and 3 were prepared by CanmetENERGY-Varennes with information compiled from a variety of sources including: http://www.miningnorth.com, http://www.yukonminers.ca, http://www.alexcoresource.com/s/Home.asp, http://yukonzinc.com/en/index.cfm, http://www.coppernorthmining.com/s/Home.asp, http://capstonemining.com/home/default.aspx, http://www.mining-technology.com, http://corporate.arcelormittal.com/ and the Conference Board of Canada Autumn 2014 Territorial Outlook.

[92] http://www.cbc.ca/news/canada/north/northern-mineral-exploration-and-development-spending-drops-by-22-1.2921731

[93] "Commodity crash reflects global slump; Trouble sports are everywhere as weak demand for raw goods drives prices below the lows seen during 2008-09 recession". The Globe and Mail, Report on Business, February 24, 2015.

[94] Mining activities can be followed and monitored more closely through regular discussion with the Yukon Chamber of Mines (www.yukonminers.ca) and with the NWT & Nunavut Chamber of Mines (www.miningnorth.com).

$100 per metric tonne […]."[95] In retrospect, "most experts" were wrong as iron prices fell as low as $52 in July 2015, as indicated in Figure 11 at the end of this section.

Mines generally have short life spans, and energy supply infrastructures generally reflect this short-term investment situation. Industrials are risk-averse and reliability of supply is considered vital – much more so than lower energy costs. Longer paybacks are not likely to be considered in most cases and a northern strategy targeting mines should focus on quick-to-install, reliable technologies with very short paybacks.

1. MINING PROJECTS IN YUKON

Carmacks Copper: Carmacks Copper project, owned by Carmacks Mining Corp., is located 198 km north of Whitehorse. It is expected to be a low-cost producer of cathode copper which will employ solvent extraction and electro-winning techniques to recover oxide copper as well as gold and silver dore. This is an open pit mine type with an expected lifetime of 7+ years. It is located 220 km north of Whitehorse and 400 km from the year-round port at Skagway, Alaska. The site has good road access and is located 11 km away from the Yukon power grid. The project is currently undergoing a new Preliminary Economic Assessment to reflect changes in the process to heap leach, solvent extraction/electrowinning of copper and cyanide leach of gold and silver.

Minto: Minto mine, owned by Minto Explorations Ltd., is a copper-gold mine located 240 km northwest of Whitehorse. Minto started producing concentrate in July of 2007 and the first truckloads of concentrates were delivered on July 16, 2007, to the Port of Skagway Ore Terminal. Yukon Energy's completion of a hydro transmission line from Carmacks to Pelly Crossing, with a spur line to the Minto mine, has allowed the Minto mine and the community of Pelly Crossing to switch from diesel to hydroelectricity, reducing greenhouse gas emissions by up to 24,100 tonnes per year. The mine's remaining life is about 7 years.

Keno Hill Silver District Operation: The Keno Hill Silver District Operation is a silver/lead/zinc mine located 354 km north of Whitehorse, 50 km northeast of the Town of Mayo, and 3 km east of Keno. The Bellekeno silver mine, one of the world's highest-grade silver, commenced commercial production at the beginning of calendar year 2011 and was Canada's only operating primary silver mine from 2011 to 2013. Alexco, the mine owner, suspended production in 2013 in order to decrease costs and reposition the District for long-term operations. The company is in the process of re-awakening production using a combination of contemporary environmental technology as well as modern mechanized mining methods.

Whitehorse Copper Tailings Reprocessing and Reclamation Projec: The Whitehorse Copper Tailings Reprocessing and Reclamation Project, owned by Eagle Whitehorse LLC, is located in Whitehorse. The project involves the reprocessing of tailings located at the old Whitehorse Copper site near the Mt. Sima Road. Magnetite, which is a source of iron, would be extracted from the tailings and trucked to Skagway. Eagle Whitehorse LLC is proposing to process 12,000 tonnes per day, for 6 to 7 months during the snow-free season, producing 250 to 350 thousand tonnes of magnetite per year over a duration of 6 to 7 years, and employing up to 20 people seasonally. The project will also involve reclamation of the site for possible future industrial development.

[95] 2013 Nunavut Economic Outlook. Nunavut's Next Challenge: Turning Growth into Prosperity." Nunavut Economic Forum, December 2013.

Wolverine: The Wolverine mine, owned by Yukon Zinc Corporation, is located in the Finlayson district of the southeast Yukon, approximately halfway between the communities of Watson Lake and Ross River. The Wolverine Project is an underground mine which produces 1,700 tonnes per day. Yukon Zinc completed major site construction at Wolverine throughout 2009 and 2010. Mill commissioning commenced in late 2010 and operations started in 2011. In March 2012, commercial production was achieved and in Q1 2013, full design capacity was reached. Concentrates are trucked to tidewater at Stewart, British Columbia. The mine facilities include an airstrip, a 25 km access road to the Robert Campbell Highway, an underground mine, a tailings impoundment facility, a temporary waste rock storage area, a process mill, a camp facility and ancillary buildings and equipment. Power is provided by on-site diesel generators.

2. MINING PROJECTS IN THE NORTHWEST TERRITORIES

Ekati Diamond Mine: The Ekati Diamond Mine is Canada's first surface and underground diamond mine. It officially began production in October 1998, following extensive exploration and development work dating back to 1981. Like Diavik, the Ekati mine site is located in the Lac de Gras region of the NWT, approximately 300 kilometers northeast of Yellowknife. The Ekati mine plan calls for continuous production to 2019, but there are additional resources which could become economical with increased diamond prices. In late 2013, Dominion Diamonds submitted a permit application to mine three additional pipes, which has the potential to add 10-20 years to the Ekati mine life.

Diavik Diamond Mine: Canada's second diamond mine, Diavik, began production in January 2003 and employs approximately 1,000 people. Diavik is located on a 20-square kilometre island, informally called East Island, in Lac de Gras, approximately 300 kilometres by air northeast of Yellowknife, and 220 kilometres south of the Arctic Circle. A single road, built out of ice and crossing frozen lakes, connects the mine with Yellowknife during two months in winter each year. The mine, which has a current footprint of approximately 10 square kilometres, is projected to produce well over 100 million carats of diamonds over its mine life of 16 to 22 years. Diavik transitioned from open pit mining to an all-underground mine in September 2012.

Snap Lake Diamond Mine: The Snap Lake diamond deposit, 100% owned by De Beers Canada Inc. (part of the De Beers Group), is located approximately 220 km northeast of Yellowknife in the NWT. When mining operations started in October 2007, SnapLake achieved commercial production status in the first quarter of 2008. At full production, the mine is designed to produce about 1.4 Mct/y and to have a life of just over 20 years. Compared to other types of mining, diamond mining has less impact on the environment.

CanTung Tungsten Mine: The Cantung Mine is located in the Nahanni area of western NWT, approximately 306 km by road northeast of Watson Lake, Yukon, close to the Yukon border. Opened in 1962, the mine is a primary producer of tungsten concentrate from open pit and underground mines. Currently, the major features and facilities associated with Cantung are the Cantung deposits, consisting of the open-pit resource near the surface, and the E Zone, underground; the physical plant site including an underground mine, a small open pit, process plant, diesel power plant, workshops, warehouses, administration buildings, a town site and single status accommodation, and an airstrip; and waste rock storage facilities and a tailings storage facility.

3. MINING PROJECTS IN NUNAVUT

Meadowbank Gold Mine: The Meadowbank mine is located in the Kivalliq region of Nunavut and is one of Agnico-Eagle's largest mines. It is 300 kilometres west of Hudson Bay and 70 kilometres north of Baker Lake, the nearest town. It has almost 2.2 million ounces of proven gold in reserves and potential for more. Mine commissioning and first gold production began in early 2010. The mine is expected to produce approximately 300,000 ounces of gold per year from 2012 through to 2014, with a mine life through 2017. The Meadowbank Mine employs approximately 1,200 people of which 38% are Inuit from the Kivalliq region. Meadowbank depends on the annual, warm-weather sealift by barge from Hudson Bay to Baker Lake for transportation of bulk supplies and heavy equipment. A 110-kilometre all-weather road links Baker Lake to the site. An on-site airstrip is used for shipping food and goods and for transporting employees who work on a fly-in, fly-out basis.

Mary River Iron Mine: The Mary River Project is located on northern Baffin Island, in the Territory of Nunavut in the Canadian Arctic. It is considered one of the best iron ore projects in development in the world, with an ore grade of approximately 67%. Due to the quality of the ore, no processing is required before shipping it to market, reducing overall impact to the environment and keeping production costs low. The Mary River Project consists of mining iron ore from the reserve at Deposit No. 1 at a production rate of 21.5 Million tonnes per year (Mt/a). The original project had a development cost of about $4 billion. The project was scaled back to a much smaller proposal in 2012 as a consequence of global uncertainty regarding natural resources. Initially, during an Early Revenue Phase (ERP), 3.5 Mtpa of iron ore will be mined in 2015, transported by trucks to Milne Port and shipped to markets from Milne Port during the open water season. As global markets improve for the prices of iron ore, the Company intends to proceed with the construction and operation of the larger project which includes the construction, operation, closure, and reclamation of a large-scale mining operation (open-pit mine) and associated infrastructure for extraction; a railway link for the transportation of ore to Steensby Port; and the construction and operation of a year-round port facility on Steensby Inlet for the shipment of iron ore. Once Steensby Port and the railway are operational, Baffinland expects that it will continue to ship up to 3.5 MTPA of ore via Milne Port for the duration of the Project which has an expected life of 21 years.

Gold Price
1,107.15 USD/ozt
9 Sep '15

Ferro Tungsten Price
27.72 USD/kg
31 Jul '15

Iron Ore Fines Price
52.15 USD/t
31 Jul '15

Silver Price
14.62 USD/ozt
9 Sep '15

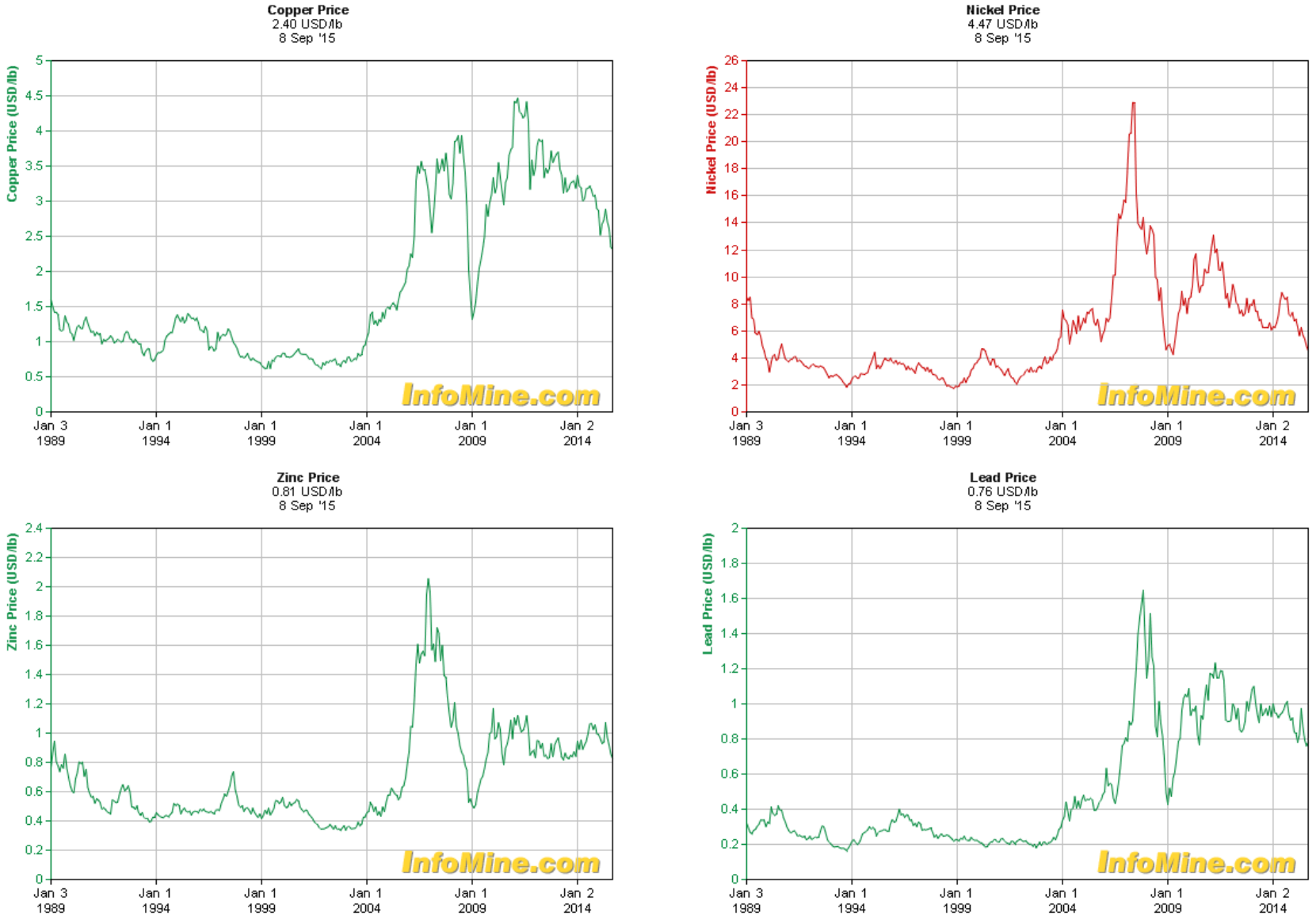

Figure 17. Selected Commodities Historical Prices[96]

[96] http://www.infomine.com/ Consulted on September 8, 2015.

CONCLUSIONS

The analysis of the energy policy context and market characterization of the North leads to a number of important conclusions and provides clear direction for the development of a Northern Communities Energy Technology Intervention Strategy.

First, there are many misconceptions about the North that need to be better understood before moving forward. Three of the most common misconceptions that should be retained are:

- Energy is expensive… ***yes, but not everywhere.***
- Energy supply is all based on imported fuel… ***for the most part, but not everywhere.***
- Revenues generated by energy supply and demand flow out of the territory… ***often the case, but not always.***

With this in mind, we can further note that there are some issues in the North that exist because of the structural and political organization of the territories. For historical reasons, the Federal Government is present in many aspects of the territorial life while communities are also quite independent from one another. Economic diversity of the territories is somewhat limited, and their internal economy is relatively small with little industrial and manufacturing capacity. This means the tax base is relatively modest, hence the lack of capacity to finance initiatives and projects. Their borrowing capacity is controlled by the Federal Government. Finally, every community ought to maintain modern services: this is not always economically viable and somewhat unrealistic to achieve and then maintain.

Devolution is a game changer, but it comes at a time when the national and international markets for natural resources have seriously declined due to lower demand and increased national and international supply. Just looking at the mining industry, it will take years before measurable benefits start accruing significantly enough to make a difference. Combined with a depressed market for natural resources, devolution will not generate sufficient revenues for the territories in the short term.

The three territories have enabling energy policies, detailed energy plans or strategies to deal with energy supply and demand, energy efficiency as well as the deployment of renewable energies. However, most of them are aging and this creates a strategic opportunity to participate in the upcoming review and update process all while providing technical assistance, particularly on renewable energy discussions and energy efficient equipment and technologies. In many cases – and despite the existing territorial energy plans and strategies – programs and projects within communities may not necessarily fit specific concerns formulated at the local government level. Needs expressed by communities are opportunities for project implementation, but their replication will depend on their alignment with territorial or provincial priorities and programs.

In some other cases, there could be a need to scale down the territorial governments' expectations for future energy supply and consider (or re-consider) micro needs and relevant options at the community level. For example, the NWT recently renounced building power lines to connect with the Alberta electricity grid. While Nunavut's government is seriously looking at the hydro power option, this may not be feasible (technically and financially) except maybe in and around Iqaluit. This will not be of value for the 24 other communities in Nunavut and other options must therefore be explored.

Most communities do not own diesel plants – utilities do. These can be privately owned or

publicly owned. For electricity production facilities, the latter is the norm. So if communities start owning electricity production equipment, they will need to learn new management and technical skills. Potential alternative energy projects are, in general, more complex to manage and operate than diesel engine. Furthermore, because of mismatches between electricity supply and demand, deploying more complex energy systems will require electricity supply and use to be increasingly coordinated through time of use strategies, units sequencing, grid connectivity, and so on.

Diesel plants throughout the North are aging. This is particularly true in Nunavut where they are the only source of electricity generation. The issue of replacing or upgrading these systems is complex as there is no one single alternative. Also, whatever that choice of alternative might be, there will be a need for back-up supply (because of the seasonality of renewable resources – solar and wind regime) which will most likely remain fossil fuel based. This will add significant capital cost as well as stand-by charges by utilities.

Solar energy has significant seasonal limitations, and hydro is expensive to develop. Geothermal energy – both high temperature and ground source heat pumps – is limited. Seeing as renewable energy is limited, a new focus is placed on local supply. The NWT have a strong bias towards increased use of biomass in government buildings and have adopted a strategy in this regards. Yukon is also exploring this avenue and has already published a draft biomass strategy. Heat recovery can be considered in some communities, but it does not resolve the power supply issues. CHP technology is generally good for winter but will generate excess heat during the summer. Technology solutions must be carefully selected and targeted because of wide-ranging electricity rates. Like anywhere else in the world, the deployment of efficient solutions must follow sound economic considerations and must make sense economically.

Because of subsidies in the residential sector, the target audience is not necessarily the end-user or the building occupant; the best stakeholder will often be the local housing corporation. The departments of public services also own and operate a relatively large public buildings portfolio. The private sector also owns a significant number of energy-intensive buildings such as groceries, hotels and restaurants.

Concomitantly, DSM could be difficult in some areas since communities are not tax-based. Working on the supply side might be more efficient, particularly for electricity loads which do not appear to be very different than in non-hydro based provinces. There are no building inspectors in Nunavut, therefore standard-based efficiency is limited. The focus tends to be more on incentivization. They prefer to provide $ (incentives) to upgrade rather than regulate since regulation require inspectors.

For some technologies, a multi-stakeholder approach is necessary. A good example of this is the cold chain. Sometimes, the potential technology adopters will be the communities themselves with their community freezers, while other times, adopters will come from various private sectors with their groceries, restaurants, hotels and other privately-owned commercial buildings. In both cases, however, the local utility could get involved.

There are important networks in the North including territorial departments, housing corporations, associations, utilities and colleges. All these stakeholders have a solid knowledge of their communities and their needs. They also have ideas on how to move the energy R&D agenda further and in sync with local priorities. Clearly, these stakeholders need to be consulted and included in the development and deployment of any energy technology

intervention strategy aimed at providing solutions to their needs.

Seeing as there are many different needs, responses – strategy and specific ensuing actions – must be adapted. There is no one-size-fits-all approach, particularly when energy supply (and resource availability) is highly different from one area to the other, and when consequent fossil fuel prices and electricity rates show significant differential factors, sometimes up to tenfold.

Finally, Nunavik and Nunatsiavut can rely on the extensive resources – both financial and technical – of Quebec and Newfoundland & Labrador. Concerns about energy supply and demand and energy efficiency within the communities are dealt with by utilities in the two provinces. These utilities can rely on their extensive customer base to finance and provide energy efficient solutions to their communities. Nevertheless, energy solutions developed for a northern environment can be adapted to these communities and vice-versa. The latter point should be reflected in the strategy and shared priorities considered in specific actions.

With these conclusions in mind, the development of a cohesive intervention strategy should minimally reflect the following guidelines:

- Alignment with territorial energy strategies bearing in mind potential solutions will not be equally applicable everywhere.
- Reflecting locally identified priorities and capacity of the host community to ensure project sustainability.
- Consulting with local stakeholders such as colleges, associations, utilities and local governments. They know their needs and this will eventually facilitate and speed up the deployment of technologies and acceptance by communities.
- Energy technology options should ideally address the needs of small, medium and large communities. In other words, technologies and projects must be scalable.
- Solutions requesting input and participation from local workforce will receive more attention from territorial governments and communities and are more likely to succeed in the long term. Projects must be replicable by local stakeholders.
- Mini-Mega projects are good for large industrial applications but usually inadequate for most of the communities located far away from the industrial operation sites.

Northern communities are eager for solutions to remedy their dependence on fossil fuel for electricity generation and heating. Despite the scope of initiatives deployed thus far, the local governments and communities sometimes need technical assistance in implementing their strategies, particularly when deeper technical knowledge is required but lacking locally. By leveraging local talent (colleges, industry associations, territorial government departments, community staff, etc.), it is possible to accelerate the adaptation of existing technologies and the development of new systems through targeted R&D. The deployment of renewable energy technologies in the North would therefore be possible on a larger scale. Targeted and sensible actions inspired by local priorities and facilitated by local stakeholders will contribute to keeping significant financial resources in the North – which are currently flowing down South for the purchase of expensive fossil fuel and, at times, misfit technologies for northern applications.

Based on the findings, conclusions and guidelines of this study, the next step would consist in formulating a Northern Communities Energy Technology Intervention Strategy.

APPENDIX 1 – TELECOMMUNICATIONS AND CONNECTIVITY

Given the vast distances, few roads, and relatively small populations living in communities spread out in the Arctic regions, the finance models of southern telecommunications (designed to serve larger populations living in close proximity) have not been particularly successful in delivering affordable, robust communication services across the three territories. The key challenge lies in the North's insufficient communications 'backbone' – the infrastructure that connects northern communities to each other, and to the rest of the world.

There are currently several telecommunications technologies used to connect Arctic communities. These technologies – whether they be fibre, microwave or satellite – dictate to a large degree which Internet speeds can be delivered to consumers and institutions. Currently, Yukon and the NWT have an average of 2.6 Mbps per household (for microwave and satellite served communities), while Nunavut has an average of 1.5 Mbps per household (satellite only).

The current and future telecommunications infrastructure and technology choices depend on many inputs, ranging from the population of the community that is to be connected, to the distance that must be covered, to the existence of roads or the backbone options available for the terrain in question. In cases where distances are long, the population is small and roads are lacking, the capital cost of installing fibre is very high when calculated on a per-user basis. However, once the fibre is installed, the additional operation cost of accommodating an increased demand is relatively minimal as it has significantly greater reserve capacity and lower upgrade costs than satellite. Satellite ground infrastructure is cheaper to install than fibre in remote communities, but is characterized by much higher operating costs given that the bandwidth inevitably needs to be increased as communication services evolve.

Northwestel delivers a broad range of telecommunication solutions and television services to a population of 120,000 northern Canadians in 96 communities scattered throughout Yukon, the NWT, Nunavut, Northern British Columbia and Alberta. The majority of its nearly 600 employees live and work in communities all across the North.

In 2013, Northwestel adopted a five-year modernization plan to improve broadband Internet services and increase the availability of advanced mobile wireless services so that northern Canadians could receive telecommunications services that are comparable – and in some cases superior – to those available in the South.

As a side note, the Northwestel scenario represents an interesting energy-related issue which depicts a good example of multi-stakeholder cooperation in deploying technologies. Northwestel actively worked to reduce the costs of operating microwave stations at remote sites across Northern Canada. The price tag of operating and maintaining these remote stations is significant, costing Northwestel up to $5.00/L to fuel and up to $2.5M per year to maintain. Northwestel and the Energy Solutions Centre partnered with the Cold Climate Innovation Centre of Yukon College and, together, tried to find ways to save time and money, all while reducing the company's carbon footprint.[97] The search for a solution started with

[97] The project was completed through a partnership with Northwestel, Cold Climate Innovation of the Yukon Research Centre at Yukon College and the Energy Solutions Centre of the Government of Yukon's Department of Energy, Mines and Resources. Researchers determined that the use of solar photovoltaic (PV) cells could reduce Northwestel's base energy costs in some locations by more than 80%. Northwestel currently maintains 156 microwave stations in its operation area. Of these sites, 87 rely on independent sources of power and 37 are only

an energy feasibility study, and ended with the successful installation of a solar panel array that allows the Northwestel microwave site at Engineer Creek (along the Dempster Highway in Northern Yukon) to run on solar energy when possible, as opposed to diesel-fueled engines.

As the exploration industry spreads into the most remote locations in the North, Northwestel needs to develop creative telecommunication solutions. In 2013, Northwestel partnered with Total North Communications to deliver state-of-the-art communication services to remote mining, oil and gas businesses in Northern Canada. Through a service called VSAT Reach, now available through a joint offering between the two northern-based companies, organizations can access Internet and telephone services in areas that do not have access to fibre or microwave connectivity. This new service provides connectivity through Northwestel's satellite infrastructure and Total North's site engineering, installation and management offerings.

Tables at the end of this section provide detailed information – including backbone capacity – on telecom technologies used in all communities in the three territories. This information is essential for the deployment of energy production or DSM technologies that rely on remote controls or data collection protocols.

accessible by helicopter. These sites currently rely on 2 to 4 air cooled diesel engines, depending on their size. In the cited study, researchers tested the use of a solar PV array at the Engineer Creek microwave site. The operational load at this site was between 1.8kW and 2.8kW. The base cost of an installed PV site of this size was $0.28/kWh, which is significantly lower than the $1.53/kWh base cost of diesel required for the same site.

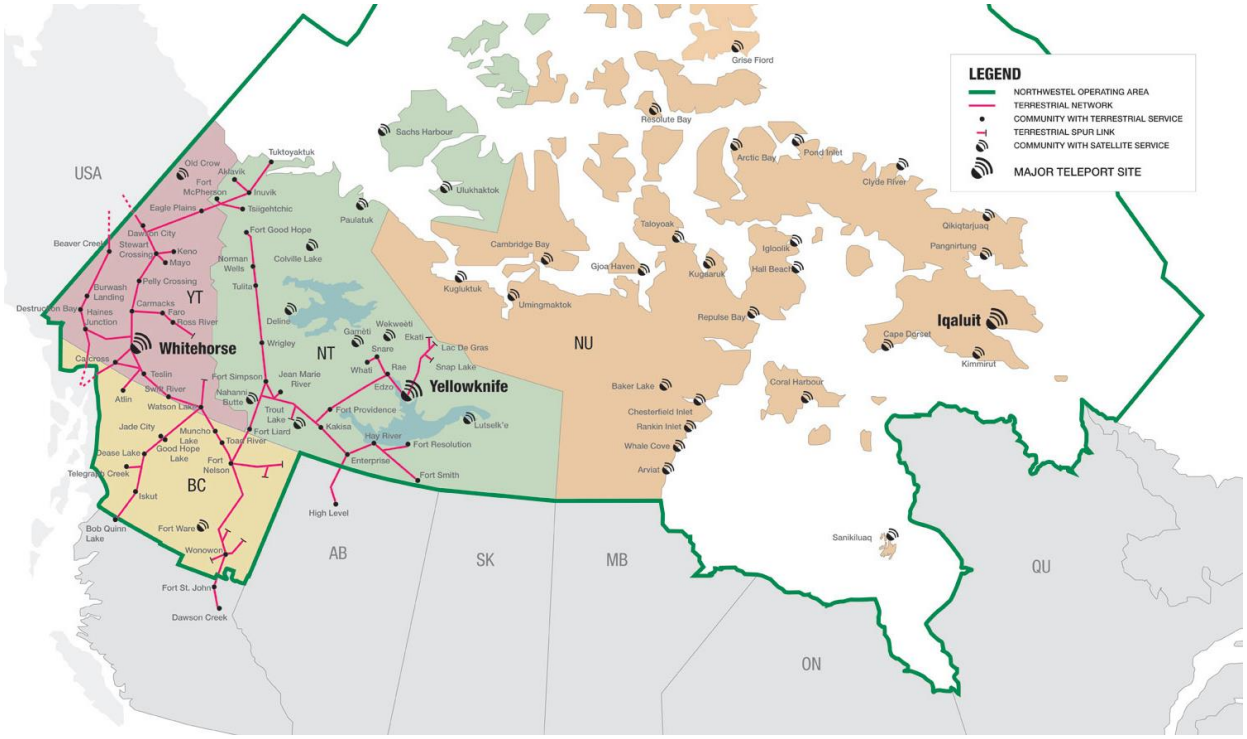

Figure 18. Northwestel Telecommunications Network in the North

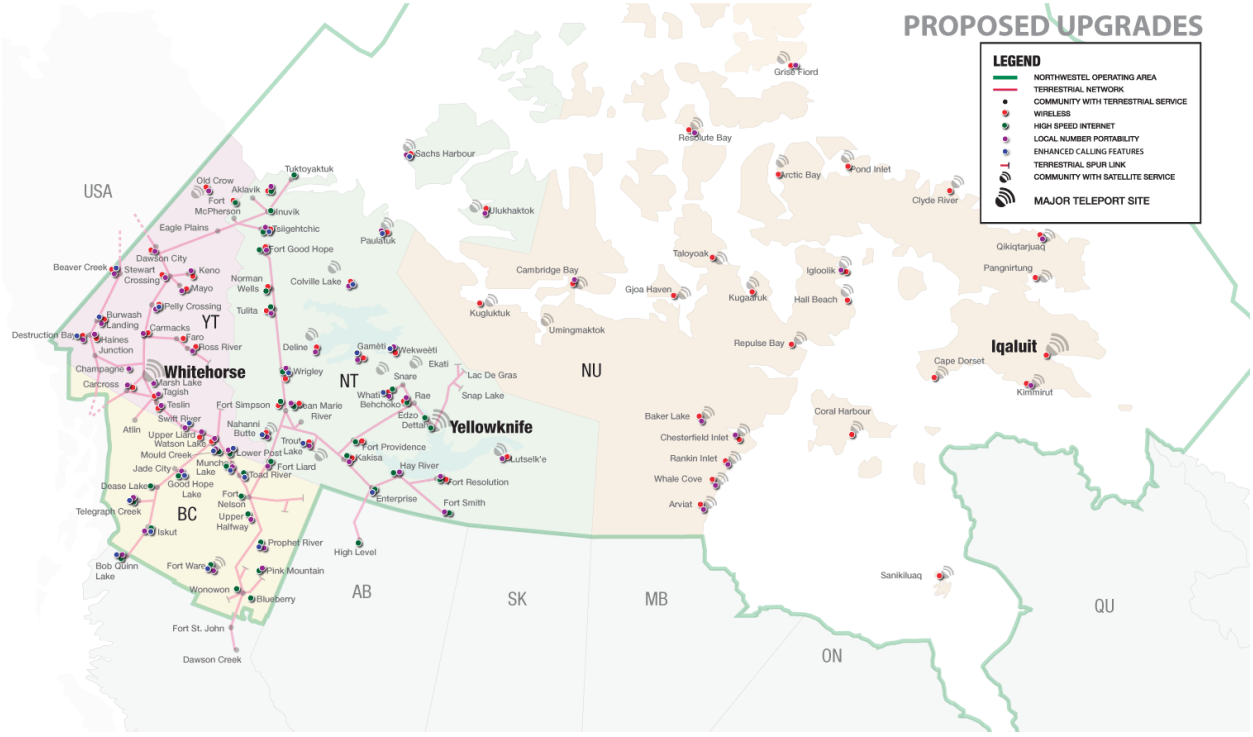

Figure 19. Northwestel Proposed Network Upgrades

Table 15. Telecommunications Backbone Capacity – Yukon

YUKON

Communities	Pop.	Road	Technology	Backbone Capacity (Mbps)
Beaver Creek	100	all season	micro	24
Burwash Landing	85	all season	micro	50
Carcross	289	all season	fibre	3500
Carmacks	503	all season	fibre	2500
Champagne	24	n/a	n/a	n/a
Dawson City	2,000	all season	micro	155
Destruction Bay	51	all season	micro	50
Elsa	336	n/a	n/a	n/a
Faro	344	all season	micro	155
Haines Junction	593	all season	fibre	2500
Johnson's Crossing	15	n/a	n/a	n/a
Keno	15	all season	micro	3
Marsh Lake	620	all season	fibre	155
Mayo	226	all season	micro	155
Old Crow Settlement	245	none	satellite	32
Pelly Crossing	291	all season	fibre	155
Ross River	352	all season	micro	155
Stewart Crossing	25	n/a	n/a	n/a
Swift River	14	n/a	n/a	n/a
Tagish	391	all season	fibre	667
Teslin	122	all season	fibre	2635
Upper Liard	178	n/a	n/a	n/a
Watson Lake	802	all season	fibre	2545
Whitehorse	23,276	all season	fibre	10270

Table created from:

Northern Connectivity - Ensuring Quality Communications

Nordicity, January 2014

Table 16. Telecommunications Backbone Capacity – Northwest Territories

NORTHWEST TERRITORIES

Communities	Pop.	Road	Technology	Backbone Capacity (Mbps)
Aklavik	628	winter road	micro	41
Behchokö / Rae-Edzo (Dog Rib Rae)	2,004	all season	fibre	175
Colville Lake (Behdzi Ahda)	140	none	micro	81
Déline (Fort Franklin Settlement)	543	winter road	micro	99
Dettah	260	all season	micro	160
Enterprise	110	all season	fibre	2517
Fort Good Hope (K'asho Got'ine)	564	all season	fibre	172
Fort Liard (Acho Dene Koe)	596	all season	fibre	639
Fort McPherson (Tetlit Gwich'in)	804	all season	micro	41
Fort Providence (Deh Gah Gotie Dene Council)	753	all season	fibre	1717
Fort Resolution (Deninu K'ue)	485	all season	fibre	639
Fort Simpson (Liidlii Kue)	1,243	all season	fibre	639
Fort Smith (Salt River)	2,448	all season	fibre	639
Gamèti (Rae Lakes)	295	winter road	satellite	82
Hay River (West Point)	3,840	all season	fibre	167
Hay River Reserve (K'atlodeeche)	319	all season	fibre	5172
Inuvik	3,615	all season	fibre	310
Jean Marie River	80	all season	micro	172
Kakisa (Ka'a'gee Tu)	54	all season	fibre	2517
Lutsel K'e Dene Band (Snowdrift Settlement)	329	none	satellite	82
Nahanni Butte (Nahanni Butte Dene / Deh Cho)	123	winter road	satellite	81
Norman Wells	860	all season	fibre	155
Paulatuk	306	none	satellite	81
Sachs Harbour	127	none	satellite	81
Trout Lake (Sambaa K'e Dene)	95	winter road	satellite	81
Tsiigehtchic (Arctic Red River / Gwichya Gwich'in)	183	all season	micro	41
Tuktoyaktuk	915	winter road	fibre	172
Tulita (Tulita Dene / Fort Norman)	542	winter road	fibre	167
Ulakhaktok (Holman)	420	none	satellite	81
Wekweèti (Dechi Laot'l / Snare Lake)	143	winter road	satellite	81
Whatì (Tlicho / Lac La Martre)	495	winter road	micro	41
Wrigley (Pehdzeh Ki)	114	all season	fibre	41
Yellowknife (City of Yellowknife and N'dilo)	19,739	all season	fibre	2517

Table created from:

Northern Connectivity - Ensuring Quality Communications

Nordicity, January 2014

Table 17. Telecommunications Backbone Capacity – Nunavut

NUNAVUT

Communities	Pop.	Road	Technology	Backbone Capacity (Mbps)
Arctic Bay	750	none	satellite	113
Arviat	2,508	none	satellite	113
Baker Lake	2,140	none	satellite	113
Cambridge Bay	1,658	none	satellite	44
Cape Dorset	1,491	none	satellite	109
Chesterfield Inlet	393	none	satellite	108
Clyde River	1,004	none	satellite	107
Coral Harbour	945	none	satellite	120
Gjoa Haven	1,386	none	satellite	109
Grise Fiord	157	none	satellite	106
Hall Beach	851	none	satellite	115
Igloolik	1,974	none	satellite	108
Iqaluit	7,177	none	satellite	194
Kimmirut	479	none	satellite	109
Kugaaruk	878	none	satellite	107
Kugluktuk	1,547	none	satellite	110
Pangnirtung	1,611	none	satellite	109
Pond Inlet	1,612	none	satellite	107
Qikiqtarjuaq	520	none	satellite	108
Rankin Inlet	2,777	none	satellite	153
Repulse Bay	1,040	none	satellite	107
Resolute Bay	225	none	satellite	107
Sanikiluaq	884	none	satellite	127
Taloyoak	980	none	satellite	107
Whale Cove	463	none	satellite	108

Table created from:

Northern Connectivity - Ensuring Quality Communications

Nordicity, January 2014

APPENDIX 2 – FEDERAL PROGRAMS AND INITIATIVES[98]

Several programs are available to support the deployment of energy efficient and renewable energy technologies in Canada's North. Although funding is always scarce, there are many specific funds especially designed to support the various territorial and provincial initiatives, plans and strategies. Energy distribution companies also have the capacity to provide financial assistance, particularly for the demonstration of technologies connecting to their grids.

Programs are inevitably moving targets – created or abolished according to the current policy priorities, but also as a means to resolve temporary crises created by sporadic or permanent imbalances between supply and demand, energy price movements, economic and population growth, etc.

The following list of programs is not comprehensive as it covers only the programs that are federally funded.

[98] Most of the program listed in this Appendix are excerpts from : "Mobilizing Canada's Energy Advantage: Leveraging Energy Technology Innovation and Efficiency to Drive Competitiveness and Future Prosperity." Prepared for the Energy and Mines Minister's Conference, Sudbury, Ontario, August 2014. Cat. No. M154-78/2014E-PDF (Online). Additional information was also taken from various departments' website and program documentation.

ABORIGINAL AFFAIRS AND NORTHERN DEVELOPMENT CANADA (AANDC)

Aboriginal Forestry Initiative (AFI)

Program/Initiative	Objective	Areas of Focus
Aboriginal Forestry Initiative (AFI) The AFI is supported by Aboriginal Affairs and Northern Development Canada and the Canadian Forest Service within Natural Resources Canada and works with other federal departments through the Strategic Partnerships Initiative. The Aboriginal Forestry Initiative is supporting the forest sector by financing business plans, feasibility, training and entrepreneurship development projects with the aim of helping entrepreneurs to competitively engage in markets, spreading benefits across communities and organizations and to other partners. Activities involve optimizing the use of forest tenure or wood supply to develop innovative value-added forest products, competing in new markets with innovative forest products and services for government and industry. AFI also supports Aboriginal communities in developing feasibility and technical studies related to forest-based bioenergy production and distribution	The AFI focuses its resources on Aboriginal forestry projects that are acting on an immediate economic development opportunity, have potential for regional-scale economic development, and appeal to multiple partners/funding agencies. With a focus on economic development, the AFI empowers Aboriginal entrepreneurs in the forest sector by serving as a knowledge centre for Aboriginal forestry and forest sector innovation and to facilitate knowledge exchange and coordination of federal and other supports to Aboriginal forestry projects and partnerships.	The AFI focuses investment on three key subsector activities: biomass and bioenergy research, development and production; forestry services that fill identified service gaps or niches; and development of value-added forest products. ▪ **Energy efficiency technologies:** The total funding amount was not allocated by technology type for this initiative. Nor are technologies the focus of the initiative. ▪ **Distributed power generation ($2 million)** – AFI has identified bioenergy as a priority area and has supported feasibility, technical and biomass supply studies related to forest-based bioenergy projects across the country. ▪ **Technologies with potential longer-term impact:** N/A Eligible participants are Aboriginal communities, associations, industries and entrepreneurs who have a focus on economic development in forestry. The focus of the AFI going forward will be in the development and support of communities and businesses involved in the bioenergy economy and participation in forest opportunities related to major resources projects

Comments
A new version of this program is currently in development for 2014-2015.

ABORIGINAL AFFAIRS AND NORTHERN DEVELOPMENT CANADA (AANDC)

Northern Responsible Energy Approach for Community Heat and Electricity (REACHE)

Program/Initiative	Objective	Areas of Focus
Northern Responsible Energy Approach for Community Heat and Electricity (REACHE) *proposed under renewal*	Improve social wellbeing and economic prosperity for aboriginal and Northern communities through small to medium scale responsible energy projects	**$20 M/ 5 years to fund 8-12 small projects per year (40 – 60 total)** using off the shelf technology in Northern communities and Aboriginal off-grid communities south of 60.

Comments

ARCTIC COUNCIL

Program/Initiative	Objective	Areas of Focus
A high level intergovernmental forum	To provide a means for promoting cooperation, coordination and interaction among the Arctic States, with the involvement of the Arctic Indigenous communities and other Arctic inhabitants on common Arctic issues, in particular issues of sustainable development and environmental protection in the Arctic.	With respect to energy, the Arctic Council's Task Force on Arctic Marine Oil Pollution Prevention (TFOPP) was established at the Kiruna Ministerial Meeting in May, 2013 to explore how the Arctic Council can help to advance oil pollution prevention in the Arctic. *The Task Force is focused particularly on potential safety measures to prevent oil pollution from maritime and petroleum activities.*

Comments

ATLANTIC CANADA OPPORTUNITIES AGENCY

Atlantic Innovation Fund

Program/Initiative	Objective	Areas of Focus
Atlantic Innovation Fund A part of the Government of Canada's commitment to increasing business productivity, growth and competitiveness, the AIF is helping Atlantic Canada compete at home and abroad by supporting the development of innovative products and services that lead to commercial success.	**Objectives** ▪ develop and bring to market new products and services that meet market demands and global quality standards; ▪ adapt new technology to meet business needs or respond to market opportunities; ▪ help Atlantic Canada's new and traditional sectors pursue opportunities, solve challenges, stay competitive and grow.	

Comments

Innovative Communities Fund

Program/Initiative	Objective	Areas of Focus
Innovative Communities Fund The Innovative Communities Fund (ICF) invests in strategic projects that build the economies of Atlantic Canada's communities. Working in partnership with Atlantic communities and stakeholders, ICF builds on the strengths of communities and provides the tools needed to identify opportunities available for their sustainable economic growth. ICF focuses on investments that lead to long-term employment and economic capacity building in rural communities. Urban initiatives that stimulate the competitiveness and vitality of rural communities may be considered on a selective basis.	The purpose of ICF is to diversify and enhance the economies of Atlantic communities. ICF capitalizes on the opportunities and strengths that exist in these communities to: ▪ develop competitive, productive, strategic industry sectors; ▪ strengthen community infrastructure in rural communities; and ▪ invest in projects that enhance communities' capacity to overcome economic development challenges and take advantage of their strengths, assets and opportunities presented.	To be considered for ICF funding, projects should: ▪ be compatible with the overall objectives of the program and clearly demonstrate linkages and partnerships within the community; ▪ be beneficial to the economic development of a community; ▪ be consistent with economic development plans/objectives that address challenges and opportunities of a community; ▪ lead to sustainable and viable economic activity; ▪ be incremental in nature; ▪ be of a fixed duration; and ▪ demonstrate adequate managerial, financial and technical capability to conduct the proposed activity.

Comments
The program is funded with $175 million over five years. Assistance is non-repayable. The amount provided to each individual project will be determined by an assessment of the level of funding necessary to allow the project to proceed. Eligible recipients include non-commercial/not-for-profit organizations such as local development associations, municipalities and their agencies, business or technology institutes, industry/sector associations, economic development associations, local co-operatives, universities and educational institutions.

CANADIAN HIGH ARCTIC RESEARCH STATION (CHARS)

Program/Initiative	Objective	Areas of Focus
To be a world-class research station in Canada's Arctic that is on the cutting edge of Arctic issues. The Station will anchor a strong research presence in Canada's Arctic that serves Canada and the world. It will advance Canada's knowledge of the Arctic in order to improve economic opportunities, environmental stewardship, and the quality of life of Northerners and all Canadians.	Mobilize Arctic science and technology: ▪ To develop and diversify the economy in Canada's Arctic; ▪ To support the effective stewardship of Canada's Arctic lands, waters, and resources; ▪ To create a hub for scientific activity in Canada's vast and diverse Arctic; ▪ To promote self-sufficient, vibrant, and healthy Northern communities; ▪ To inspire and build capacity through training, education, and outreach; ▪ To enhance Canada's visible presence in the Arctic and strengthen Canada's leadership on Arctic issues.	**$225,000 through 2016 for early energy-related activities, including $100,000 for the SDTC MOU and preliminary resource assessment and renewable energy feasibility studies** **Priorities and Outcomes** *Resource Development* ▪ Long–term outcomes ➢ Resource development that is economically and environmentally sound and promotes social development; ➢ Renewable resources and unconventional energy sources that contribute to greater energy security and sustainability. ▪ Short-term priority areas ➢ Alternative and renewable energy for the North ➢ Baseline information preparedness for development *Exercising Sovereignty* ▪ Long–term outcomes ➢ Efficient and effective monitoring and surveillance of Canada's vast Arctic; ➢ Effective management of Canada's Arctic waters under changing conditions; ➢ Improved response to, and mitigation of, environmental and other disasters. ▪ Short-term priority areas ➢ Underwater situational awareness *Environmental Stewardship & Climate Change* ▪ Long–term outcomes ➢ Effective environmental stewardship through greater knowledge of natural and human systems and their interconnections; ➢ Strengthened mitigation efforts through greater understanding of changes in the Arctic climate and the

Program/Initiative	Objective	Areas of Focus
		links to global systems, and increased capacity to adapt. ▪ Short-term priority areas ➢ Predicting the impacts of changing ice, permafrost, and snow on shipping, infrastructure, and communities *Strong & Healthy Communities* ▪ Long–term outcomes ➢ Improved infrastructure and diversified economic opportunities; ➢ Improved health outcomes and community wellness and resiliency. ▪ Short-term priority areas ➢ Infrastructure for development

Comments
The department of Aboriginal Affairs and Northern Development Canada (AANDC) is the lead department on the Northern Strategy and the department with the federal mandate for fostering, through scientific investigation and technology, knowledge of the Canadian north and of the means of dealing with conditions related to its further development. As such, AANDC will lead the development of the new research Station.

CANADA MORTGAGE AND HOUSING CORPORATION

Housing Research, Demonstration and Information Dissemination

Program/Initiative	Objective	Areas of Focus
Housing Research, Demonstration and Information Dissemination CMHC undertakes technical research to build industry capacity and promote consumer knowledge, awareness and acceptance of best practices and technologies to advance the sustainability of new and existing housing throughout Canada, including in the North. The Corporation also supports information transfer activities, including demonstration projects, web-based information, seminars, workshops, presentations and other outreach activities.	An expected outcome of CMHC's research is the reduction of greenhouse gas emissions attributable to the residential sector through improved performance of new and existing homes.	CMHC contributes approximately $500,000 in grants and contributions annually for sustainable housing-related research activities through Part IX funding. The activities are focused on: ▪ Energy efficiency technologies and practices – Technology development and demonstration activities to advance affordable and sustainable housing more broadly in the housing sector, including the North.

Comments
Eligible recipients are external research contractors, universities, research centres within other government departments, collaborative research projects with other housing stakeholders including housing agencies To address the unique and challenging housing needs in northern communities, CMHC works closely with northern housing providers through the Northern Sustainable Housing Initiative. Demonstration projects in Dawson, Yukon; Inuvik, NWT; and Arviat, Nunavut showcase four homes that were designed and built to demonstrate high levels of energy efficiency and cultural appropriateness. Some of the homes involve "flex" features that support accessibility for occupants and/or visitors, and adaptability to changing needs. Community members were highly engaged in the design of these demonstration projects.

CANADIAN NORTHERN ECONOMIC DEVELOPMENT AGENCY (CANNOR)

Strategic Investment in Economic Development (SINED)

Program/Initiative	Objective	Areas of Focus
Strategic Investment in Economic Development (SINED) was renewed in Budget 2014. SINED has 4 programs, all of which could fund some element of an energy RD&D initiative. 1 – Targeted Investment Program 2 – Innovation and Knowledge Fund 3 – Partnership and Advisory Forums 4 – Pan-Territorial Fund Multiple other programs across a variety of areas, including: infrastructure improvement, building education centers, support for entrepreneurs, and education.	(SINED) focuses on strengthening the driver sectors of the economy in the territories, economic diversification, and encouraging the participation of Northerners in the economy. Of primary relevance is the Innovation and Knowledge Fund, which will help territorial residents seize opportunities in the knowledge-based economy (and those activities new to the North), and help to further science, technology and research activities in the North.	**SINED: $40 million over two years, starting April 1st, 2014** to support a range of eligible planning and development activities related to community energy, resources development, and energy technology development. Under this program, major construction and capital items, wages, and funding program top-ups are not eligible expenditures. Since CanNor was created it has invested $185 million in over 910 projects (average of about $200,000 per project) to create a more dynamic, sustainable and diverse northern economy.

Comments

INFRASTRUCTURE CANADA

New Building Canada Fund – Provincial-Territorial Infrastructure Component and Small Communities Fund

Program/Initiative	Objective	Areas of Focus
New Building Canada Fund – Provincial-Territorial Infrastructure Component and Small Communities Fund The $10-billion Provincial-Territorial Infrastructure Component (PTIC) which supports infrastructure projects of national, regional and local. It includes the $1 billion for projects located in communities of fewer than 100,000 residents through Small Communities Fund (PTIC–SCF).		Admissible categories: ▪ Public transit ▪ Drinking water ▪ Wastewater ▪ Solid waste management ▪ Green energy ▪ Innovation ▪ Connectivity and broadband ▪ Brownfield redevelopment ▪ Disaster mitigation infrastructure ▪ Local and regional airports ▪ Short-line rail ▪ Short-sea shipping ▪ Highways and major roads ▪ Northern infrastructure (applies to Yukon, Nunavut and NWT only)

Comments

Eligible recipients are restricted to those whose projects are situated within or are for the benefit of, communities with a population of fewer than one hundred thousand people (100,000) as determined by Statistics Canada — Final 2011 Census.

The following are eligible recipients for the purposes of the PTIC–SCF:

a. A municipal or regional government established by or under provincial or territorial statute;
b. A provincial or territorial entity (e.g., a department, corporation or agency) that provides municipal-type infrastructure services to communities, as defined in provincial or territorial statute;
c. A band council within the meaning of section 2 of the *Indian Act*; or a government or authority established pursuant to a Self-Government Agreement or a Comprehensive Land Claim Agreement between Her Majesty the Queen in right of Canada and an Aboriginal people of Canada, that has been approved, given effect and declared valid by federal legislation;
d. A public sector body that is established by or under provincial or territorial statute or by regulation or is wholly owned by a province, territory, municipal or regional government which provides municipal-type infrastructure services to communities; and
e. A private sector body, including for-profit organizations and not-for-profit organizations, whose application is supported by a municipal or regional government referred to above. Such support could take the form of a resolution from the municipal or regional government council.

NATIONAL RESEARCH COUNCIL OF CANADA (NRC)

Aerospace

Program/Initiative	Objective	Areas of Focus
Aerospace NRC Aerospace supports EME in exploiting gas turbine technologies for advancing stationary applications using waste biomass and MSW (under the Energy Production and Mining initiative).	NRC innovation initiatives have the overarching goal of economic development and wealth creation for Canada and involve significant collaboration with industry throughout the value and supply chain, as well as other government departments, to achieve these outcomes.	▪ Distributed power generation: Technology development and demonstration: Support for the development advanced gas turbines engineered for biofuel applications

Comments
NRC is the sole recipient

Construction

Program/Initiative	Objective	Areas of Focus
Construction NRC Construction will deliver the following energy-related outcomes via programs: 1) improved building regulations and solutions to reduce compliance costs and de-risk building designs; this also includes the National Energy Code for Buildings that established the minimum level of energy efficiency for buildings in Canada, and energy requirements for houses 2) validated energy retrofit technologies and decision-making tools for commercial and institutional buildings; 3) innovative bio-based building products that reduce raw materials and energy consumption, including insulation materials	NRC Construction works with firms in Canada's construction value chain to support innovation of building products, systems and services that are deployed domestically and internationally. It provides research- and technology-based solutions and services to accelerate commercialization of construction products and services that achieve higher-performing buildings and infrastructure. It integrates multi-disciplinary technical expertise and national facilities; national services for performance assessment and validation for building products and systems; and leadership and operation of Canada's National Model Building Codes, including the National Energy Code for Buildings. Jointly with Natural Resources Canada and Canada Mortgage and Housing Corporation (CMHC), NRC operates the Canadian Centre for Housing Technologies, a unique facility that evaluates and deploys energy-efficient technologies.	The activities are focused in the following technology areas: ▪ Energy efficiency technologies ($31 million) – Technology development and demonstration: Support for improvements in indoor air quality delivered with reduced energy consumption, through technologies and validation for contaminant reduction, air cleaning and ventilation. This includes supports for energy-efficient building environmental control systems for LED lighting and HVAC; ultra-high efficiency thermal insulations for wall and roof systems; novel glazing films and coatings to control solar load; and innovative recycled, composite and bio-based building materials and products, including insulation materials. ▪ Distributed power generation ($3 million) – Technology development: Support for the development of roof-integrated photovoltaic material with improved durability and efficiency (20 years and 12 percent, respectively) and building-level electro-chemical storage technologies for load-leveling as well as improved value from photovoltaic (PV) systems. ▪ Technologies with potential longer-term impact ($2 million) – Technology development and demonstration: Support for development of hydrogen/fuel cell (as part of energy storage for grid applications).

Comments
NRC is the sole recipient.

Energy Production and Mining

Program/Initiative	Objective	Areas of Focus
Energy Production and Mining Under this initiative the National Research Council Canada (NRC) works with energy and mining production companies and their supply chains with impacts in improved global competitiveness and increased employment. It has a number of objectives, principal among them being 1) reducing the cost of grid storage by up to 50 percent 2) developing waste biomass and municipal solid waste (MSW) as an energy source for stationary power production particularly to displace diesel use in remote and off-grid communities and industrial sites 3) rendering separation processes and comminution in mining more energy efficient 4) reducing water consumption in mining thereby reducing the energy requirements for separation, drying and tailings ponds management.		Under Energy Production and Mining, NRC focuses its efforts under the following technology areas: ▪ Unconventional oil and gas ($10 million) – Technology development and demonstration: support for development of more effective tailings treatment technologies and for improved recovery strategies and processes for bitumen upgrading. ▪ Energy efficiency technologies ($10 million) – Technology development and demonstration: Support for development of energy-efficient separation technologies and comminution. ▪ Distributed power generation ($20 million) – Technology development and demonstration: Support for biomass waste-to-energy for power production to reduce the costs of energy supply in remote/off-grid communities and industry by 20 percent and development of energy storage technologies for grid reliability and smart grid applications leading to cost reductions by 50 percent. ▪ Technologies with potential longer-term impact ($2 million) – Technology development and demonstration: Support for development of hydrogen/fuel cell (as part of energy storage for grid applications). These outcomes should be realized within the next six to ten years through an overall government investment of approximately $40 million. This will be matched by industry investment of about $80 million for a total of about $120 million.

Comments

Industrial Research Assistance Program (IRAP)

Program/Initiative	Objective	Areas of Focus
Industrial Research Assistance Program (IRAP) NRC-IRAP does not target specific sectors but its contribution to any given sector can be determined by summing activity against relevant NAICS codes. Using this approach, NRC-IRAP has contributed more than $84 million over the past five years to innovation related to energy technologies.		The activities are focused in the following technology areas: ▪ Unconventional oil and gas: $12 million over the past five years for this technology cluster. ▪ Next generation transportation: $38.5 million over the past five years for this technology cluster. ▪ Energy efficiency technologies: $9.5 million over the past five years for this technology cluster. ▪ Distributed power generation: $11 million over the past five years for this technology cluster. ▪ Technologies with potential longer-term impact: $9.5 million over the past five years for this technology cluster.

Comments

Measurement Science and Standards, Information and Communication Technologies, and Disruptive Energy Technologies

Program/Initiative	Objective	Areas of Focus
Measurement Science and Standards, Information and Communication Technologies, and Disruptive Energy Technologies The Disruptive Energy Technologies program focuses on two themes: ▪ development of cost effective electrical energy capture and storage technologies, and development of fiber optic Bragg grating sensors and ▪ instrumentation that are operational within the harsh environments of integrated gasification combined cycle (IGCC) power plants.		The activities are focused in the following technology areas: ▪ **Distributed power generation ($1.8 million)** – Technology development and demonstration: Support for calibrations of high-voltage, high-current power transformers, cables, sources and field measurements of cable degradation to establish efficiency of grid system and assess innovative smart-grid technologies.

Comments
NRC is the sole recipient

Ocean, Coastal and River Engineering

Program/Initiative	Objective	Areas of Focus
Ocean, Coastal and River Engineering The NRC Arctic program will be the Government's catalyst in developing engineering technologies to ensure sustainable, low-impact resource development of the Arctic while increasing the quality of life of northerners.	Efforts in this program will: a) reduce design ice loads for oil and gas platforms in the Arctic by 40 percent b) increase the detection of oil under ice and forecasting its location c) decrease the number of ice-related Arctic shipping incidents and structural damage by 50 percent d) optimize route planning in ice and ice management to increase operational windows and efficiencies e) increase survivability of personnel in emergencies by a factor of five and increase the life expectancy of Arctic infrastructure by100 percent f) significantly reduce the operational costs of homes in the Arctic Another theme focuses on increasing the commercial viability of Canadian marine renewable energy (MRE) technologies and projects (for extracting useful energy from ocean waves and water currents in Canadian rivers and coastal waters) and unconventional hydropower. The goal of this effort is to reduce typical MRE project costs by 10 percent and advance two wave and two hydrokinetic technologies from an immature to a mature stage.	The activities are focused in the following technology areas: ▪ Unconventional oil and gas: Technology development and demonstration: Support for development of technologies for oil spill detection, for forecasting and clean-up under Arctic conditions, for emission (CO2, NOx, SOx) reduction in ships, for reduced ice loads on offshore oil and gas exploration and development platforms in Arctic conditions, and other. ▪ Energy efficiency technologies: Technology development and demonstration: Support for development of technologies for reliable water supply and energy-efficient houses in the Arctic. ▪ Next generation transportation: Technology development and demonstration: Support for development of improved ship designs and technologies for more efficient operations. ▪ Distributed power generation: Technology development and demonstration: Support for development of improved assessment and mapping of unconventional hydropower resources. ▪ Technologies with potential longer-term impact: Technology development and demonstration: Support for development of marine energy technologies and advance two-wave and two hydrokinetic technologies from an immature to a mature stage.

Comments
NRC is the sole recipient

NATURAL RESOURCES CANADA

ecoENERGY Innovation Initiative (ecoEII)

Program/Initiative	Objective	Areas of Focus
ecoENERGY Innovation Initiative (ecoEII) The ecoENERGY Innovation Initiative (ecoEII) received funding in Budget 2011, the Next Phase of Canada's Economic Action Plan, for a comprehensive suite of research and development (R&D) and demonstration projects. The program's objective is to support energy technology innovation to produce and use energy in a cleaner and more efficient way. This initiative is a key component of the Government of Canada's actions to achieve real emissions reductions, while maintaining Canada's economic advantage and its ability to create jobs for Canadians. For the program's external R&D and demonstration components, the following are eligible recipients: companies, utilities, Canadian academic institutions, industry associations, First Nations, research institutions, standards organizations, not-for-profit organizations, municipalities, and provincial, territorial, regional and municipal governments and agencies.	The ecoEII is providing $268 million over five years (2011–12 to 2015–16) to fund clean energy research, development, and demonstration (RD&D) activities to support energy technology innovation to produce and use energy more cleanly and efficiently.	The ecoEII supports the following technology cluster in the outlined areas of the innovation spectrum: ▪ Unconventional oil and gas ▪ Next generation transportation ▪ Energy efficiency technologies ▪ Distributed power generation ▪ Technologies with potential longer-term impact

Comments
For the program's internal R&D components, the following are eligible: federal researchers and research organizations.

Forest Innovation Program (FIP)

Program/Initiative	Objective	Areas of Focus
Forest Innovation Program (FIP) Under Budget 2012, the federal government invested $105 million over two years to support Canada's forest sector. The funding is targeted at fostering innovation and expanding market opportunities for the sector. Additional funding of $92 million over two years was announced under Budget 2013 to further support market diversification and forest sector innovation. This funding is available until March 31, 2016.	The goal of the Forest Innovation Program (FIP) is to support research, development and technology transfer activities in Canada's forest sector. Together, these activities will help the sector pursue its ongoing transformation through the adoption of emerging technologies ready for commercialization.	▪ Energy efficiency technologies (~$4.7 million over three years) – Technology development and demonstration: To enhance the energy efficiency of forest industry facilities and operations. ▪ Distributed power generation (~$1.3 million over three years) – Technology development and demonstration: To advance the development and demonstration of forest-based bioenergy facilities. ▪ Technologies with potential longer-term impact (~$11.3 million over three years) – Technology development: To support the transformation of the forest sector toward bio economy applications, including the development of integrated bio refineries for the production of biochemicals, biocomposites and next-generation wood products.

Comments

Program of Energy Research and Development (PERD)

Program/Initiative	Objective	Areas of Focus
Program of Energy Research and Development (PERD) PERD funds research and development designed to ensure a sustainable energy future for Canada. PERD is managed by the Office of Energy R&D (OERD) of Natural Resources Canada and is the only interdepartmental energy R&D program. PERD only provides funding to federal departments and agencies. ▪ Aboriginal Affairs and Northern Development Canada ▪ Agriculture and Agri-Food Canada ▪ Atomic Energy of Canada Limited ▪ Canada Mortgage and Housing Corporation ▪ Environment Canada ▪ Fisheries and Oceans Canada ▪ Health Canada ▪ Industry Canada ▪ National Defence ▪ National Research Council Canada ▪ Natural Resources Canada ▪ Public Works and Government Services Canada ▪ Transport Canada	PERD funding is aimed at developing new knowledge and advancing technological solutions in aid of regulatory development, codes and standards and public good to ensure the safety and security of energy supply in Canada. Today, it can be described in terms of three characteristics: it is long-term; it is needs-driven; and it is interdepartmental. PERD is about creating knowledge: it provides a foundation for short-term, focused technology development programs as well as generating new knowledge to support codes, standards and regulations that are necessary to address barriers to the adoption of clean energy technologies.	PERD funds projects spanning the range of fundamental R&D to pre-demonstration R&D, with a principal focus on applied R&D, in three thematic energy technology areas: ▪ fossil fuels: oil sands, frontier oil and gas, pipelines, clean coal and carbon capture and storage ▪ renewables and clean electricity: renewables, smart grid, storage, bioenergy, and Generation-IV Nuclear (to be phased out in 2015–16) ▪ end use: built environment, industry and transportation

Comments
Recipient science-based departments and agencies (SBDAs) are expected to leverage PERD funds with their own A-base and are encouraged to partner with the private sector, universities, non-governmental organizations, provincial and municipal governments and research organizations. PERD projects typically average $1.50 to $2.00 for each $1 of PERD funding.

OFFICE OF ENERGY EFFICIENCY (OEE)

Northern Communities Efficiency Pilot

Program/Initiative	Objective	Areas of Focus
Responsible Energy Use: Northern Communities Efficiency Pilot *proposed under renewal*	Demonstrate how community energy needs can be met through integrated energy efficiency and renewable energy investments; create network of expertise.	**$6 M/ 5 years to fund 3-5 medium community energy demonstration projects** in off-grid communities, with existing community energy plans, including those where new resource development is taking place.

Comments

OFFICE OF ENERGY R&D (OERD)

Energy Technology Innovation Program: Northern and Remote Energy Efficiency

Program/Initiative	Objective	Areas of Focus
Energy Technology Innovation Program: Northern and Remote Energy Efficiency *proposed under renewal*	Demonstrate not-yet proven energy systems and technologies; create export opportunities; and reduce diesel use.	$20 M/ 5 years to fund 2-3 large demonstration projects at off-grid mining operations.

Comments

Contact

NATIONAL SCIENCES AND ENGINEERING RESEARCH COUNCIL OF CANADA (NSERC)

Climate Change and Atmospheric Research Initiative (CCAR)

Program/Initiative	Objective	Areas of Focus
Climate Change and Atmospheric Research Initiative (CCAR) Northern support falls under one of 3 themes being funded, i.e. *"understanding recent changes in the Arctic and cold region environments"*	Advances from this theme would enhance our understanding of recent changes in the Arctic and cold region environments, and better position Canada to preserve and enhance the quality of the natural environment and to adapt to environmental change.	**$32 M / 5 years to fund up to seven university-based research networks** for collaborative climate change and atmospheric research.

Comments

SUSTAINABLE TECHNOLOGY DEVELOPMENT CANADA SDTC

NextGen Biofuels Fund™

Program/Initiative	Objective	Areas of Focus
NextGen Biofuels Fund™ Budget 2007 announced a conditional grant of federal funding to establish the NextGen Biofuels Fund™, subject to a funding agreement that sets the terms and conditions separate from the SD Tech Fund™.	The purpose of the NextGen Biofuels Fund™ is to: ▪ facilitate the establishment of first-of-kind large demonstration-scale facilities for the production of next-generation renewable fuels and co-products ▪ improve the sustainable development impacts arising from the production and use of renewable fuels in Canada ▪ encourage retention and growth of technology expertise and innovation capacity for the production of next-generation renewable fuels in Canada	The NextGen Biofuels Fund™ primarily supports technology demonstrations under: ▪ Technologies with potential longer-term impact – Technology demonstration

Comments
Support for first-of-kind facilities that primarily produce a biofuel (ethanol or biodiesel) using next-generation processes at a commercial-scale demonstration. Eligible projects must be located in Canada and use feed stocks that are, or could be, representative of Canadian biomass. The project proponents must have completed a pre-commercial pilot-scale demonstration of the technology that has run on a continuous or semi-continuous basis and successfully validated technical efficacy.

SD Tech Fund™

Program/Initiative	Objective	Areas of Focus
SD Tech Fund™ The SD Tech Fund™ has received federal funding through several successive conditional grants, which are subject to a funding agreement that sets the terms and conditions. The latest federal funding announcement was $325 million in Budget 2013, bringing the total to $915 million for the SD Tech Fund™.	The purpose of the SD Tech Fund™ is threefold: a) to provide financial support for the late-stage development and pre-commercial demonstration of technology solutions that address climate change, air quality, clean water, and clean soil b) to foster and encourage innovative collaboration and partnering amongst diverse entities in the private sector and in academic and not-for-profit organizations to channel and strengthen the Canadian capacity to develop and demonstrate sustainable development technologies c) to ensure timely diffusion by the funded recipient of the sustainable development technologies in relevant market sectors throughout Canada.	Small-scale technology demonstrations in the following areas: ▪ Responsible resource development: Mitigate environmental impacts associated with Canada's natural resource sector through technologies in the oil and gas, mining, and forestry sectors. ▪ Next generation transportation: Technologies related to next-generation vehicles having reduced emissions and higher energy efficiency, with a focus on freight transportation. ▪ Resource and energy efficiency: Technologies that encourage energy efficiency in buildings and industrial processes, with a focus on industrial water use efficiency. ▪ Clean energy: Technologies that enable clean energy production, distributed power generation and energy storage as well as technologies related to carbon capture and storage, integrated energy systems and bio refinery/biochemical production. ▪ Agriculture: Technologies that increase yield and improve temperature and drought resistance of agricultural crops, mitigate land-use changes and biodiversity loss and diversify farm incomes. ▪ Northern and remote communities: Innovative technologies and solutions for self-sufficiency in smaller communities, such as food security, heavy-lift transportation, small-scale renewable energy and micro grid applications. Applicants should have expertise in sustainable development technology and be part of a project consortium that meets one of the following three descriptions: 1) a for-profit corporation, a partnership, a limited partnership or a business trust that has entered into a contract relating to the execution of the applicant's project with one or more of the following

Program/Initiative	Objective	Areas of Focus
		legal entities: ▪ another corporation ▪ a partnership, a limited partnership or a business trust that has expertise in sustainable development technology ▪ a university, college or other provincially accredited post-secondary educational institution ▪ a research institute ▪ an individual who has expertise in sustainable development technology ▪ a not-for-profit corporation, with one of its purposes being to undertake, fund or otherwise support the development or demonstration of sustainable Development technology 2) same as above, except a for-profit corporation, a partnership, a limited partnership or a business trust that has entered instead into a collaborative arrangement with one or more of the legal entities listed above to apply jointly to SDTC for funding to carry out the applicant's proposed project 3) a not-for-profit corporation, with one of its purposes being to undertake or fund the development or demonstration of sustainable development technology

Comments

WESTERN ECONOMIC DIVERSIFICATION

Western Innovation Initiative (WINN)

Program/Initiative	Objective	Areas of Focus
Western Innovation Initiative (WINN) The Western Diversification Program (WDP) is the main program through which Western Economic Diversification makes strategic investments in initiatives that enhance and strengthen the economy of Western Canada. Contributions made through the program are towards projects that support the development and diversification of the western Canadian economy and activities where economic and/or employment benefits accrue primarily in Western Canada.	Program objectives include: ▪ knowledge translated into new products and services and into new ways of designing, producing or marketing existing products or services for public and private markets, through innovation ▪ enhanced business productivity and competitiveness, trade and investment attraction and penetration of western Canadian technologies, services and value-added products into international markets, access to risk capital and business services for SMEs ▪ economic development and diversification in communities to sustain their economies and adjust to changing and challenging economic circumstances ▪ undertaking research and analysis required to inform policy and program decisions In terms of innovation-related projects, some basic research capacity in the past has been supported through WDP, however, the majority of funding is focused towards technology development, technology demonstration (small- and large-scale), and technology deployment as well as post-commercialization activities such as market penetration.	The activities are focused in the following areas: ▪ Unconventional oil and gas – Support for research improvements to extraction and treatment of waste by-products in the oil sands industry and for technology development to reduce maintenance in the oil sands sector. ▪ Next generation transportation – Support to attract foreign investment and increase exports in the hydrogen and fuel cell sector ▪ Distributed power generation – Support to develop small-scale and off-grid renewable power generation technologies and demonstrate a biomass fueled district heating system in an urban location. ▪ Technology with potential longer-term impact – Support for the validation of the economic and environmental benefits of biochar technology and for developing camelina and carinata into crops for industrial applications.

Comments
Funding is primarily provided to not-for-profit organizations such as industry associations, post-secondary institutions, Indian bands (as represented by their Chief and Council), provincial or municipal governments, agencies and Crown corporations. On January 21, 2015, Western Economic Diversification Canada (WD) launch a new Western Diversification Program (WDP) Call for Proposals (CFP). The WDP-CFP is targeted to not-for-profit organizations that are eligible for funding under the WDP and applications were accepted until February 19, 2015. More detailed information on the WDP-CFP application process, including objectives and priorities, are available on the WD website.

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About CanmetENERGY

Natural Resources Canada's CanmetENERGY is the Canadian leader in clean energy research and technology development. Our experts work in the fields of clean energy supply from fossil fuel and renewable sources, energy management and distribution systems, and advanced end-use technologies and processes. Ensuring that Canada is at the leading edge of clean energy technologies, we are improving the quality of life of Canadians by creating a sustainable resource advantage.

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