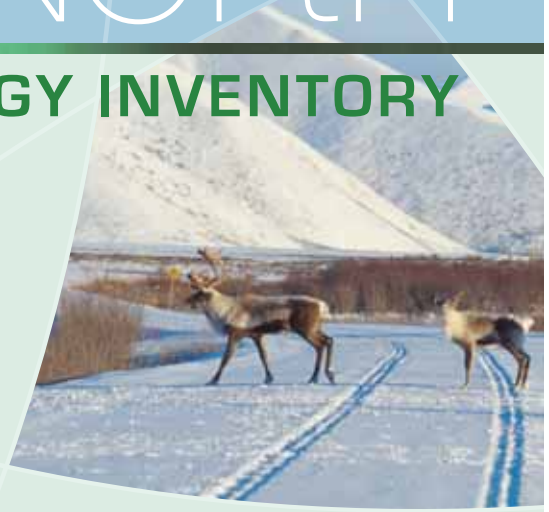
# Paths to a Renewable North

## A PAN-TERRITORIAL RENEWABLE ENERGY INVENTORY



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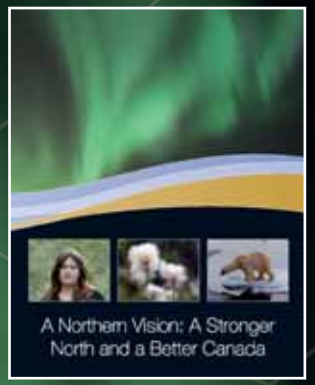


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**A NORTHERN VISION: A Stronger North and a Better Canada.**
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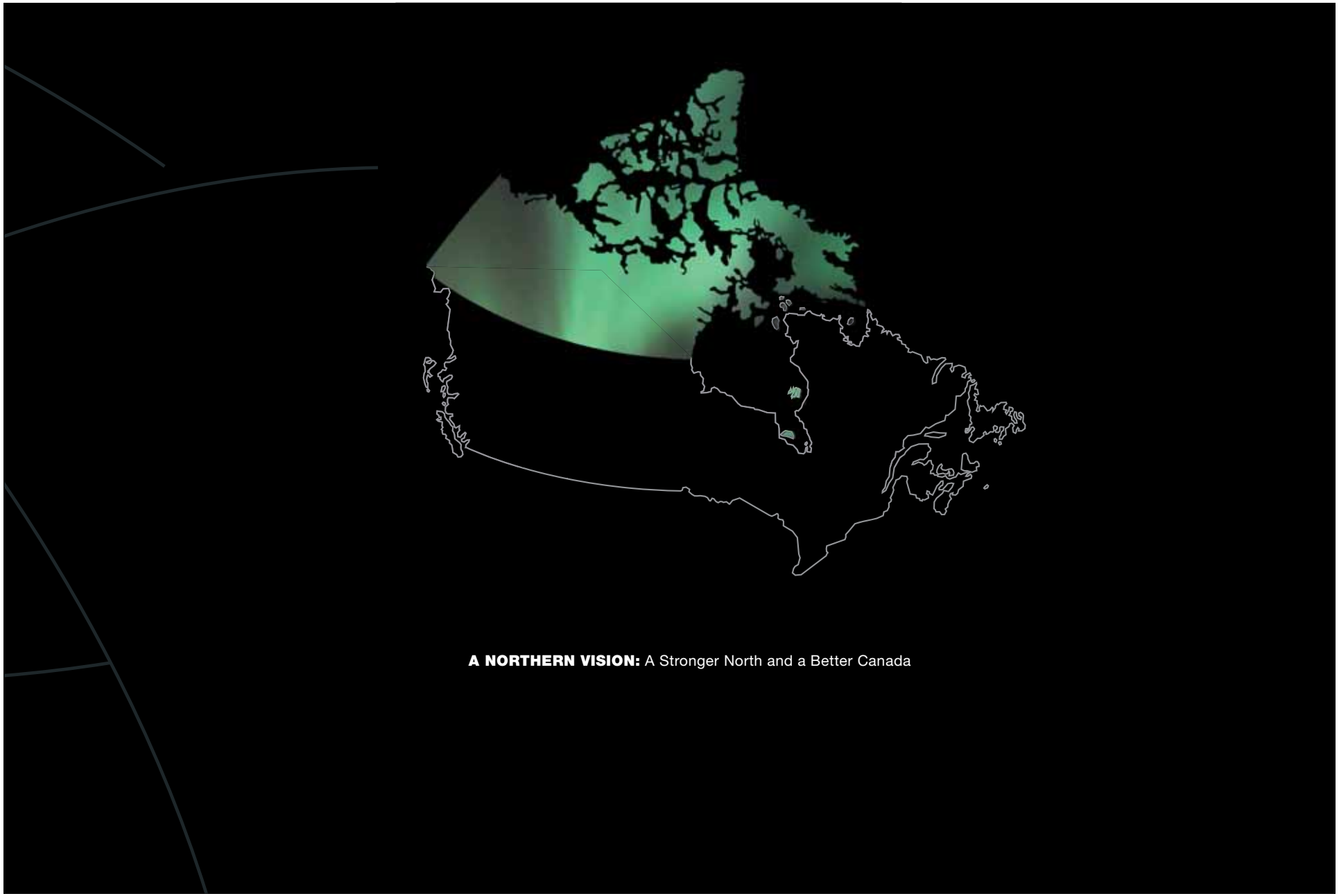


**A NORTHERN VISION:** A Stronger North and a Better Canada

# CONTENT

# INTRODUCTION

Providing energy to meet the needs of Northern households, communities, and industry in Canada's three territories is difficult, but critically important. Currently, imported fossil fuels provide a large percentage of the heat and power used in Nunavut, Northwest Territories and Yukon. 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.

At the 2009 Northern Premiers' Forum, the three territorial Premiers committed to developing an inventory of current and future renewable energy resources. This inventory describes the current state of renewable energy use in the territories, outlines actions being taken and describes policies under development to increase renewable energy use in the North. Finally, the inventory highlights the geographic and policy contexts faced by each territory that shape our distinct opportunities and challenges in the development of renewable energy.

# NORTHWEST TERRITORIES

Work to encourage the growth of renewable energy in the Northwest Territories is guided by the comprehensive policy and planning framework articulated in Energy for the Future: An Energy Plan for the Northwest Territories, and in the Northwest Territories Greenhouse Gas Strategy: 2007-2011.

Key energy priorities in the Northwest Territories Energy Priorities Framework identify specific initiatives and investments that can be undertaken immediately, such as providing residents and communities with the tools required to manage their own energy use through energy conservation and efficiency. Investments in alternative energy sources and the application of emerging technologies are also key objectives. The Department of Public Works and Services and the NWT Housing Corporation are working to improve the energy performance of buildings and public housing that they construct and maintain.

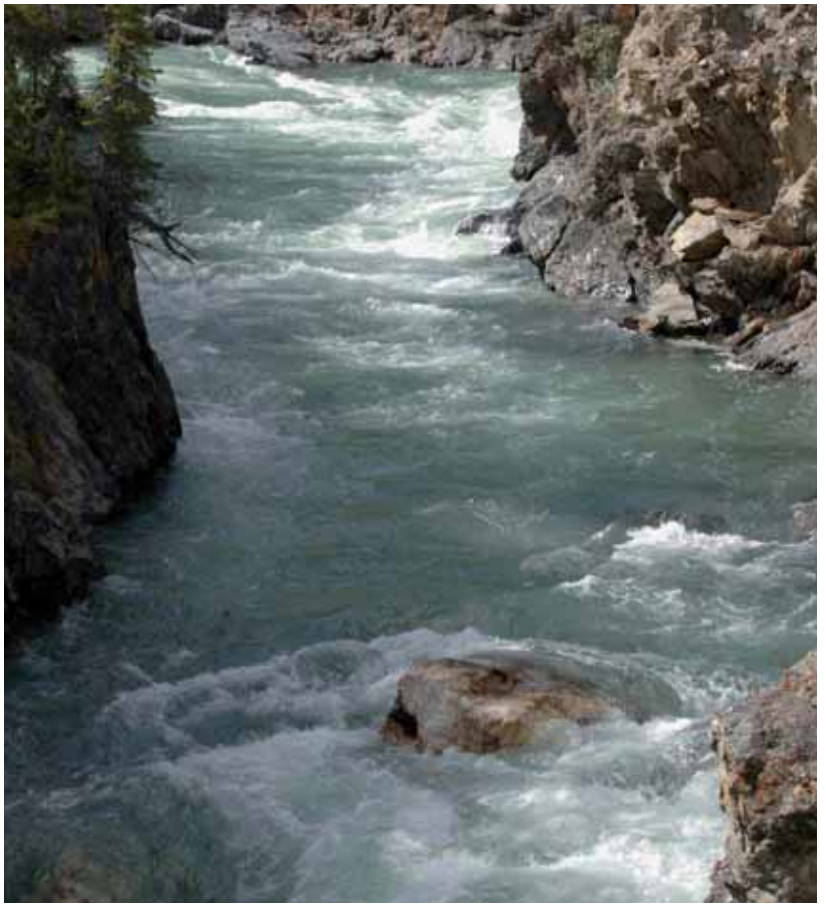
The Northwest Territories Biomass Energy Strategy and draft Northwest Territories Hydro Strategy seek to implement alternative energy investments to increase the use of wood products and water resources to heat and power northern homes and businesses. The Government of the Northwest Territories has three programs to assist residents and communities address the high cost of energy and take steps to reduce their greenhouse gas emissions. These are the Energy Efficiency Incentive Program, the Energy Conservation Program, and the Alternative Energy Technologies Program. Advice and technical support for residents and communities on energy efficiency is provided by the Arctic Energy Alliance, a not-for-profit organization supported by the government.

# BACKGROUND

The Canadian North is experiencing some of the most rapid and intense climate changes on the planet. Average annual temperatures in many northern communities have increased by two to three degrees Celsius over the last fifty years. This warming trend is expected to increase as long as global emissions of greenhouse gases continue at current rates *(Arctic Climate Impact Assessment, 2004)*. Melting permafrost and changing ice conditions are already affecting infrastructure foundations and making transportation systems less reliable.

While global efforts will be needed to reduce levels of greenhouse gases in the atmosphere, we recognize each territory's responsibility to take actions to control our own emissions. Each territory has established climate change and energy plans that include actions to reduce energy use and develop renewable energy sources. Energy conservation and efficiency are key tools in the broader energy planning context and provide short term environmental and economic returns on investment. One example of how the territories are encouraging efficiency is the provision of incentives to residents for energy retrofits and the purchase of energy efficient appliances.

The territories recognize the importance of taking a strategic approach to developing renewable energy sources. Production of energy through sources such as hydro and wood already provides important economic benefits. Expanding the use of these energy sources and developing wind, solar, geothermal and tidal energy will require strategic planning and targeted investments.



Strong partnerships are also needed so that the development of renewable energy resources benefits all northern residents, including our partners in Aboriginal governments and organizations, industry, and all levels of government.
Community involvement is essential for developing locally available renewable energy sources.

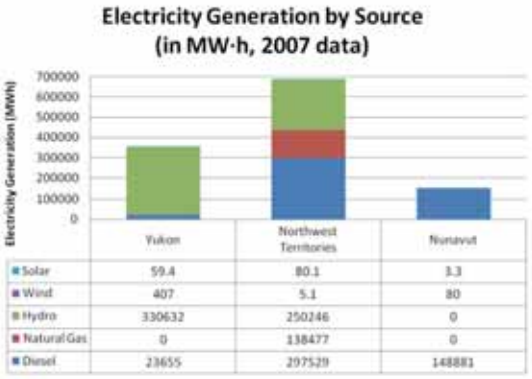
# Existing Energy Systems

Systems of energy generation and use vary across the territories. Hydroelectricity has been an important source of power in Yukon and the Northwest Territories for many decades. Most energy for heating is derived from petroleum, although wood has always been an important source of home heating in Yukon and the Northwest Territories and even powered the early steamboats. Natural gas is also used in two communities in the Northwest Territories for both heat and power. Diesel-fired power generation provides the remaining electricity and heating needs in the three territories, including the vast majority of energy generation in Nunavut.

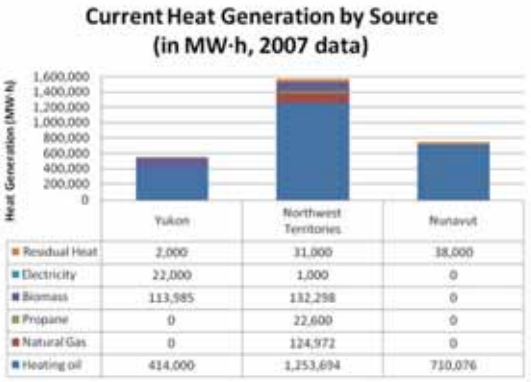
# A megawatt (MW)

A megawatt (MW) in the context of this inventory measures the amount of electricity or heat a generating unit can produce from a given fuel. A typical coal powered power station in southern Canada has a generation capacity of around 600-700 MW of electricity.

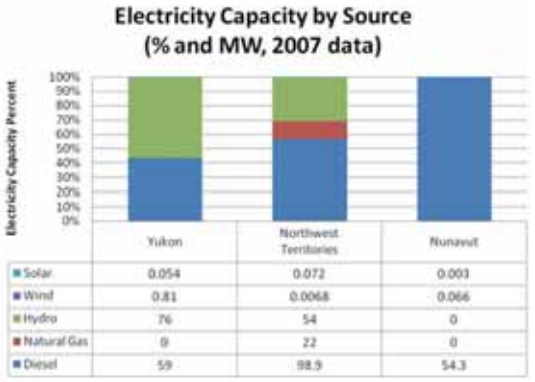
Energy in watt hours is the multiplication of the generation capacity in watts and time in hours. A megawatt hour (MW·h) is equal to consumption of 1,000 kilowatts over one hour.




Total electricity generation in all three territories over a year by source in megawatt hours (MW·h).

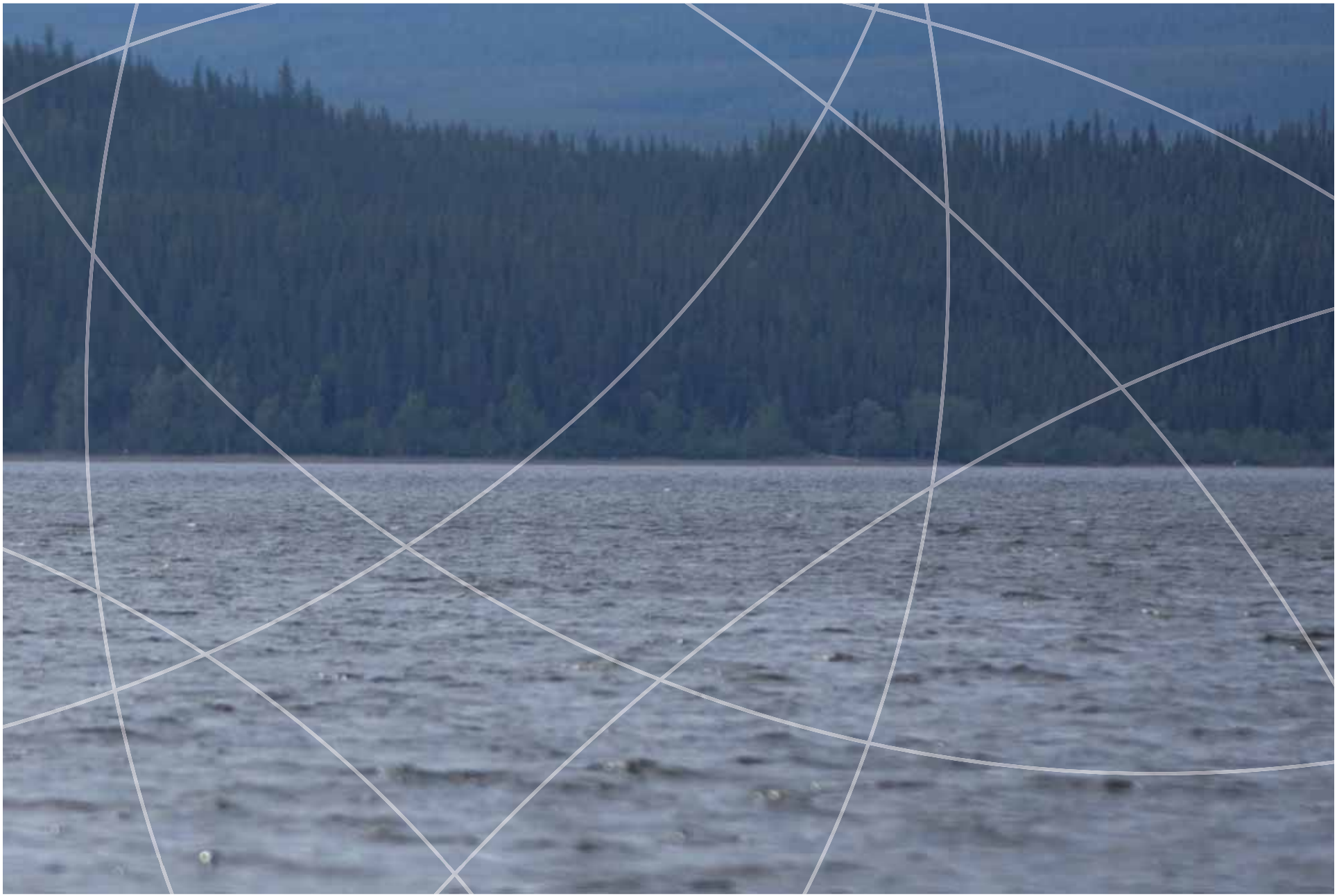



Total heat generation over a year by source in MW·h. These graphs provide a useful starting point to compare the types of energy systems currently fuelling the territories as well as the total energy consumption for electricity and heat.




Total installed electrical generation capacity includes backup capacity fuelled with diesel for emergency situations when the primary sources of electricity generation fail. Diesel generators have been chosen because of their reliability and affordability. Even though a community may rely on hydro power as its primary source of electricity, diesel generators are also installed and maintained near the community.

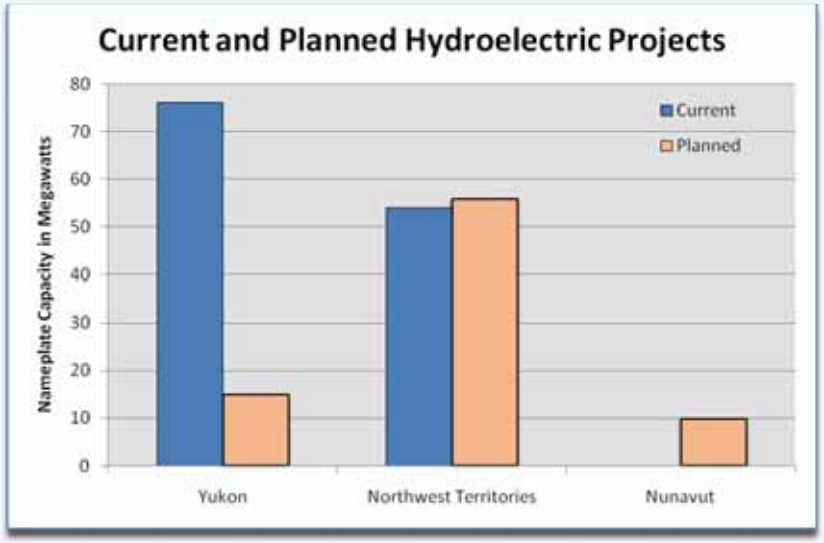
Note: all graph data is from 2007.



# Hydro electricity

Hydroelectricity has been generated in Yukon and the Northwest Territories since the 1940s. Hydro projects were often developed with significant federal investment to coincide with the opening of a new mine, which was the anchor customer to finance the project. These projects provide the hydro generation capacity that now supplies significant portions of the electricity used by residents in Yukon and the Northwest Territories.

The territories have some of the best undeveloped hydroelectric resources in Canada. Each territory has identified significant hydro potential that could be developed over the long term and has active plans for new generation or transmission lines that will be developed over the next three years.




All current and planned short-term hydroelectric projects for each territory.

There are considerable challenges, however, in realizing hydro potential: cost, lack of capital, the need to guarantee customers, and environmental and socio-economic impacts. Hydro projects have high capital costs that governments have to finance while trying to avoid increasing rate charges to customers. There are also community concerns about development on some rivers, and logistical difficulties as many potential hydro sites in the Northwest Territories and Nunavut are located too far away from consumers.

The Government of the Northwest Territories (GNWT) is currently finalizing a draft hydro strategy. The strategy will comprise 13 key actions to ensure that residents of the Northwest Territories are positioned to build upon the existing hydro legacy. For example, hydro development, including the Taltson Dam expansion, mini-hydro projects for selected communities, and extension of the existing electricity grid are key priorities in which the GNWT will continue to invest. Recently, the Northwest Territories Power Corporation installed a small in-stream hydro turbine that is now being tested on the Mackenzie River near Fort Simpson.

Solar photovoltaic panels transform solar radiation into electrical energy using a thin layer of semiconductor-based cells, usually made of silicon, spread on a panel. Photovoltaic panels operate well at sub-zero temperatures due to lowered resistance in electrical components. In addition, snow reflection increases solar intensity and in northern climates, photovoltaic panels often outperform their rated capacity. The experience in the territories has demonstrated that photovoltaic technology is reliable when tied into batteries to reduce the amount of fuel used by small gas or diesel fuelled generators. These small hybrid photovoltaic systems are cost effective sources of renewable energy for off-grid camps and residences.

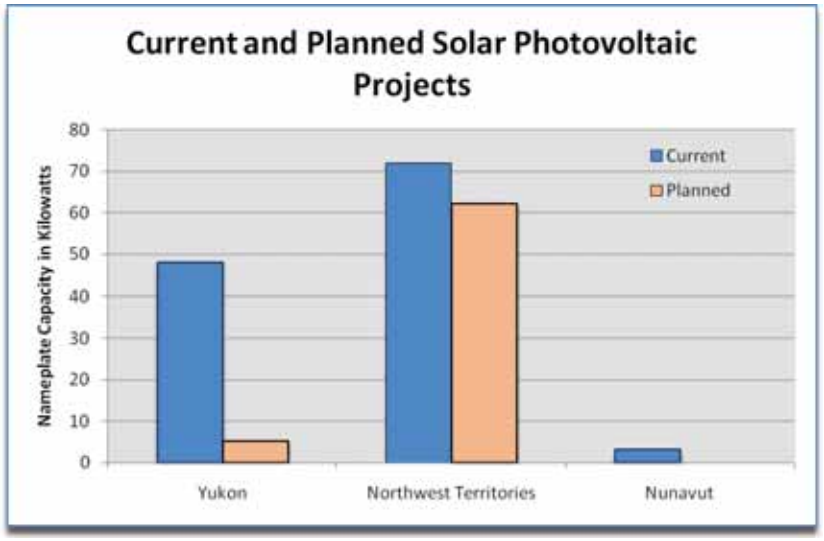
A problem for integrating photovoltaic technology in northern communities is the seasonal availability of the sun. Abundant sunlight in the summer can provide an almost continuous source of electricity that is shortened or non-existent during the cold, dark winter months when electricity demand is highest. This problem can be addressed by tying a photovoltaic project into an existing

# Solar Electricity

electrical grid, which can diversify the electricity supply and offset diesel power production or allow water to be stored in hydro reservoirs.

Photovoltaic electricity is more expensive per watt to install than conventional diesel or hydroelectric sources. However, prices for photovoltaic technology have been declining in recent years and will continue to fall as global market demand and production capacity increases and research for this technology continues.

Integration of photovoltaic power into community grid systems is being considered in Yukon and the Northwest Territories through pilot projects to gain an understanding of distributed generation issues. For instance, in Yukon a combined solar heat and power application is operating at the Yukon College in partnership with the Northern Research Institute. All three territories are working to develop policies and pricing for self-generated or non-utility electricity sold back into the grid.

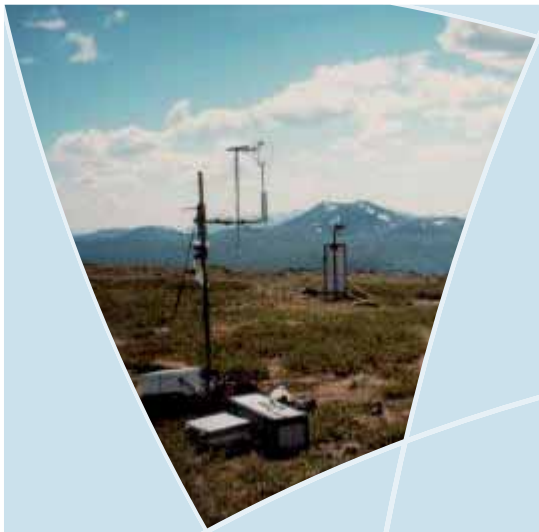



Current and planned photovoltaic capacity in the North.
Note: all graph data is from 2007.

# Solar Heating

Solar air and hot water heating are relatively simple and robust technologies. Water-based systems absorb heat from the sun in enclosed solar collector panels and transfer that heat through an exchanger to be stored in an auxiliary hot water tank. This heated water can then be used for space heating or as pre-heated domestic hot water. Solar energy can also be used in a similar fashion to pre-heat air directly. This pre-heated air can then be used for space heating. A solar heating system can offset over 50 per cent of household annual hot water and heating costs by significantly reducing the large amounts of electricity or fossil fuels that standard heaters typically consume. Like photovoltaic panels, this form of solar energy is most available in the spring and summer when the sun is strongest.

Currently, residents of the Northwest Territories produce 79 MW·h of heat per year from solar hot water heating. This is roughly the same amount of heat needed to replace 50 per cent of the heating load for hot water in 40 households. Planned upgrades for eight seasonal swimming pools are estimated to produce an additional 22 MW·h of heat per year. The overall potential for solar hot water heating is vast. If all 41,000 households in the three territories were to install solar domestic water heating it would result in a saving of 80,000 MWh.



# Wind

Wind energy technology is important to the long-term energy supply of Northern Canada. Many isolated, diesel-dependent communities in the Arctic islands of Nunavut and the Northwest Territories have no source of locally available renewable energy other than solar, which is only available for half the year.

There is potential for wind technology to be developed in the North, but significant challenges remain leading to high costs. Wind turbines need to be located close to communities to reduce the cost of constructing transmission lines, and integrating wind projects with existing power producing facilities is a technical challenge. Other challenges include training of local maintenance staff and operators, locating functional technology for cold weather, and the lack of cranes for hoisting towers. As in other Canadian jurisdictions, wind development in the North requires careful testing and precise turbine placement in order to design economical wind energy projects.

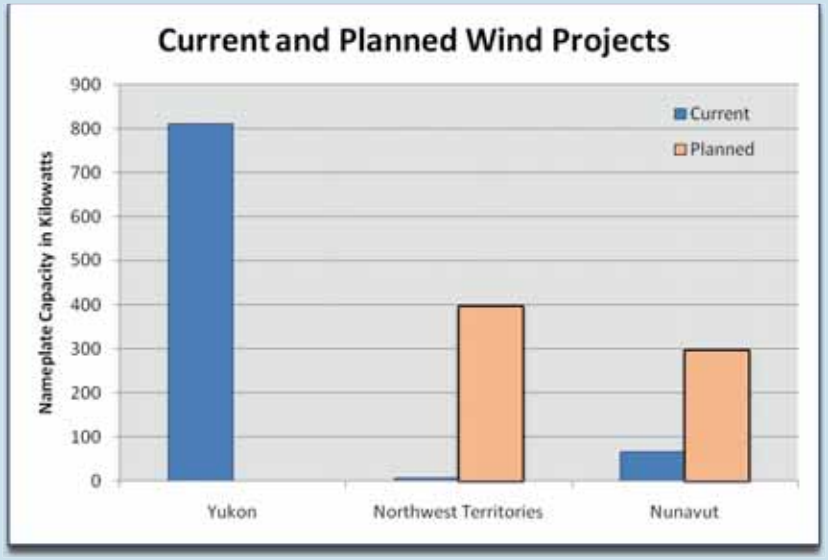
Despite these challenges, over ten years of experience in Alaska has demonstrated that wind power technology can be successful in reducing the amount of imported diesel required by remote

communities. Significant improvements in the control systems for wind/diesel integrated generation have been witnessed in recent years. A number of northern communities have sufficient wind resources to warrant further investigation into the feasibility of developing a full-scale wind energy project that could provide more than half of their electrical load.

Several wind energy projects have been completed or are being constructed in the territories. The Nunavut power utility company, Qulliq Energy Corporation, is working toward installing a wind-hydrogen-diesel generation plant in Cape Dorset, with hopes of deploying similar technology in other communities. Nunavut also has a 66 kilowatt (kW) turbine in operation in the town of Rankin Inlet.

The largest wind turbines in the North stand prominently on Haeckel Hill near Whitehorse in Yukon. These turbines have an installed capacity of 800 kW and have been operating since the 1990s.

The Hamlet of Tuktoyaktuk in the Northwest Territories is promoting a regional hub-and-spoke model based on the Alaskan experience. A 300 kW wind power project in Tuktoyaktuk could be operating as early as the summer of 2012. Building on the capacities raised from that project (the hub) can help to implement wind power in smaller, more remote communities in the region (the spokes) where some of the most promising wind regimes have been measured.




Current and planned wind projects in the North.
Note: all graph data is from 2007.

# Biomass

Firewood for conventional woodstoves is harvested around most communities in the Northwest Territories and Yukon. On an annual average, woodstoves currently produce roughly 65,000 MW·h of heat in the Northwest Territories and 110,000 MW·h in Yukon. Nunavut is above the tree line and thus has no forests, although waste wood from packaging and construction is diverted from landfills and used for heat to a limited extent.

The future for biomass as a cornerstone energy source in the North is bright. The development of new efficient technologies has made wood a reliable source of energy for large-scale applications. Large wood pellet boilers can heat institutional building such as schools and offices. These types of boilers can also fuel district heating systems and generate electricity.

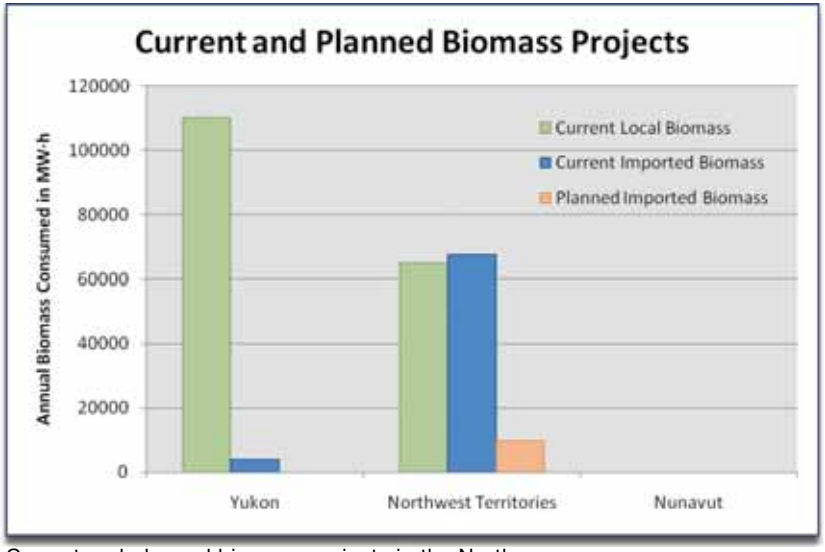
However, transportation and distribution systems for wood pellets are not well developed. This leads to higher transportation costs and vulnerability to possible supply chain interruptions. It is also extremely important that proper forest management practices be applied to ensure that the harvest of local wood supplies for this energy source remains sustainable.

The Northwest Territories Biomass Energy Strategy is intended to build on the growing interest in the territory for using wood and wood pellets. It promotes greater use of biomass as a clean and efficient source of heat and a means of creating a sustainable biomass economy employing northerners to harvest the heat energy they need.

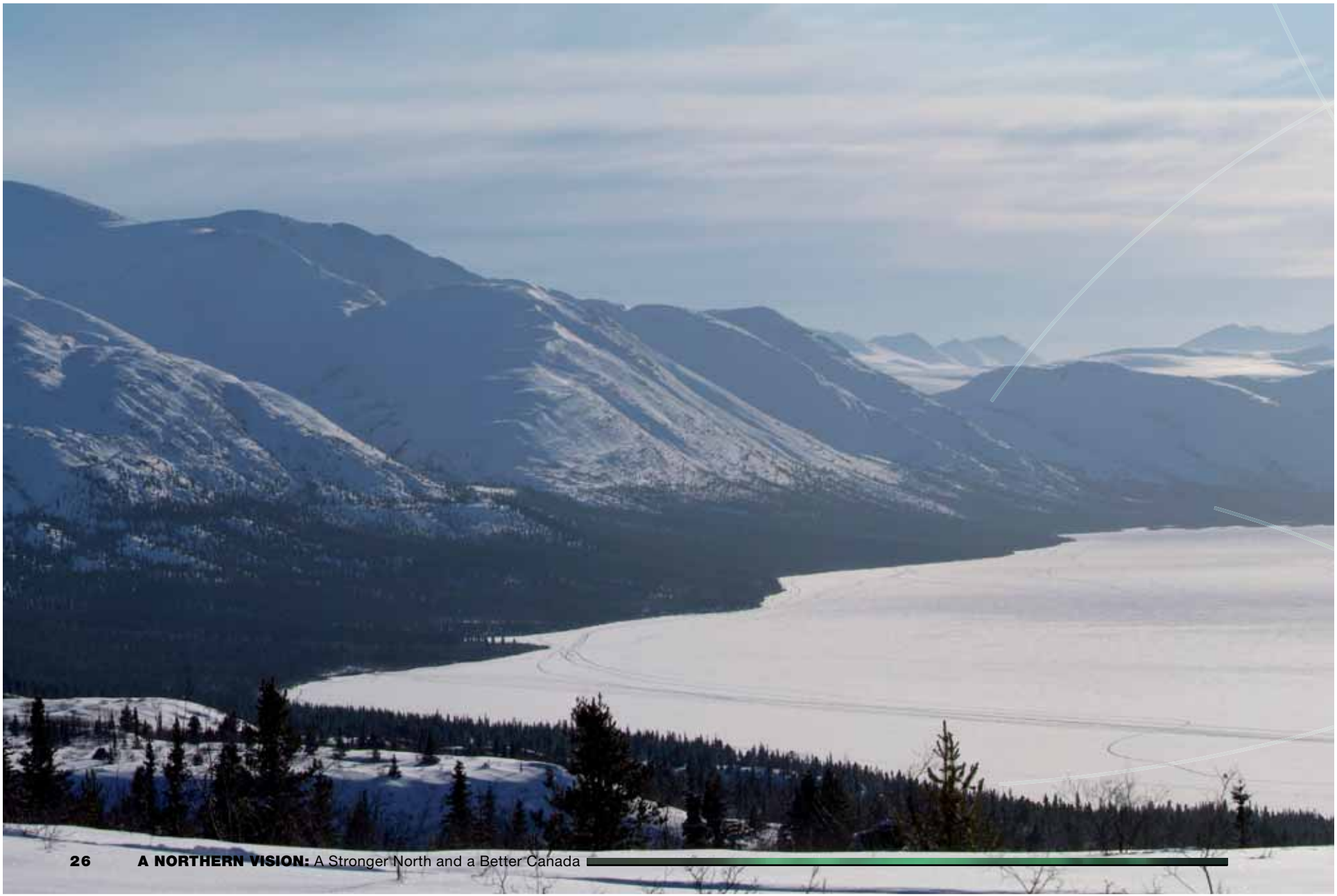
Similarly, Yukon is developing a bioenergy strategy to provide a strategic approach for helping Yukon stakeholders achieve long-term economic and environmental benefits from biomass. There is considerable potential in Yukon to replace much of the fossil fuels used for heating buildings with wood.

First, district heating could potentially deliver heat to larger buildings in urban areas to replace the oil and propane predominately in current use. Wood could provide an alternative source of heat, in addition to electric heaters powered by surplus hydroelectricity or residual heat recovered from thermal electricity generation.

Second, development of bulk wood pellet production and delivery infrastructure in Yukon would allow smaller buildings, or those too far from a district energy grid, to produce the majority of their heat at a lower economic and environmental cost than with heating oil. Nunavut has very little in the way of biomass that could be potentially used for fuel. Biofuels made from fish waste from Nunavut's emerging fishing industry might be an option in the future. Significant research is needed in this area.




Current and planned biomass projects in the North.
Note: all graph data is from 2007.



# Geothermal

Geothermal energy is heat from the earth. This heat generally increases as one digs deeper into the ground. Heat can be accessed by drilling or using pre-existing holes (mine shafts, exploration wells). Shallow systems for residential or commercial buildings using ground source heat pumps have limited application in the North. Cold ground temperatures in the bedrock of the Canadian Shield and permafrost are major limitations across much of the North.

There is considerable potential for geothermal energy from retired gold mine shafts under the city of Yellowknife. These mine tunnels and shafts are filling with water heated as high as 50 degrees Celsius and could provide a thermal reservoir for a district heat system that serves buildings in the downtown core. This project could provide as much as 20 MW of heating capacity.

A deep geothermal favourability map recently completed for the Northwest Territories indicates that there is a high potential that suitable temperatures to produce heat and power can be found at depths of two to three kilometres over a broad zone between Fort Simpson to Hay River. A pilot geothermal project that would provide 1 MW of electricity in Fort Liard is currently in the business plan development stage. Exploration drilling for natural gas in that region has already encountered water at 130 degrees Celsius.

In Yukon, interest in geothermal resources has primarily focused on heat pump systems associated with hot or warm aquifers. Haines Junction investigated the potential of using an artesian well (at a temperature of 16.9 degrees Celsius) for space heating in the community. The Town of Mayo has studied the potential of using two deep warm water wells to heat local government buildings. A 2.95 million dollar project has been initiated that will provide the First Nation of Na-cho Nyäk Dun Government House with energy-efficient, sustainable, and low-cost central heating. The system will also be expandable to serve other buildings in the community. Currently, the City of Whitehorse uses low-grade geothermal resources (warm ground water) to keep its water pipes from freezing in the winter.

Studies of the total potential of geothermal energy in Yukon are promising. Yukon is estimated to have 500 - 1,500 MW of geothermal energy available for electricity production.

No studies have been completed in Nunavut in relation to geothermal heat, although thermal hotspots are known to exist close to the surface that could be used in the future.

# Residual Heat Recovery

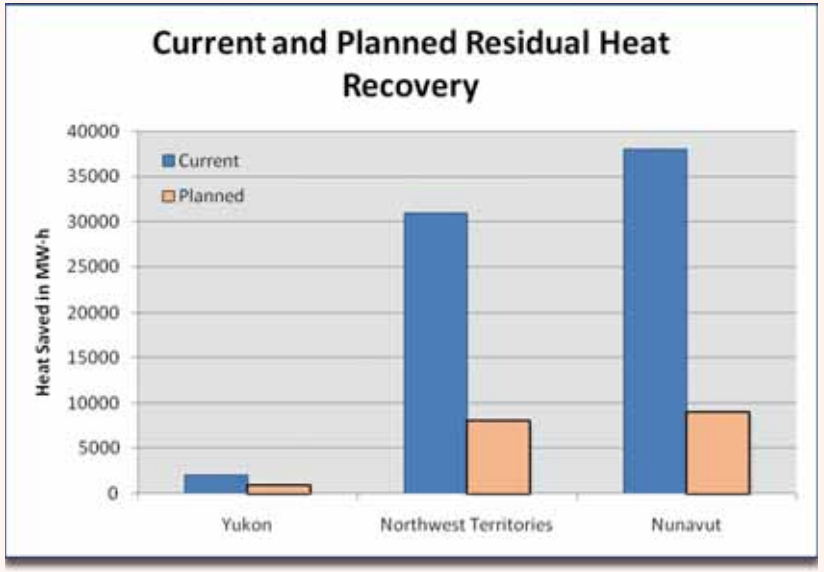
While not generally considered a form of renewable energy, residual heat captured from diesel electrical generation in northern communities is an underused source of heat that will remain available as long as fossil fuel-based generation is used. Approximately one third of the energy in the fuel used in diesel generation is converted into electricity. Another one third of the heat energy is transferred into cooling waters, but this heat can be easily recovered and used to heat nearby buildings, costing less than using heating oil. It is also possible to recover most of the final third of residual energy from exhaust gases using heat exchange technology, although at a higher cost.

Residual heat recovery is not new to the North. Since the 1990s, the Qulliq Energy Corporation in Nunavut and the Northwest Territories Power Corporation have reduced the cost of their operations by recovering heat captured from diesel generators to heat their own facilities. Also, residual heat recovery systems have been installed in several communities to transfer this heat to nearby buildings.

Cost is a major barrier to the expansion of residual heat recovery. Installing the necessary infrastructure for residual heat requires a large initial capital investment. Some residual heat projects have been delayed because many communities eventually want diesel plants moved away from residential areas. However, for residual heat systems to function in an efficient and cost-effective manner, the diesel generator should remain in close proximity to the buildings it heats.

Residual heat systems can provide a backbone for district heating systems and can be designed to accept additional heat from distributed conventional oil boilers or renewable energy sources. Diesel-electric generators only produce heat when there is a demand for electricity and buildings that use residual heat need to maintain their own heating sources for cold periods when electricity demand is low.

District heating systems present an opportunity to combine different forms of renewable energy, such as biomass or geothermal, in order to supplement the available heat load from residual heat recovery.




Current and planned residual heat recovery systems in the North.
Note: all graph data is from 2007.

# Ocean Current and Tidal Energy

The rise and fall of the sea where tidal ranges are high provides a source of energy that can be harnessed to generate electricity. When tides come into the shore, the water can be trapped in reservoirs behind dams. Then when the tide drops, the water behind the dam can be let out just like in a regular hydroelectric power plant. Completely submerged systems are also available that use tidal currents to provide electricity. In order for the reservoir system to work well, an increase of at least 5 metres from low tide to high tide is needed. There are only a few places in the world where this tide change occurs. The South Baffin region of Nunavut is one of the world class sites. Some power plants in different parts of the world are already operating using this method. It is estimated that Nunavut has the potential to build 30,000 MW of generation capacity from projects harnessing tidal energy from 34 sites, while the Northwest Territories could build 35 MW of generation capacity from four sites. There are, however, significant technical challenges to implementing these emerging technologies in the North, including very harsh ice conditions and isolation.

# Energy Efficiency and Conservation

While they do not technically fall into the category of renewable energy, energy efficiency and conservation are key and complementary tools in the broader energy planning context, as the cleanest and cheapest form of energy is the energy that we do not consume in the first place. Energy efficiency is the use of technology that requires less energy to perform the same function. Energy conservation is any behaviour that results in the use of less energy. While this concept may appear simple, there is no single, well-defined way to achieve these measures.

The territories are working towards better energy efficiency and conservation and are moving forward through a variety of programs and initiatives. In Yukon, the Energy Solutions Centre and the Yukon Housing Corporation provide advice on renewable energy technology and programs, housing retrofits, fuel prices, economic and social costs and environmental impacts of energy choices, indoor air quality and safety concerns.

The Government of Yukon provides a Good Energy Rebate Program through the Energy Solutions Centre and provides rebates for high efficiency kitchen and laundry appliances, solar domestic hot water systems, pellet and cordwood stoves, and oil and propane furnaces and boilers. Rebate amounts vary depending on item and the community's electricity source.

The Yukon Home Repair Program provides homeowners with an opportunity to borrow up to 35,000 dollars to repair their principal residence for energy efficiency. Technical officers offer home assessments and provide lists of eligible repair options. All new government construction is mandated to meet high standards of energy efficiency, LEED for public buildings and SuperGreen for residential units. SuperGreen represents a Yukon Housing Corporation standard of construction that calls for superior insulation of homes through advanced framing designs. SuperGreen buildings have a minimum EnerGuide evaluation rating of 87.

In the Northwest Territories, the government has taken significant steps to implement energy efficiency and conservation programs and initiatives. For example, all new Government of the Northwest Territories buildings are required to be 25 per cent more energy efficient than a comparable building built to the minimum requirements of the National Building Code. The NWT Housing Corporation has developed its own brand, Ecobuild 80 Plus, to reflect its commitment to designing, building, and retrofitting houses that meet or exceed EnerGuide 80.

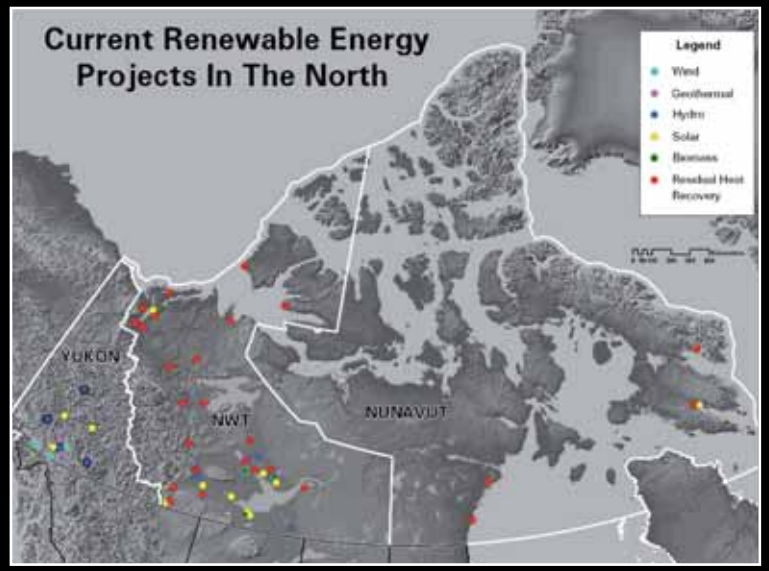
The NWT Energy Efficiency Incentive Program provides rebates to residents and businesses when they purchase Energy Star rated appliances, furnaces or boilers, wood or pellet stoves, home energy performance upgrades and other efficient equipment that can reduce energy consumption and greenhouse gas emissions. This rebate program is available through the Arctic Energy Alliance that provides general advice and information about energy management and emission reduction opportunities, including home energy assessments, through the EnerGuide for Houses program.

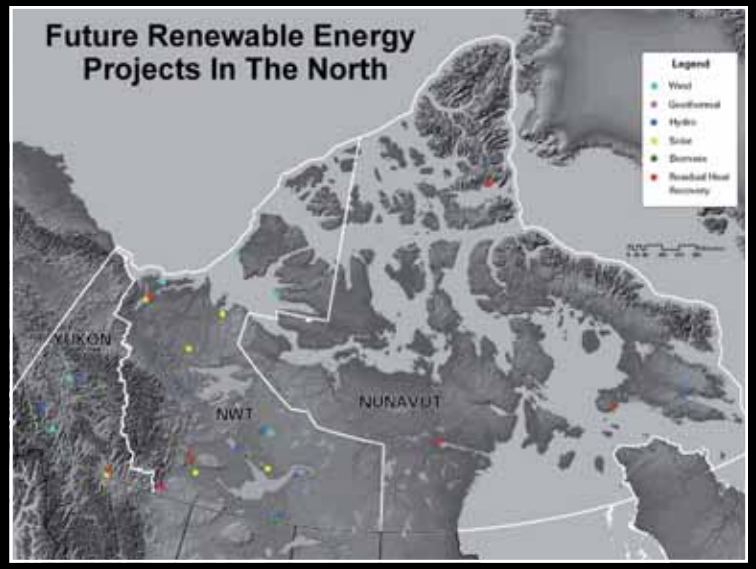
The Nunavut Energy Management Program is providing significant opportunities for energy efficiency improvement though performance contracting. The upfront capital costs of improvements are financed

through private means and paid back through guaranteed energy savings.  Phase One of this program targeted 39 Government of Nunavut-owned buildings in Iqaluit. Phase Two will move beyond Iqaluit to retrofit government-owned buildings in other communities.

The Homeowner Energy Efficiency Rebate Program, administered by the Nunavut Housing Corporation, provides financial incentives to individuals to pursue energy efficiency improvements and reduce their power consumption. The program currently offers a 50 per cent rebate, up to 2,000 dollars, for repairs that improve energy efficiency, the purchase of energy efficient major appliances, the installation of renewable energy sources, and labour and shipping costs.
The Government of Nunavut also funds Save 10, a two-pronged education program designed to assist building managers in operating newly retrofitted facilities and to help employees and students reduce their energy and water consumption at work, home and school.

# Projects In The North:


Current Renewable Energy
Projects In The North
Legend
Wind
Geothermal
Hydro
Solar
Biomass
Residual Heat
Recovery
YUKON
NWT
NUNAVUT


Future Renewable Energy
Projects In The North
Legend
YUKON
NWT
NUNAVUT

# YUKON

The 2009 Energy Strategy for Yukon identifies the increased use and supply of renewable energy as a priority for the Yukon government. This strategy seeks to expand the supply of renewable energy by 20 per cent by 2020 through a variety of initiatives, including the development of specific strategies on bioenergy, new policies on independent power production and net metering, the development of a policy framework for geothermal energy, the development of new government/utility demand-side management initiatives, and strategic investments in infrastructure. Yukon can also effectively increase its use of available hydroelectricity and other renewable energy resources through the development of a smart grid to match potential loads with renewable energy resources. The strategy complements the Yukon government's 2009 Climate Change Strategy and Action Plan.

The Yukon government provides a number of programs to help Yukon residents, businesses, First Nations, and municipalities reduce their energy consumption and replace fossil fuels with local renewable energy resources. The Yukon Housing Corporation offers a suite of programs that provide financial assistance for homeowners, landlords, and residents wishing to reduce energy consumption.
The Energy Solutions Centre offers the Good Energy Program that provides rebates on certain Energy STAR appliances and heating equipment, including EPA-qualified woodstoves/furnaces, EPA white-tag-rated wood boilers, ULC-rated pellet stoves/furnaces/boilers, as well as high efficiency conventional heating appliances. A wind monitoring service helps off-grid residents interested in wind energy determine if the wind resource at their location is sufficient to justify the investment into wind generation equipment.
The Rural Electrification Program provides loans to install power, either by connecting to the electrical grid or through stand-alone photovoltaic, hydro, or wind power systems.

# A Renewable North

This inventory outlines how the territories are leading by example through a range of renewable energy investments. The previous sections describe some of the unique challenges and opportunities facing each territory. We also face common challenges that require collaborative solutions and actions. This section describes some of those collaborative ideas. As Nunavut, the Northwest Territories and Yukon move forward together, renewable energy provides tremendous potential to create a more prosperous and sustainable North.

*Cost of Energy*

Heating and electricity costs vary across the territories but are typically many times more expensive than in southern Canada, due in part to the small and widely dispersed market of consumers in the territories relative to the rest of the country. For example, while electricity rates are around nine to ten cents per kilowatt-hour in Toronto, they can be as high as two dollars per kilowatt-hour in some northern communities.

High and rising energy costs from fossil fuels create considerable long-term incentives to expand the economic case for renewable energy sources in each territory. Targeted planning and preparation will be required to take advantage of the unique opportunities to develop renewable energy sources as they become economically viable across the territories.

*Renewable Energy Technologies*

The small market size of territorial jurisdictions also presents a challenge for the development of technology that is suited to sub-Arctic and Arctic conditions of the North, and discourages local businesses from servicing new technologies. Particularly in remote communities, capacity and human resource challenges are common. All of this increases the construction, operation, and maintenance costs of energy projects, decreasing the economic viability for renewable energy projects in the North. In recent years, however, some promising entrepreneurs have begun to emerge.

Policy changes to encourage an increased supply of renewable energy, such as net metering and independent power producer agreements, are becoming important considerations for grid-connected wind, photovoltaic, and geothermal electricity. Work has already begun on the development of such policies in Nunavut, Yukon, and the Northwest Territories.

We jointly recognize the importance of supporting studies and pilot projects in our jurisdictions to determine the effectiveness and feasibility of various renewable energy technologies and locations. These studies and pilot projects provide critical knowledge and experience as well as public education and skills development. The rapid technological improvements now taking place mean that using renewable energy for heat and electricity in the sub-Arctic and Arctic will become more reliable and less expensive in the future. Some of these improvements include control systems and smart grid technology to better integrate renewable energy into conventional systems. Further research and experience will improve the understanding of the economic potential of renewable energy sources and how they can be integrated into existing energy systems. It is critical for the

territorial governments to share this information and learn from one another as we move towards a renewable North.

*Financing*
Partnerships between territorial governments, Aboriginal governments and organizations and private/public financers are vital for developing expensive renewable energy projects. This becomes more critical as the cost of any given renewable energy project increases.

*Electrical Grid Connectivity*
Long distances between communities as well as mining, oil and gas activities create segregated electrical networks in Northern Canada. In Yukon, the majority of communities are connected to the grid. The Northwest Territories has two partially integrated grids and a number of isolated communities and mines. In Nunavut there is no interconnection between communities. All three territories are isolated from other North American grids.

Future growth in both domestic and international energy demand will provide a market to sell renewable power generated in the territories. In order to capitalize on such opportunities, improvements in transmission and transportation capacity are needed.

Given the potential of renewable energy in the territories, energy exports could create a vibrant and sustainable new northern economy. Investment from the public and private sector in energy infrastructure will be essential to expand opportunities.

Currently, the most favourable opportunity for an electrical grid connection to southern Canada is a transmission line from a hydro development in northern Manitoba to small communities in the Kivalliq area and possibly mine developments around Baker Lake. Alternatively, there is significant potential for small and large hydro development in the central-interior Kivalliq and Kitikmeot regions and coastal areas of the Kivalliq region. It is estimated that there are 56 potential sites with a generating capacity of 3,600MW. This energy could support mining activity in the area or be exported south through Manitoba. The Qulliq Energy Corporation is also examining the potential for an electrical grid upgrade in Iqaluit from 6 kV to 25 kV, which would significantly reduce electrical loss in Nunavut's largest centre and capital city.

In Yukon, all communities except five are connected to the electrical grid. In 2008, Yukon Energy's cost estimate of a 1,303 km, 240 kV transmission line capable of carrying approximately 150 MW of power from Whitehorse to Terrace, BC was roughly $1 billion. BC Hydro has since begun work to extend the British Columbia electrical grid as far as Bob Quinn Lake. This shorter distance would reduce the cost of connection by 15-20 per cent.

There are two large electrical grids in the Northwest Territories which are supplied by Snare/Bluefish Hydro facilities and Taltson Hydrofacilities. Several communities around Great Slave Lake are connected to these electrical grids. In the long term, connecting these two grids will reduce reliance on diesel generators utilized for back-up generation. This grid connection could be facilitated by expanding the Taltson hydro system to supply power to resource

development in the NWT's Slave Geological Province. The existing Taltson system could be expanded by 50 to 60 megawatts, with relatively limited impact. The Northwest Territories Hydro Corporation and Aboriginal partners have proposed to move forward on this expansion to serve existing diamond mines in the region, filing a Developer's Assessment Report with regulators in March 2009. The regulatory process is currently paused while the proponents consider changes to the business case supporting the project.

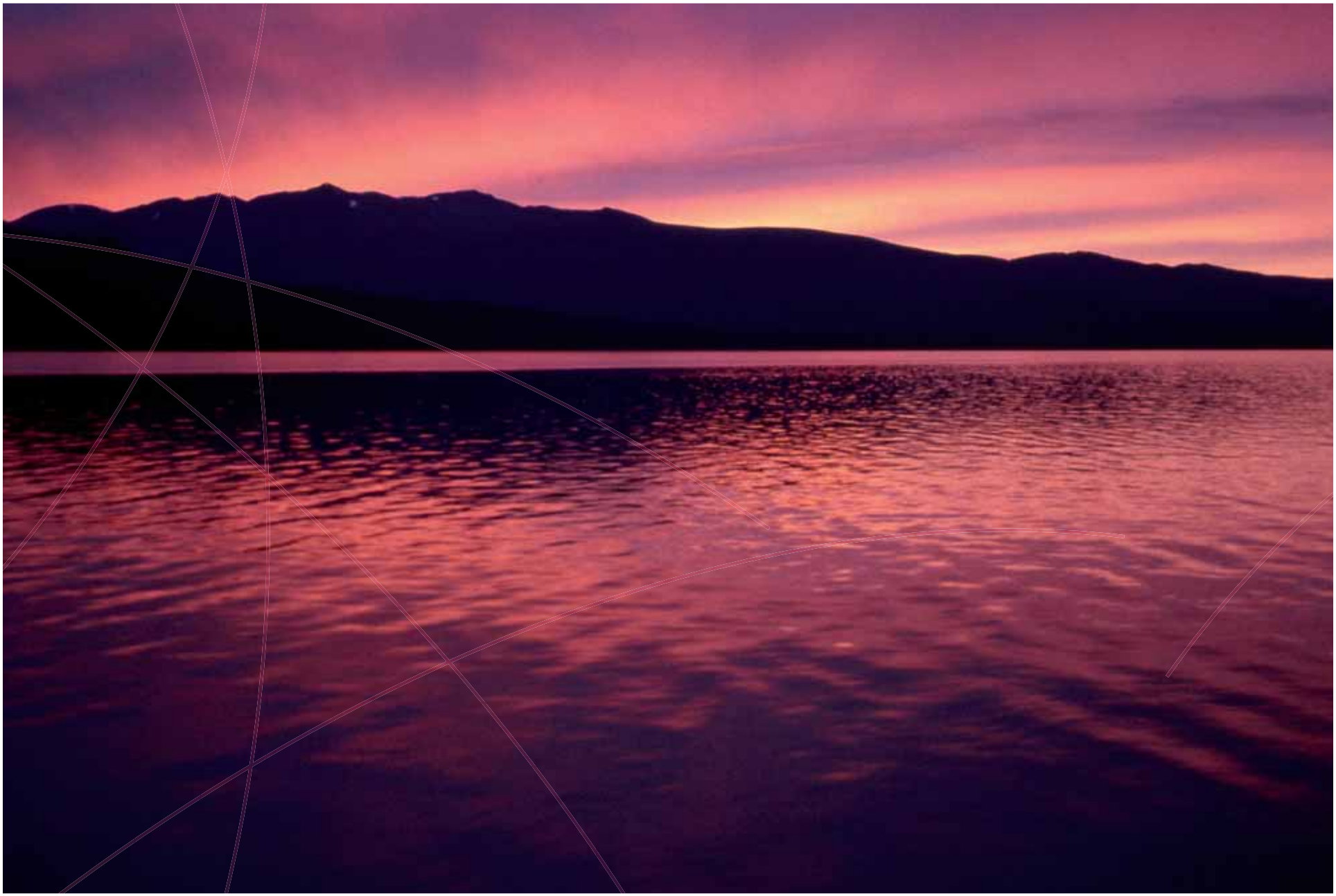
In the long term, the economic and environmental costs of fossil fuel use are expected to continue to rise. It is not difficult to envision a future in which the territories produce power for export to southern markets. This development could secure a clean energy future for the North and provide an economic base for future generations.

# NUNAVUT

In Nunavut, the main policy driver for energy is *Ikummatiit: The Government of Nunavut Energy Strategy*, which lays out a framework to reduce Nunavut's dependence on fossil fuels. Ikummatiit primarily focuses on increasing energy efficiency and conservation, adopting alternative energy, and improving energy management practices. Work toward these objectives is guided by 37 program and policy objectives, all of which will steer Nunavut toward an energy system that is affordable, sustainable, reliable, and environmentally responsible.

*Ikummatiit* calls for an alternative energy resource study to be developed in the next three years as the basis for a renewable energy plan for Nunavut. Nunavut will also be taking steps toward an independent power purchase policy, with an aim of further integrating clean energy sources into the territory's energy mix.


C-GMGD



# Territorial Priorities

With our large landmass and diversified geography, we have substantial renewable resources that can be used to produce energy. Although we face common challenges and opportunities, each territory has its own unique conditions that lead to the prioritization of different types of renewable projects.

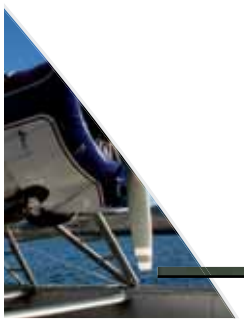
# Northwest Territories

The Northwest Territories has several new, large mines that have been constructed 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 perhaps wind. Hydro development, including the proposed Taltson expansion,

mini-hydro for communities, and the extension of the existing hydro grid are key priorities for the Government of the Northwest Territories. Wind is the most available renewable energy in high Arctic communities. The Government of the Northwest Territories is planning wind-diesel hybrid systems in the Beaufort region. A “Hub and Spoke” model for turbine deployment in remote communities has been adopted from the successful Alaskan experience. The proposed first installation in Tuktoyaktuk (the hub) will develop technical, operational and maintenance capacity for the smaller and more remote communities of Ulukhaktok, Paulatuk, and Sachs Harbour (the spokes).

The location of a wood pellet producing facility in northern Alberta on the north-south highway system provides the Northwest Territories with a unique opportunity to save money and reduce greenhouse gases by converting homes, businesses, and government facilities from fossil fuel to biomass heat energy. The Government of the Northwest Territories has aggressively stimulated growth in local wood pellet consumption in recent years by retrofitting many large public facilities with wood pellet boilers. The Government of the Northwest Territories will continue to build on this work by implementing the new Northwest Territories Biomass Energy Strategy.

Planned pilot projects for the use of geothermal energy for heat and power in the Northwest Territories also merit attention, and the geothermal potential underlying the southern parts of the territory is very promising.



# Yukon

Development of a wood pellet market is progressing. The first institutional installation of a wood pellet boiler is at the new Whitehorse Correctional Centre, and the consumption of locally available cordwood remains strong. The Government of Yukon has identified biomass as a strategic renewable sector, evidenced by work to develop a biomass strategy and a Northern Bioenergy Conference.

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, further supplementing the extensive hydroelectric regime. In fact, Yukon is the leading territorial jurisdiction in both hydroelectric and wind power.

Similar to the Northwest Territories, Yukon has high quality geothermal resources and the feasibility of several new projects is currently being examined. Finally, the ongoing initiatives to encourage energy efficiency have been effective in reducing the overall intensity of electrical and heat energy consumption. Demand-side management initiatives will increasingly be factored into energy supply planning.

# Nunavut

The common challenges for a renewable North are compounded in Nunavut. 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 the most remote territory. Several solar projects, both for electricity and air heating, are being developed across Nunavut to capitalize on the long summer days. Further, the availability and long-term potential of tidal and wind energy is as vast as the territory itself and far exceeds any predicted demand increase. Current plans for pilot wind projects will demonstrate this potential. The development of a wind program and supporting wind-hydrogen projects in Nunavut is another exciting step on the path to a renewable North.

There is also future potential for small and large scale hydro developments, which would be a new direction for Nunavut towards a clean and sustainable energy future. Furthermore, demand side management and smart grids are of interest to Nunavut and will be investigated in the future.

There is further room for energy efficiency improvements and the Government of Nunavut will undertake these improvements either directly or through supporting policies and programs.

# CONCLUSION

The range of landscapes and natural resources across the immense area of Yukon, the Northwest Territories, and Nunavut provide an abundance of renewable resources that can be harnessed to meet the energy needs of northern societies. We are taking actions to explore and develop opportunities to use renewable sources of energy and encourage energy efficiency and conservation.

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