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INFRASTRUCTURE
GOVERNMENT OF THE NORTHWEST TERRITORIES

ENERGY INITIATIVES REPORT 2016 – 2017

Government of
Northwest Territories

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English

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French

Kīspin ki nitawihtīn ē nīhīyawihk ōma ācimōwin, tipwāsinān.
Cree

Tłı̨chǫ yatı k’ę̀ę̀. Dı wegodı newǫ dè, gots’o gonede.
Tłı̨chǫ

ʔerıhtł’ís Dëne Sųłıné yatı t’a huts’elkër xa beyáyatı theɔ́ą ɔat’e, nuwe ts’ën yółtı.
Chipewyan

Edı gondı dehgáh got’ı̨e zhatıé k’ę́ę́ edatł’éh enahddhę nıde naxets’ę́ edahłí.
South Slavey

K’áhshó got’ı̨ne xədə k’é hederı ɔedı̨htl’é yerınıwę nídé dúle.
North Slavey

Jii gwandak izhii ginjìk vat’atr’ijąhch’uu zhit yinohthan jì’, diits’àt ginohkhìi.
Gwich’in

Uvanittuaq ilitchurisukupku Inuvialuktun, ququaqluta.
Inuvialuktun

ᑖᒃᑯᐊ ᑎᑎᖅᑲᐃᑦ ᐱᓕᒍᐃᖅᑎᑦ ᐃᓄᒃᑎᑐᑦᖁᓪᓗᑎᒃ, ᐅᕐᖅᑎᓐᓄᓂᑦ ᐅᖃᑲᓕᔪᐊᓘᓐᖅᑐᑎᑦ.
Inuktitut

Hapkua titiqqat pijumagupkit Inuinnaqtun, uvaptinnut hivajarlutit.
Inuinnaqtun

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Minister's Message

This past year, the newly formed Department of Infrastructure (INF) continued important energy conservation and efficiency work focused on addressing the territory's high cost of living and reducing our reliance on fossil fuels.

We made direct investments in 23 conservation and efficiency projects on GNWT buildings—through our Capital Asset Retrofit Fund (CARF)—that will reduce energy consumption and environmental impacts across the North.

We installed three new biomass boilers, giving the GNWT a total of 31 biomass boiler installations fulfilling 24% of our space heating requirement. The GNWT continues to be a leader in biomass heating. For example, when the new Stanton Territorial Hospital comes online, 100% of its heat (2,500 kilowatts of installed capacity) will come from the largest pellet boiler installation in the NWT.

We funded the Arctic Energy Alliance (AEA), which administered over 3 million dollars to support residents and communities to make strategic energy investments that reduce energy use and increase renewable energy production. A review will be conducted later this year to identify ways to improve our delivery model and make these programs even more effective.

Our strategic investments in emerging renewable energy technologies will give the NWT almost 900kW of solar capacity by the end of 2017. A new 55-kilowatt solar PV installation in Aklavik will enable the Northwest Territories Power Corporation (NTPC) to integrate and test the NWT's first variable speed generator (VSG), safely adding more solar energy to the local power grid, improving plant efficiency and displacing diesel fuel. We will continue making strategic investments in emerging conservation and efficiency technology in 2017/18, and focus on broader public policy and planning that will guide our approach to energy and climate change issues for the next decade.

To better understand our communities' perspectives on energy and climate change, INF and the Department of Environment and Natural Resources initiated regional engagement sessions this past year. Input received from these discussions will inform the 2030 Energy Strategy and Climate Change Strategic Framework, expected to be finalized in the first quarter of 2018.

These engagement sessions confirmed that the transition to a low carbon economy is a shared responsibility. It will require a range of practical and innovative solutions, with support from all levels of government, our communities, and the private sector.

We thank all NWT residents who participated, and contributed to developing our 2030 Energy Strategy. Together, we can improve the energy situation and quality of life for all Northerners.

Masi

The Honourable Wally Schumann
Minister of Infrastructure

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Executive Summary

Energy conservation and efficiency remained a core focus for the Department of Infrastructure (INF) in 2016/17. This seventh edition of the INF Annual Report includes highlights for the GNWT's energy programs and activities over the past year.

Extensive public engagement was completed in the regional centers of Inuvik, Norman Wells, Fort Simpson, Hay River, Fort Smith and Yellowknife for the development of an Energy Strategy and Climate Change Framework.

Highlights from completed energy-related activities in 2016/17 include:

- 23 energy efficiency projects on various GNWT facilities.
- A reduction of 9,031 tonnes of GHG emissions from energy investments in GNWT assets, representing a 20.2% reduction in annual emissions.
- 3 new biomass boiler installations, bringing the total number to 31 GNWT- wide.
- The GNWT installed 105 kilowatts (kW) of solar in the Beaufort Delta region, with two 25kW solar installations in Inuvik and one 55kW solar installation in Aklavik. These projects raised the total of grid-connected solar in the NWT to 850kW.
- In the twelve months starting March 2016, the 136kW Colville Lake hybrid solar and battery project provided 19% of the community's electrical generation, displacing 132,600kW of diesel-generated electricity.
- A small-scale biomass CHP pilot project in Fort Simpson will test the costs and benefits of using wood pellets to produce heat and electricity for a GNWT warehouse.
- Wind monitoring, planning and feasibility work for a proposed wind project in Inuvik.
- Wind scoping for a proposed wind project in Sachs Harbour.
- A feasibility study looking at building Liquefied Natural Gas (LNG) storage for power generation in Tuktoyaktuk was completed. The study found that an LNG solution in Tuktoyaktuk is technically feasible, and could reduce CO_2 emissions by up to 10%. This project will be considered in future NTPC capital plans, if diesel prices rise relative to LNG.

Looking ahead to the coming year, feedback received from the regional Energy Strategy Engagement sessions will be compiled to inform the 2030 Energy Strategy and the Climate Change Strategic Framework.

The GNWT will direct $3.8 million to energy retrofits and alternative energy projects throughout the Territory. INF's Capital Asset Retrofit Fund (CARF) Program will mark 10 years of energy efficiency upgrades to GNWT-owned assets by having the first GNWT-owned pellet boiler operating north of the Arctic Circle, which will heat the East Three School in Inuvik. Another biomass project is slated to be completed this coming fall, which will heat the Department of Environment and Natural Resources' Office/Workshop in Tulita.

Opportunities in the Beaufort Delta region will be explored, including design work for a potential wind project at the Inuvik High Point site and a variable-speed generator (VSG) in Aklavik, which will improve plant efficiency and smooth the addition of intermittent energy from the new 55kW solar array.

Together, these initiatives will continue leading the NWT on a path to reliable, affordable and sustainable energy.

Introduction

It is a demanding task to provide energy to 33 communities spread across 1.35 million square kilometres of rugged, northern terrain. The public infrastructure that is necessary to connect these communities—such as roads and transmission lines—remains limited in some areas and non-existent in others. Fossil fuels remain the primary source of energy, particularly in our remote communities.

To address these challenges—as well as the transition to a lower carbon economy—the GNWT must incorporate an array of strategies that ensure Northerners have access to secure, affordable and sustainable energy.

Over time, the vision and objectives of an energy strategy and climate change framework will set the stage for large-scale investments in energy infrastructure and human resources capacity. These strategic investments will help stabilize energy costs and the cost of living, but will take time to deliver and require support from all levels of government. However, one of the most immediate and cost-effective ways to reduce energy consumption and environmental impacts is investment in energy conservation and efficiency.

By committing to manage government energy expenses efficiently, the GNWT is leading by example and providing the support for our Indigenous governments and local communities to do the same.

Funding programs that encourage residents and businesses to reduce their energy use and promote energy efficiency will help steadily improve our energy situation over time.

It is also critical that we invest in emerging renewable energy technologies as a growing proportion of our energy portfolio. These innovations will make it easier to tap the NWT's renewable energy resources and incorporate local energy solutions.

The GNWT continues to make great strides in biomass and solar energy projects, and is encouraged by the potential for new wind, hydro and LNG initiatives that could contribute to our energy mix and reduce our greenhouse gas emissions.

The 2016 – 17 Energy Initiatives Report is a high-level review of the Territory's current energy situation and key energy initiatives undertaken by the GNWT and its partners over the past year. A summary of the results of key strategic investments in renewable and alternative energy technologies is also provided, along with highlights of work slated for the coming year.

Energy Snapshot

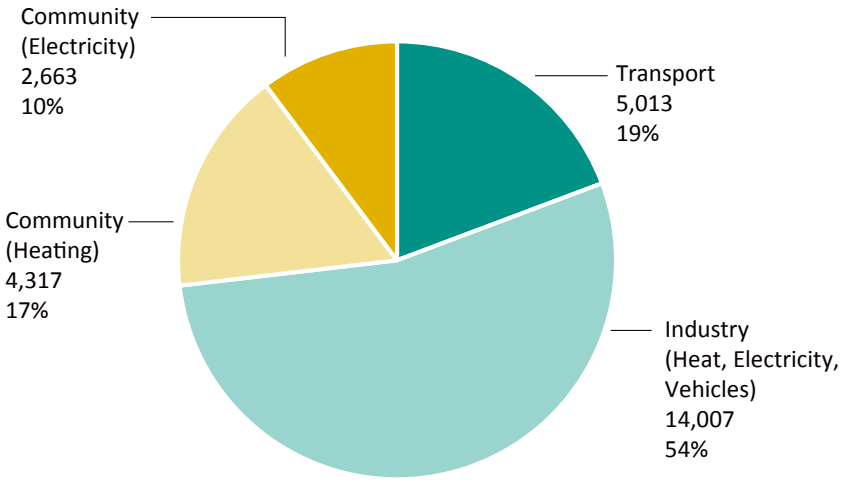
ENERGY USE

Energy use in the NWT is very different than most of Canada. A few large mines and oil fields comprise the territories' main energy consumers, whereas communities use less than 50% of energy produced.

Providing reliable and affordable energy to the NWT's many small, isolated communities remains a constant challenge.

Northerners are increasingly turning to alternative energy sources to supplement petroleum products, such as wood for heating and solar panels for electricity. This helps reduce energy costs and environmental impacts.

Total energy use in the NWT was 26,000 terajoules in 2015.

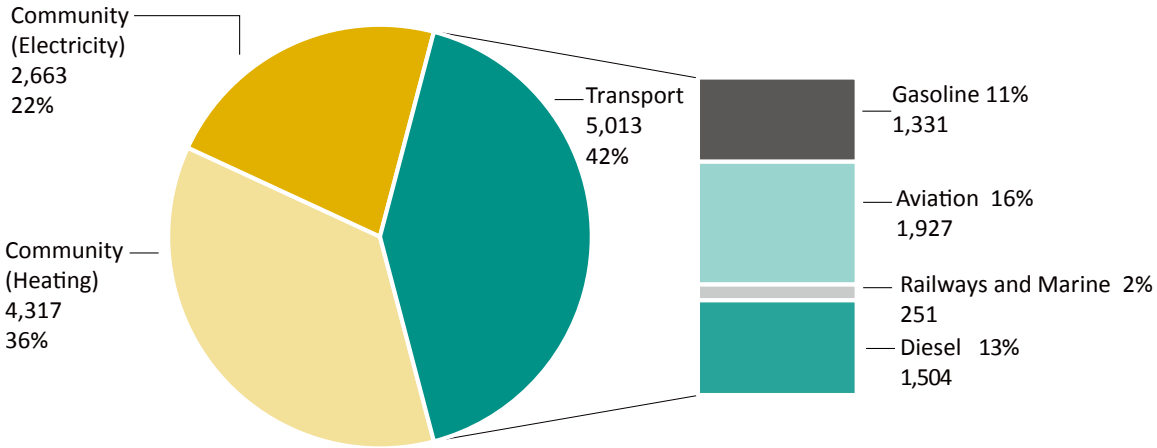


Total 26,000 Terajoules

Figure 1: 2015 NWT Energy Use by Sector

DID YOU KNOW?

One terajoule equals approximately 27,000 litres of oil or 3,000 bags of wood pellets—enough to heat an average home for five years.



Total 11,993 Terajoules

Figure 2: 2015 NWT Energy Use by Sector, Excluding Industry

POWER GENERATION

Most of the power generated for NWT communities comes from hydroelectric facilities, where the energy of flowing rivers is transformed into electricity. Communities not connected to our hydroelectric grid use diesel generators or natural gas to produce electricity. NWT-based mines also use diesel generators to produce most of their electricity.

Unlike most of Canada, the NWT is not connected to the North American electrical grid. Without access to grid-connected electricity from the North American grid, each community must have its own sources of backup power, which greatly increases the cost of providing electricity.

DID YOU KNOW?

2015 received lower than normal rainfall, and hydroelectric production was reduced compared to other years. Water levels in 2016 and 2017 are returning to normal.

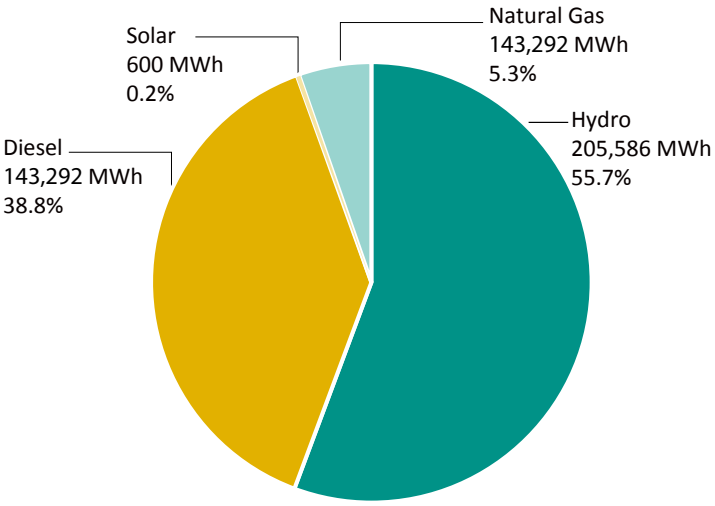


Figure 3: 2015 Electrical Sources in NWT Communities

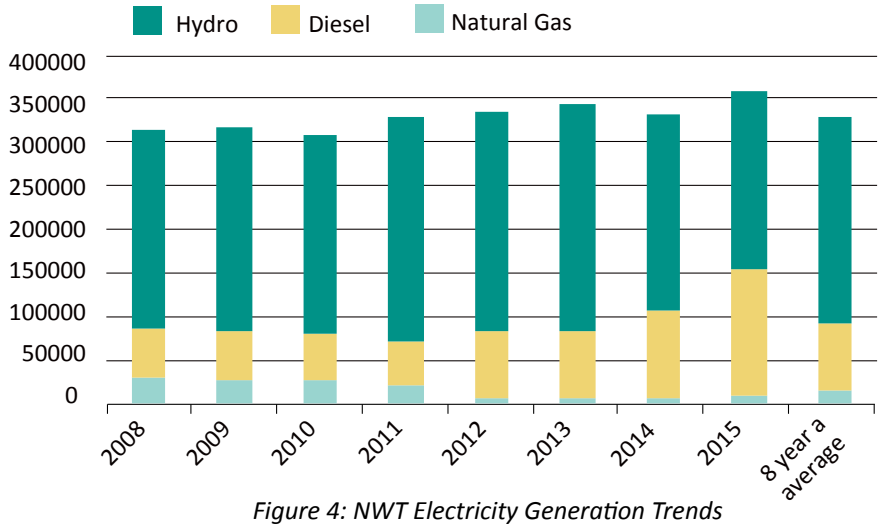
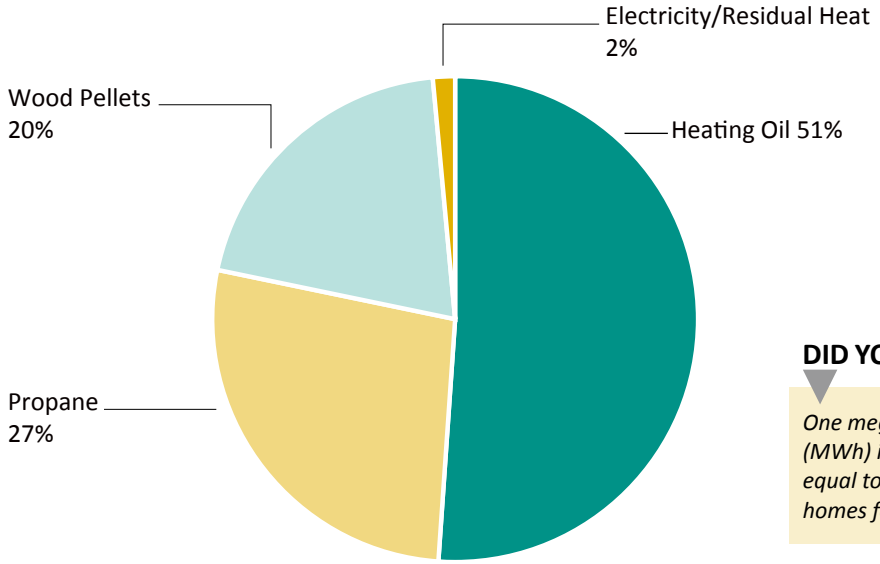


Figure 4: NWT Electricity Generation Trends

HEATING

In 2016/17, space-heating for GNWT facilities totalled 105,000 MWh, or the equivalent 9.9 million litres of oil. Of this total 22% was provided by renewable hydro and biomass energy. With the addition of new biomass boilers in 2016/2017 and 2017/2018, it is anticipated that biomass will contribute to 26% of the total space heating requirements of GNWT assets.



DID YOU KNOW?

One megawatt hour (MWh) is approximately equal to powering 330 homes for one hour.

Figure 5: 2016-17 GNWT Space Heating Energy Sources

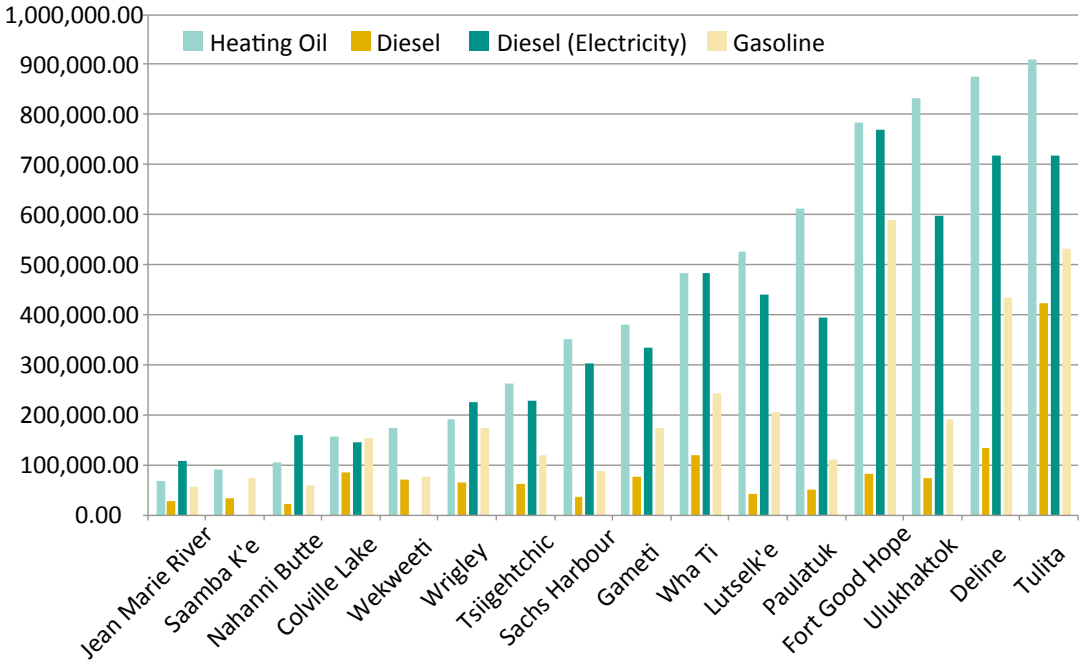


Figure 6: Community Fuel Use by Type

ENERGY PRICE COMPARISON

HISTORICAL PRICE COMPARISON

The price of home heating fuel is a major part of the cost of living for property owners and renters in the NWT. Each year, heating oil purchases account for 19% of the GNWT's $28 million utility budget. Fluctuations in the price of heating oil make budgeting for these expenditures challenging.

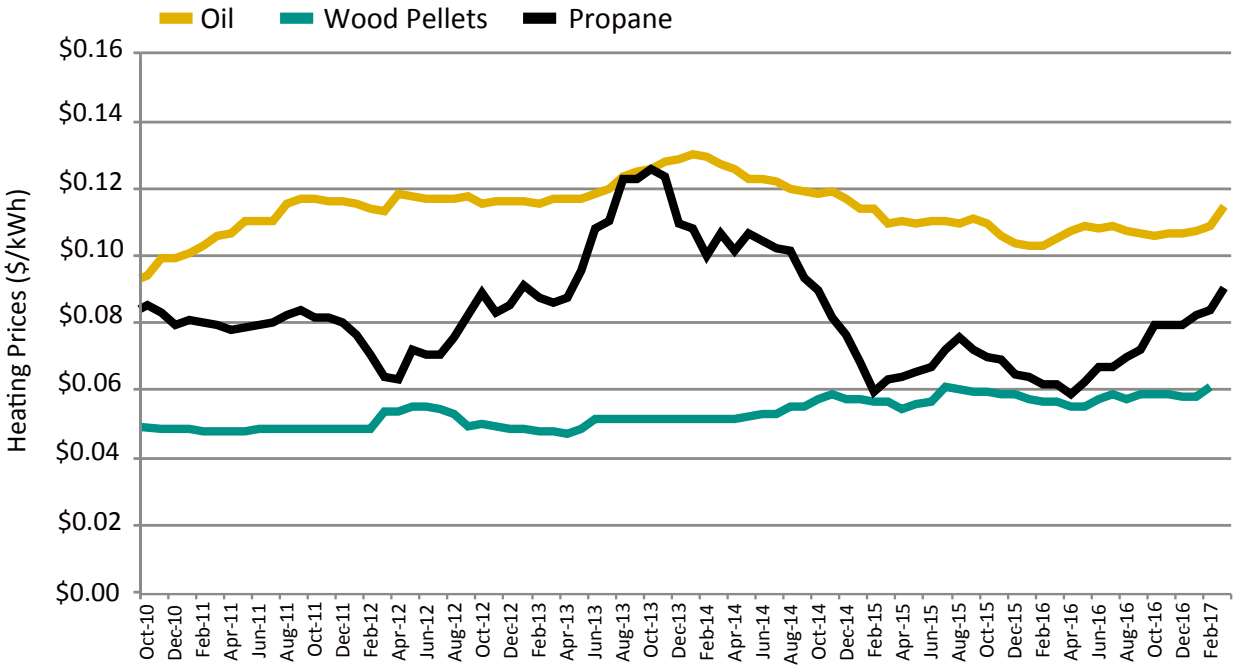


Figure 7: Average GNWT heating prices

PRICE COMPARISON OF WOOD PELLETS, PROPANE AND HEATING OIL ON A PER UNIT ENERGY BASIS IN YELLOWKNIFE

The bulk price of pellets has not significantly changed in the last five years. Wood pellets have been 44% cheaper on average than heating oil, allowing the GNWT to benefit from consistently lower cost heating which does not fluctuate like an oil commodity. Heating oil prices have fluctuated by as much as $.03/kWh or 30%, and propane prices have varied by up to 50% over the same period. One of the major influences that needs to be considered in the price variation of pellets in the NWT is location and the associated transport costs.

Figure 8 below presents the unit price comparison of heating oil, propane, wood pellets and electricity and shows that the GNWT's energy budget is heavily driven by the cost of electricity. *(See Figure 9 Page 15 for details.)*

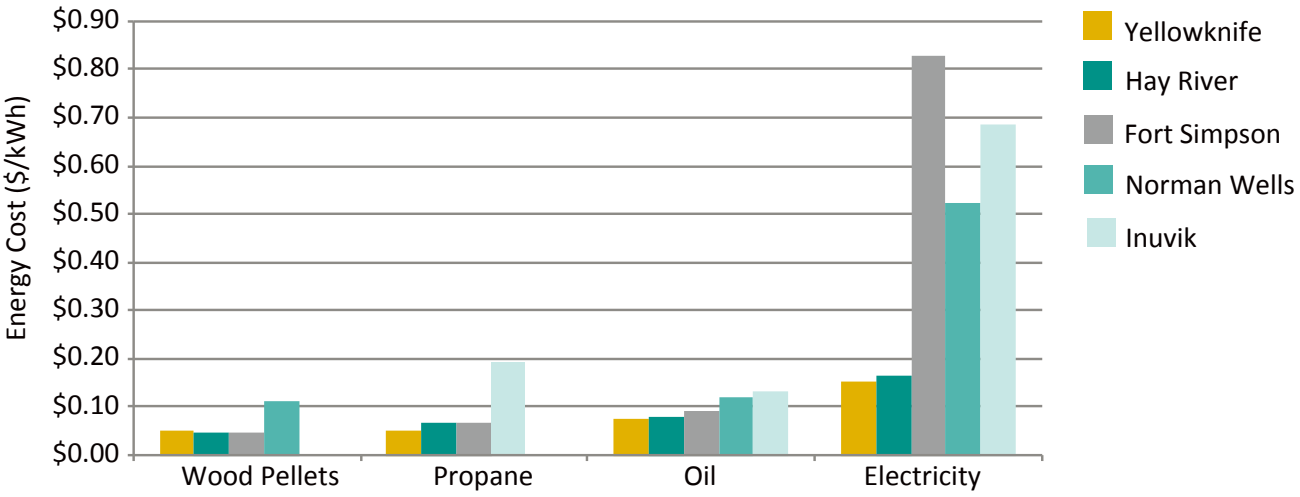


Figure 8: GNWT Energy Price Comparison by Community

Energy Conservation and Efficiency

ARCTIC ENERGY ALLIANCE (AEA)

The GNWT funds programs administered by the AEA that provide incentives for residents and businesses to use energy-efficient appliances, as well as alternative energy sources and technologies.

Burn-it-smart Workshop in Bechoko, January 2017.

New Pellet Heating System for Fort Simpson's P.R. Contracting Ltd.

COMMUNITY LED SWAP-OUT PROJECT

Targeting homes, businesses, and government buildings in thermal communities, the Community LED Swap-out Project replaced inefficient lighting with LED lighting. By using less electricity over 16 months, communities saved enough money to cover the entire cost of the project—funded by the AEA and its partners.

Seanna Grossetete-Unka and Jaycee Tsetso squint at AEA's LED bulbs during the John Tsetso Memorial Library Bazaar in Fort Simpson.

COMMUNITY WOODSTOVE PROJECT

This project helped residents install new and efficient wood stoves in their homes. The AEA—in collaboration with community governments—covered 50% of the purchase and transportation costs, as well as chimney, hearth pads and additional materials needed for code-compliant, Wood Energy Technology Transfer (WETT)-certified installation.

The Bekale family of Gameti celebrates their new wood stove.

NORTHWEST TERRITORIES POWER CORPORATION (NTPC)

NTPC's hydroelectric, diesel and natural gas generation plants, transmission systems and isolated electrical distribution systems serve approximately 43,000 people over 1.3 million square kilometres.

VARIABLE SPEED GENERATOR (VSG) WITH SOLAR

The sun doesn't always shine, and the wind doesn't always blow. The intermittent nature of renewable energy is one the factors limiting its integration into our current system. Fixed-speed generators are reliable when run on traditional fuel, but can only integrate so much renewable energy without becoming susceptible to power outages.

NTPC will test one solution to this challenge in the community of Aklavik, where a variable-speed generator (VSG) will be installed to integrate with a 55kW solar photovoltaic (PV) project already built by the GNWT. Variable-speed systems absorb input fluctuations by changing their speed and creating a smoother power output. They maintain high efficiency at all operating speeds and—after AC to DC conversion—allow a greater capacity of solar energy to be installed. The 590kW packaged generator is a pilot project in a containerized unit that will be integrated into the Aklavik power plant to test the actual fuel savings and system stability that it is predicted to provide.

Variable Speed Generator.

55 kW Solar PV Installation in Aklavik.

INUVIK HEAT RECOVERY

NTPC is designing an exhaust gas heat recovery unit (EGRU) for one of the power plant's natural gas-fired generators. An older system currently provides heat to NTPC's power plant and the Town's water treatment plant (WTP), but is supplemented by gas-fired boilers in the winter. The new EGRU will:

- Reduce the need to run the plant's backup natural gas-fired boilers—which generate heat to vaporize the natural gas that powers the generators and boilers.
- Reduce operating costs and natural gas consumption, while increasing overall efficiency.
- Maximize waste heat recovered with an improved control system.
- Meet growing heating needs of the recently upgraded WTP.
- Feed new loads, including two nearby GNWT buildings that only require funding to design and install energy transfer stations and piping.

Funding from the Government of Canada (INAC's REACHE Program) allowed this project to proceed a year ahead of schedule.

Residual heat created by power generation can be captured and used for heating.

2.5 MW Natural Gas Generator + Exhaust Gas Heat Recovery Unit.

New Heat Recovery Unit in the factory.

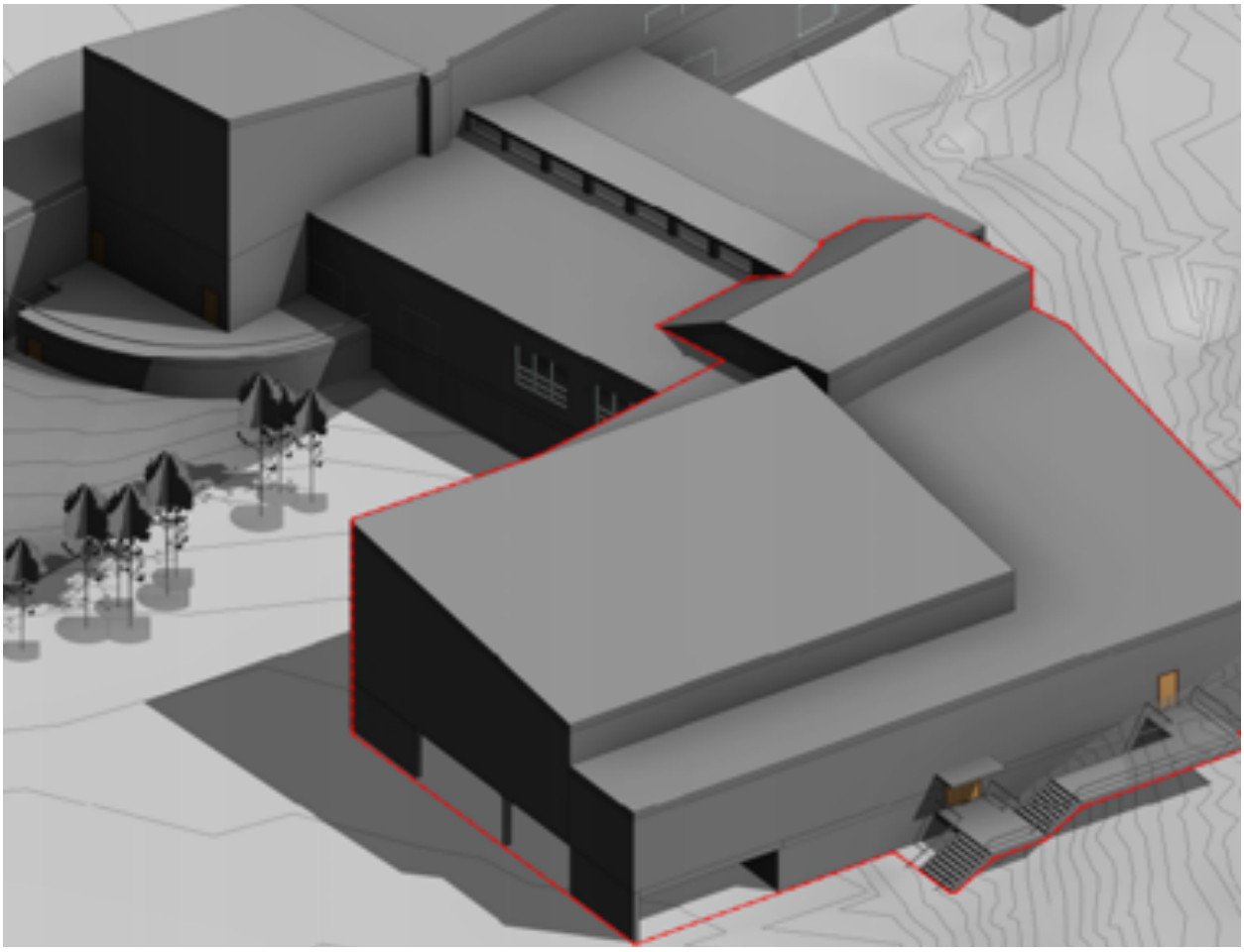
INFRASTRUCTURE (INF)

Energy activity within INF is focused on ensuring reliable, affordable and sustainable energy for NWT communities. INF implements local, alternative and renewable energy solutions while investigating emerging research and technology opportunities.

ÉCOLE ALAIN ST-CYR SCHOOL

Using a design-build process, the construction of a 1430m^2 addition to École Alain St-Cyr School is currently underway. The addition consists of a gym, two classrooms and some office space.

Infrastructure is working to ensure the GNWT receives best value for every dollar invested in construction projects. This project will meet energy targets set by the national model energy code (2015) and the GNWT Good Building Practices. Further energy modeling will be completed to define the most cost effective way to deliver energy operations and maintenance savings within the capital budget.



A rendered view of the École Alain St-Cyr building.

Fort Resolution Health Centre.

FORT RESOLUTION HEALTH CENTRE

The new Fort Resolution Health Centre was designed to include energy efficient lighting, a highly insulated building envelope and a wood pellet boiler for heat.

This same energy efficient approach was used on the recently completed Fort Providence Health Centre. Going forward, this standardized approach will save the GNWT money on design and construction costs on top of our long-term operating costs.

New LED Light Pole.

GNWT COMMUNITY FUEL STORAGE

Gameti, Wekweti, Lutsel'ke, Paulatuk and Uluhaktuk fuel storage and distribution facilities benefited from a LED lighting upgrade as one of the many CARF projects in 2016/17.

The lighting system operates around the clock as a security feature for these assets. Considering the extended hours of operation during the fall, winter and spring, the combined saving for the LED upgrade has a payback of less than 8 years. LED light fixtures are designed to last up to 50,000 hours or 25 years of operation, which also reduces annual operations and maintenance costs.

New LED Light Fixture.

TRACKING GNWT ENERGY USE AND UTILITY COSTS

GNWT ENERGY USE AND UTILITY TRACKING

In 2016/17, the cost of heat and power for GNWT facilities totalled $28.3 million. As shown in Figure 9, the largest utility cost to the GNWT is electricity at 61% of the total budget, followed by heating oil at 20% and propane at 9%.

While the GNWT's $28.3 million utility expenditures are dominated by the cost of electricity, greenhouse gas emissions and energy usage are led by the burning of fossil fuels for heating purposes as seen in Figure 10. In 2016/2017, approximately 35,600 tonnes of greenhouse gas emissions (GHGs) were released as a result of burning fossil fuels for heat and electricity generation for GNWT assets.

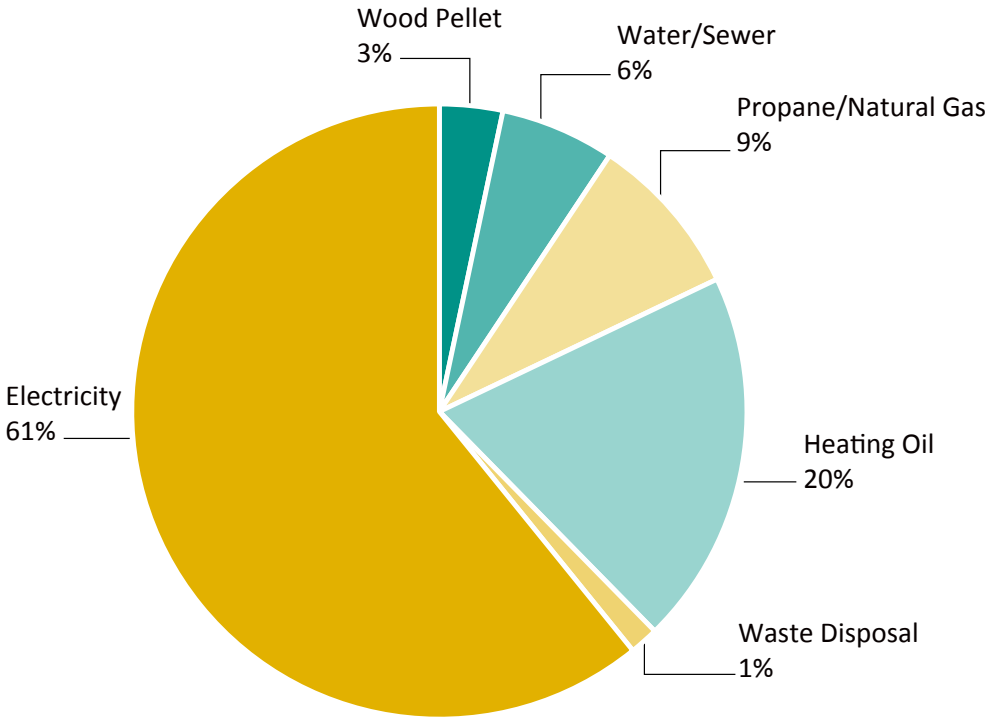


Figure 9: 2016/2017 GNWT Utility Expenditures

Energy use in GNWT facilities in 2016/2017 is shown in Figure 11. Overall energy use is approximately 6% lower than the average of the past six years.

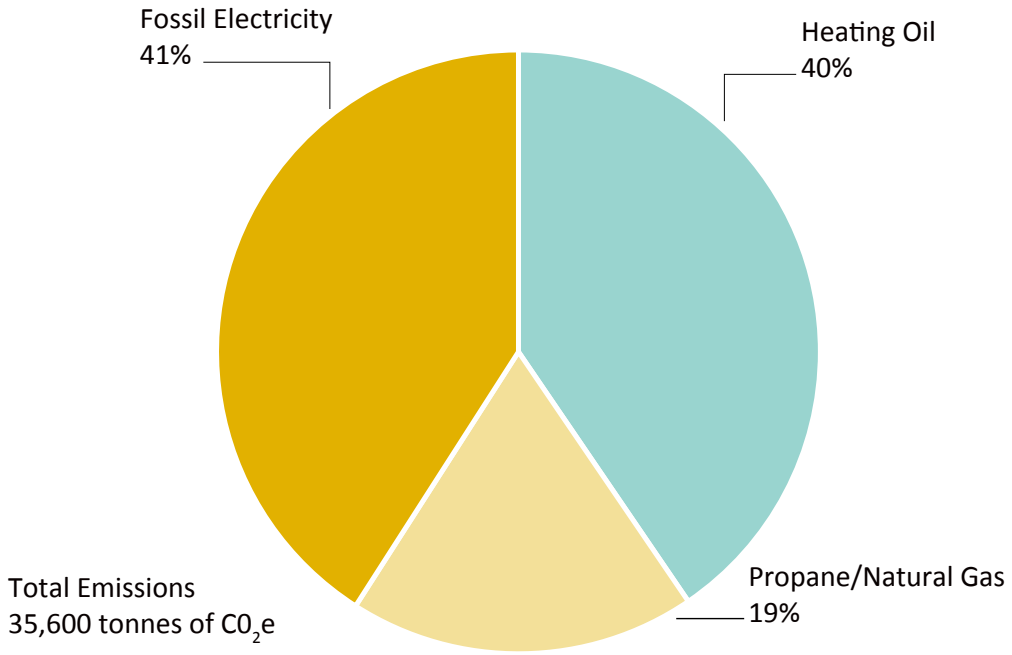


Figure 10: GNWT Greenhouse Gas Emissions by Energy Type

In 2016/2017, 31% of the GNWT's total energy used was from renewable sources. Continued use of biomass boiler technology and the return of water in the Snare hydro system means a return to increased use of renewables in the coming fiscal years.

In 2016/17, space heating for GNWT facilities totalled 105,000 MWh. Of this total 22% was provided by renewable hydro and biomass energy. With the addition of new biomass boilers in 2016/2017 and 2017/2018, it is anticipated that biomass will contribute to 26% of the total space heating requirements of GNWT assets in the coming year.

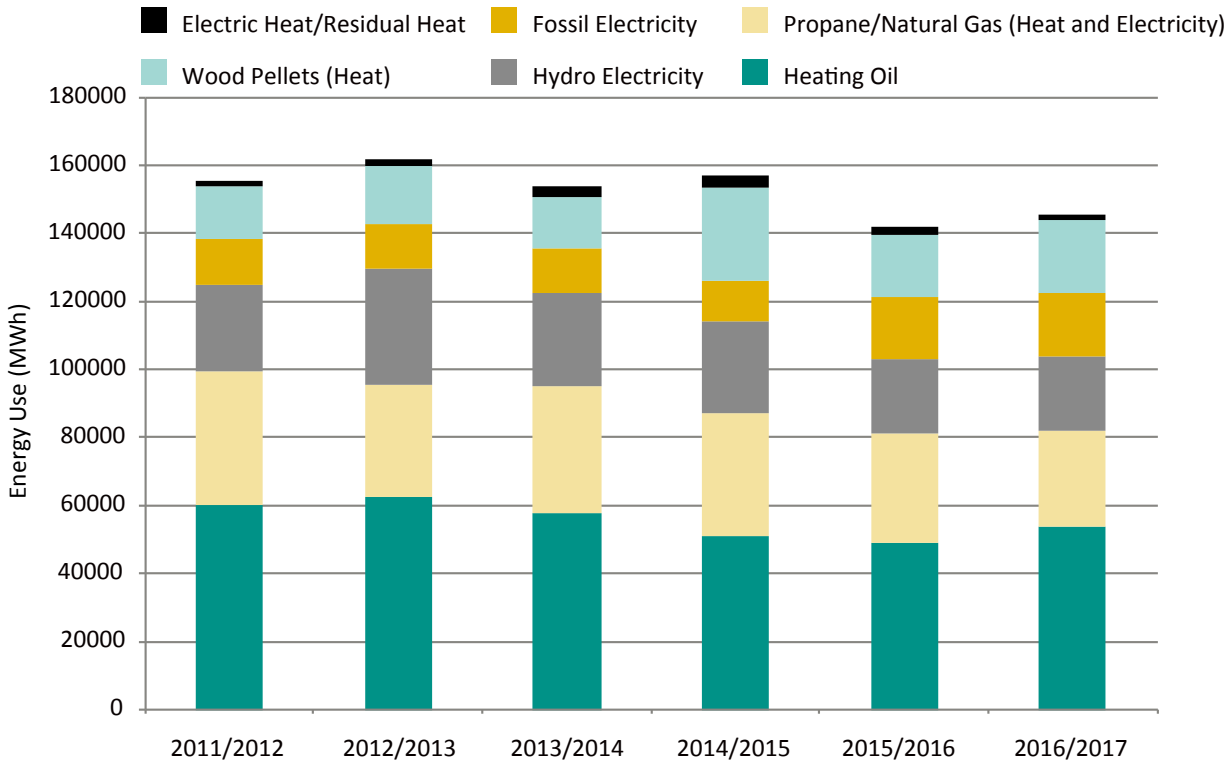


Figure 11: Energy Use by Comparison by Year

BUILDING PRACTICES AND CODES

GOOD BUILDING PRACTICES FOR NORTHERN FACILITIES

The expertise of northern designers and builders from the private and the public sector have contributed to the creation of the INF Good Building Practices for Northern Facilities (GBP) Guidelines, which guide the design of northern facilities that are reliable, maintainable and energy efficient. These guidelines are to be followed for all new builds and major retrofit projects of government facilities, to ensure the longevity and energy efficiency of the infrastructure.

DESIGN AND CONSTRUCTION OF NEW GNWT BUILDINGS

An important component of INF's mission is to provide government departments with safe and reliable facilities that are sustainable and energy efficient. How buildings are designed, constructed and maintained affects the useful life of a building, the life cycle costs of the facility and the comfort level for users of the building. INF uses many tools to achieve building designs that are reliable and energy efficient.

NATIONAL CODE DEVELOPMENT

INF participates on various national code development committees. This allows the GNWT to represent an important northern perspective to influence national code development, share best practices, and enhance our uptake of energy efficient design standards and techniques as part of the GBP.

INF is currently involved with the following committees/groups:

- The Canadian Standards Association Technical Subcommittee looking at building energy estimation methodology
- The Public Infrastructure Engineering Vulnerability Committee looking at the impact of climate change on northern engineered infrastructure
- The Building Technology Transfer Forum
- CSA – B365 Code Development
- CSA – Geotechnical Site Investigations for Building Foundations in Permafrost Zones

CAPITAL ASSET RETROFIT FUND (CARF)

The Capital Asset Retrofit Fund (CARF) program allows for the upgrading of existing GNWT buildings to improve overall energy efficiency. The program helps to reduce energy consumption, operating costs, and greenhouse gas emissions from the operation of GNWT buildings. The CARF program has been in operation since 2009/2010.

Annual energy benchmarking and auditing, thermal scanning, and feedback from operation and maintenance staff all contribute to identifying suitable projects for the CARF program.

Typical projects completed under this program include: Envelope upgrades, lighting upgrades, heating control optimizations, installation of efficient water fixtures and retrofits of aging building systems.

In 2016/2017, 26 energy efficiency CARF projects were completed. A few highlights include:

- INF will complete the installation of a 1.2 MW biomass boiler at the Inuvik Hospital. The new system will rely on wood pellets to provide building heat and domestic hot water and help offset 300 tonnes of greenhouse gas emissions.
- Further enhancement of GNWT LED light installations will continue with installations in all regions of the NWT.
- INF is also working with the Department of Education on installing a biomass district heating system at the Weledeh/St. Pats School site.
- École Alain St-Cyr will have a biomass boiler installed to heat the new and existing facility, with the potential to include heating capacity to supply a percentage of the heating requirement for William MacDonald School.
- INF will undertake a performance review of the 17 megawatts of installed wood pellet boiler capacity of GNWT assets, and document lessons learned over the years. The goal is to establish best practices for the operation and maintenance of all wood pellet assets, and improve cost reductions and GHG emissions reductions by at least 10%.

The detailed list of completed projects can be found in Appendix B.

GNWT ENERGY EFFICIENCY PERFORMANCE INDICATORS

GREENHOUSE GAS EMISSIONS REDUCTIONS

To assist global efforts to mitigate the impact of climate change, it is a priority of the GNWT to reduce greenhouse gas emissions (GHGs). Through energy efficiency upgrades Capital Asset Retrofit Fund, alternate energies (solar, biomass, hydroelectricity) and efficient building design/construction, the GNWT is making significant reductions in GHG emissions from building assets. As shown in Figure 13, GHG emission reductions totaled 9,031 tonnes in 2016/ 2017, representing a 20.2% total reduction in annual GHG emissions from GNWT assets.

Although total GHG Emissions were the same as last year, a warmer winter resulted in lower heating demand from electric heat and biomass boilers. Three new biomass boiler installations helped to offset the reduced demand for wood pellets. The GNWT will review operation and maintenance approaches to the existing wood pellet boiler fleet in the coming year and identify best practices for maintenance. It is our objective to further increase the use of biomass in 2017/18.

ENERGY REDUCTIONS

The GNWT leads by example when it comes to reducing energy use. Retrofitting GNWT assets—through the Capital Asset Retrofit Fund (CARF)—has reduced annual GNWT electricity use by about 5%, and energy used for heating by about 10%. Since initiating CARF, the GNWT has reduced energy use equal to 4.5 million litres of oil. The CARF investment has also saved 62,730 tonnes of GHG emissions over the last ten years, 12,684 of which came from energy conservation (shown in yellow on the graph below).

COST SAVINGS

The lower than average price of heating oil and propane in 2016/2017 reduces the total potential cost savings from energy efficiency projects, but helps the overall GNWT utility budget. In 2015/2016, total utility cost savings of $2.47 million resulted from the implementation of energy efficiency and renewable energy technologies and lower fuel costs.

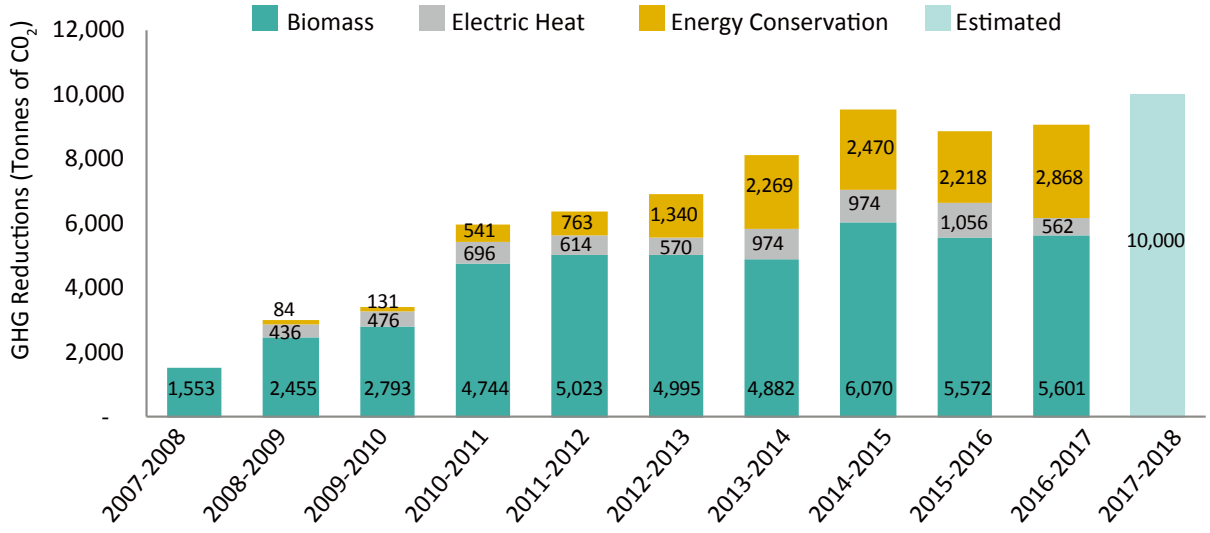
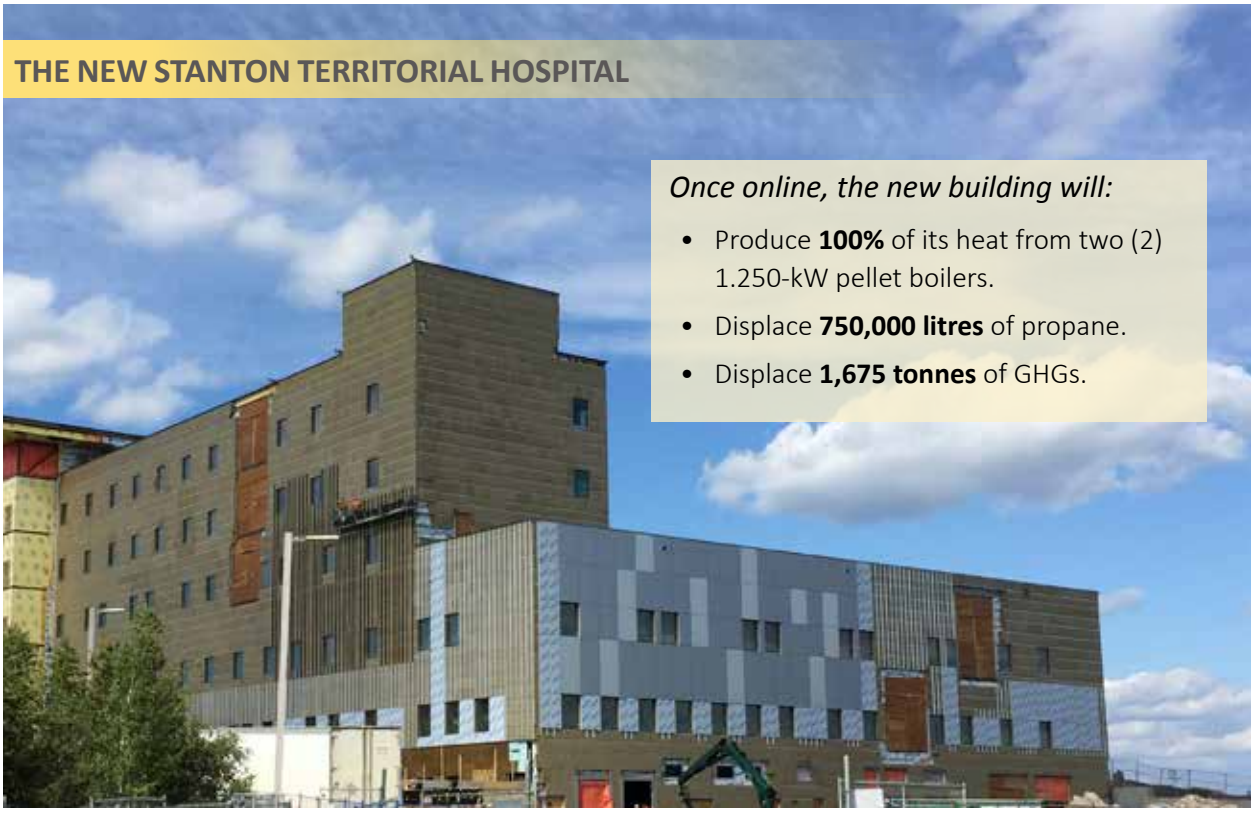


Figure 13: CARF GHG Reduction Trends 2016-2017

Alternative and Renewable Energy

BIOMASS



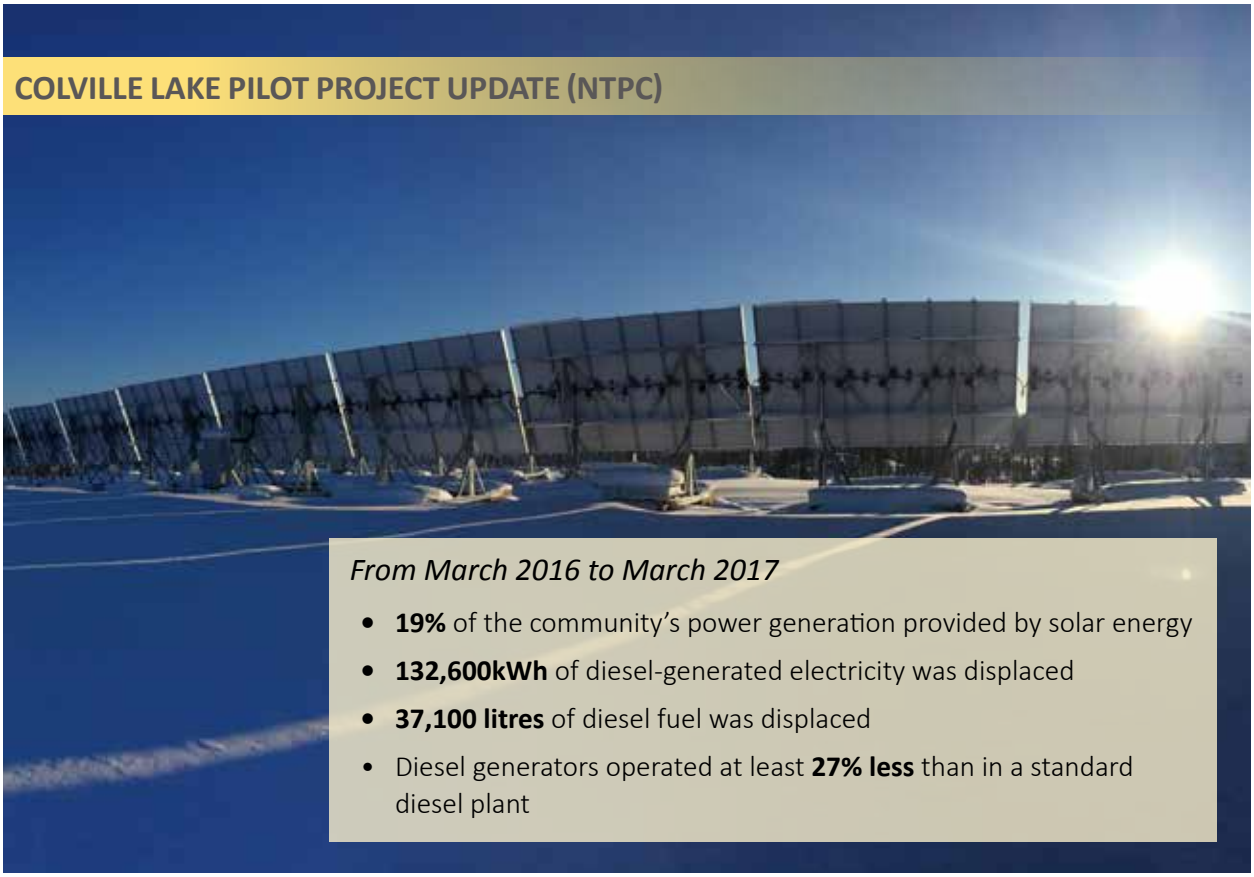
The GNWT is a leader in biomass energy.

TULITA AND FORT GOOD HOPE SCHOOLS

Pellet Boiler installations in two schools will help establish a market and demand for wood pellets in the Sahtu region. The new wood pellet boilers at the Tulita and Fort Good Hope schools were the first pellet boilers installed in these communities by the GNWT. The new boilers will provide 80% – 90% of both schools space-heating requirements. They will also displace 200 tonnes of greenhouse gas emissions in Tulita and 180 tonnes of GHG emissions in Fort Good Hope.

FORT SIMPSON BIOMASS COMBINED HEAT AND POWER PILOT PROJECT

This small biomass CHP system, scheduled to be completed in the summer of 2017, operates on pellets and generates electricity using an Organic Rankine Cycle generator. The system's primary purpose will be to supply heat, with electricity as a by-product. Sized to provide up to 25kW of heat and 5kW of electricity, this unit will provide an excellent learning opportunity while reducing diesel usage for heating and electrical generation.



COLVILLE LAKE PILOT PROJECT UPDATE (NTPC)

From March 2016 to March 2017

- **19%** of the community's power generation provided by solar energy
- **132,600kWh** of diesel-generated electricity was displaced
- **37,100 litres** of diesel fuel was displaced
- Diesel generators operated at least **27% less** than in a standard diesel plant

One of the five solar arrays at the Colville Lake installation.

SOLAR

INUVIK FREEZER (AEA)

Using a rebate from the AEA's Community Renewable Energy Program, a 2.5kW grid-tied solar PV system was installed at the Inuvialuit Community Freezer in Inuvik, where residents can store country foods.

Installing solar panels on the Community Freezer in Inuvik.

WESTERN ARCTIC RESEARCH CENTRE – INUVIK (INF)

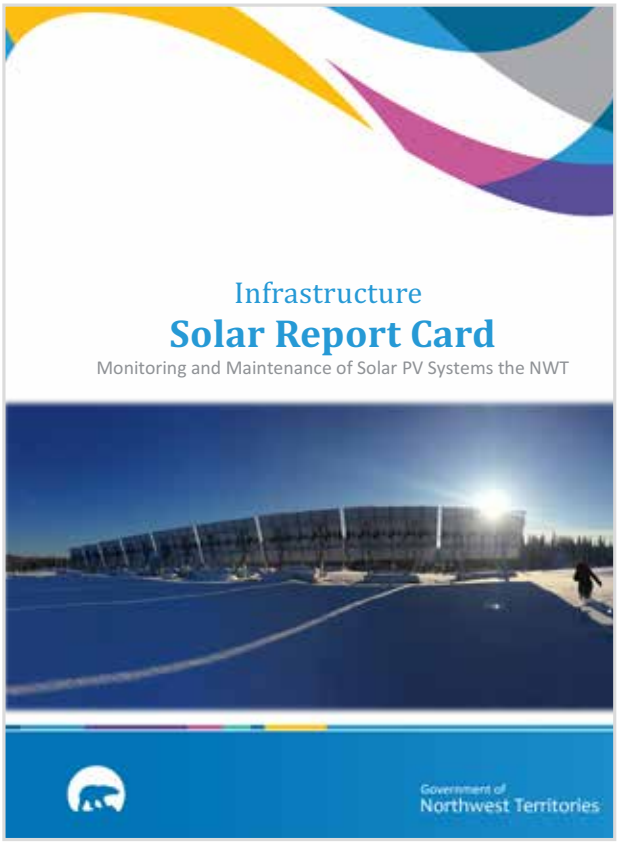
INF is collaborating with the Aurora Research Institute (ARI) and Education Culture and Employment (ECE) to build a 25-kilowatt grid-connected solar PV system on the roof of the Western Arctic Research Center in Inuvik. ECE received $100,000 from the federal Post-Secondary Institution Strategic Investment Fund while INF is providing the balance of funding and project management. When complete, the solar array will produce an estimated 22,500kWh per year, offsetting 6,800 litres of diesel and saving the equivalent of 19.4 tonnes of CO_2 annually.

INFRASTRUCTURE RECORDS BUILDING – INUVIK (INF)

A 25-kilowatt solar PV array is being installed on the roof of the INF Records Building in Inuvik. The system will provide power to the building, with any excess power going onto the electrical grid. The solar array will produce an estimated 22,500kWh per year, offsetting 6,800 litres of diesel, and saving the equivalent of 19.4 tonnes of CO_2 annually. The budget for the project is $200,000.

INUVIK 17 UNIT SINGLES COMPLEX (NWTHC)

A 20kW Solar PV array was installed in Inuvik on the newly constructed 17-unit singles complex in Inuvik. The solar PV installation is wall mounted and cost $154,000. INF worked with Northwest Territories Housing Corporation to secure funding from Indigenous and Northern Affairs Canada for the solar installation.



SOLAR REPORT CARD

Assessing the GNWT's investment in grid-tied solar energy

2012-2017 Solar Energy Strategy Target: 1,800 kilowatts (kW) total installed capacity

Total installed capacity as of March 31, 2017: 900 kW (50% of target)

Diesel displaced: 225,000 litres per year

HYDRO

NORTH SLAVE HYDROLOGY RESEARCH AND POWER GENERATION

NORTH SLAVE HYDRO SYSTEM

The Snare and Bluefish hydro systems typically provide 95% of the power for the communities of Behchoko, Detah, Ndilo and Yellowknife. Droughts (3 in the last 30 years) are hard to predict, while winter precipitation and the spring melt impact water levels. Annual snow survey results are fed into a complex model to forecast the spring run-off. The hydro plant manager uses these forecasts to estimate reservoir inflows and manage outflows to keep water levels within the license limits, and ensure water is available in high demand months.

Water consumption schedules are based on monthly forecast generation demand requirements and yearly water storage volume cycles. This year, work was done to understand gaps within the current approach to data gathering. Some of this work will be implemented immediately.

We are also gathering more precipitation data within strategic locations throughout the basin to aid in forecasting. Long-term climate predictions facilitate better planning, but the NWT's hydro systems are dependent on a fairly limited amount of historical information on stream flows. Dendrochronology (the study of tree rings) reconstructs climate histories based on tree growth. Using this science, we will add 150 years of June precipitation data for the North Slave by next year.

Carleton University research on snow water equivalent.

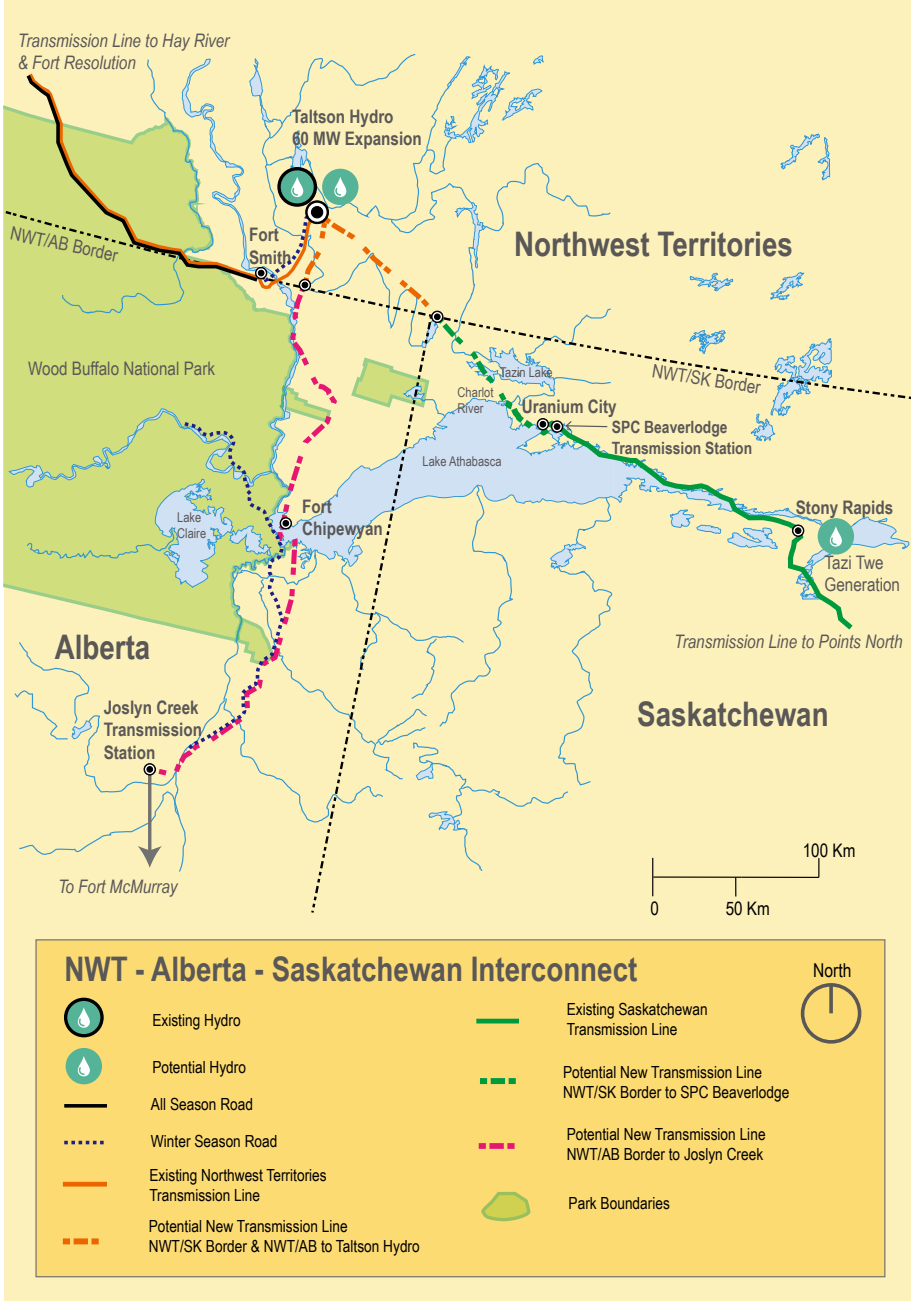
Dendrometer Installed on a jack pine.

The North Slave Hydro System includes the Bluefish Hydroelectric Facility at the north end of Prosperous Lake.

TALTSON EXPANSION

The Taltson Hydro Expansion has the potential to connect the NWT transmission system to the rest of Canada for the first time. An interconnection would stabilize electricity rates and is part of our long term plan to develop our renewable resources, grow our economy and develop our hydro potential. The opportunity is very well understood from a power generation and environmental permitting perspective.

The challenge now is to identify viable markets for power. The two closest markets–northern Saskatchewan and northern Alberta–currently rely heavily on coal for electrical generation. Both jurisdictions have introduced significant renewable energy goals that include reduced reliance on coal power generation. Work this year focused on updating cost estimates and engaging market players.



Taltson Twin Gorges Hydroelectric Power Facility

TALTSON SURPLUS

Beginning in late 2008, electricity for heating has been sold at a reduced rate to the GNWT for use in three government buildings in Fort Smith; JBT School, Breynat Hall, and the Department of Transportation's Four-Bay Maintenance Garage. The Northern Lights Special Care Home was added in 2013.

In September 2016, surplus hydro energy from Taltson was made available at a reduced rate to commercial buildings so they could convert to electric heat. With the average price of oil hovering around 76 cents a litre, oil heating in Fort Smith cost approximately 8.75 cents/kWh last year. At the discounted rate, electric heating cost 7.73 cents/kWh. Two private buildings and the Town of Fort Smith Arena took advantage of the new rate and converted to electric heat in January 2017.

By using electric heating in its buildings, the GNWT saved 562 tonnes of GHGs and over $25,000 this past year.

WIND

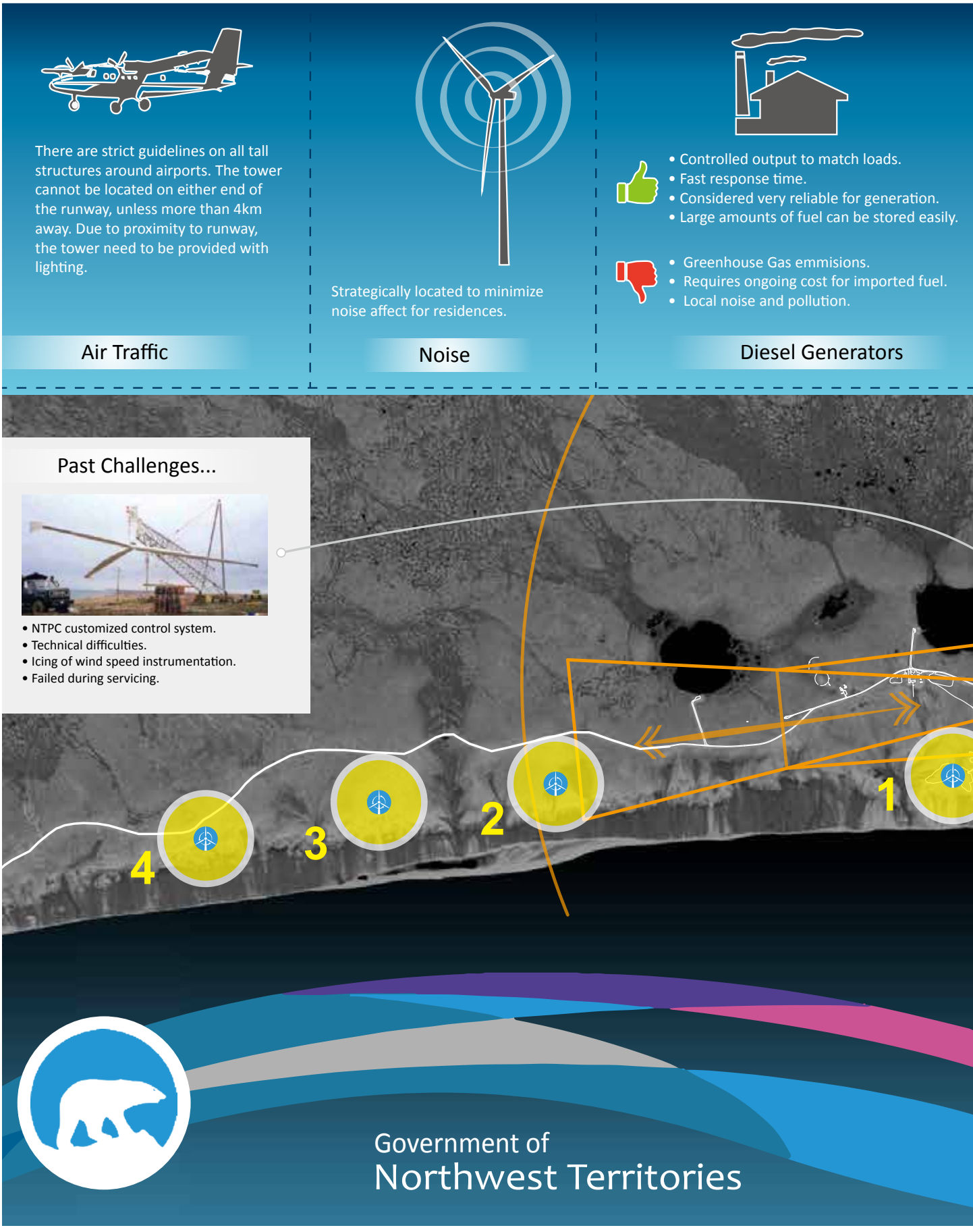
In 2016/17, INF funded wind-monitoring studies in Inuvik, Fort Liard and Yellowknife, including continued data-gathering at the Inuvik High Point and Snare Rapids wind-monitoring sites.

SACHS HARBOUR WIND STUDY

The Hamlet of Sachs Harbour (pop. 120) is located on the southwest coast of Banks Island, in the Inuvialuit Settlement Region. In 2010, the Aurora Research Institute (ARI) conducted a wind-monitoring study that predicted wind speeds of up to 6.6 metres per second at 37 metres, enough to meet a significant portion of the communities' electrical needs. A wind turbine had been installed in 1999, but maintenance issues caused it to be taken out of service in 2000.

Recent advances in wind energy technology designed for Arctic conditions and NTPC's scheduled plan to replace the Sachs Harbour power plant in two years prompted INF to fund a study—conducted from the fall of 2016 to March 2017—to understand how to integrate a modern, 300 – 500 kW wind turbine into the current electrical system and to identify candidate sites. This potential wind turbine project for Sachs Harbour is illustrated on the following pages.

Installation of Beaufort Wind Monitoring Tower.


There are strict guidelines on all tall structures around airports. The tower cannot be located on either end of the runway, unless more than 4km away. Due to proximity to runway, the tower need to be provided with lighting.
Air Traffic
Strategically located to minimize noise affect for residences.
Noise
• Controlled output to match loads.
• Fast response time.
• Considered very reliable for generation.
• Large amounts of fuel can be stored easily.
• Greenhouse Gas emmisions.
• Requires ongoing cost for imported fuel.
• Local noise and pollution.
Diesel Generators
Past Challenges...
• NTPC customized control system.
• Technical difficulties.
• Icing of wind speed instrumentation.
• Failed during servicing.
4
3
2
1
Government of
Northwest Territories

- No cost for fuel.
- No emmisions.
- Available year round.

- Cannot control wind for timing or power.
- Cannot store wind for later use (unless batteries are used)
- Up-front costs are high.

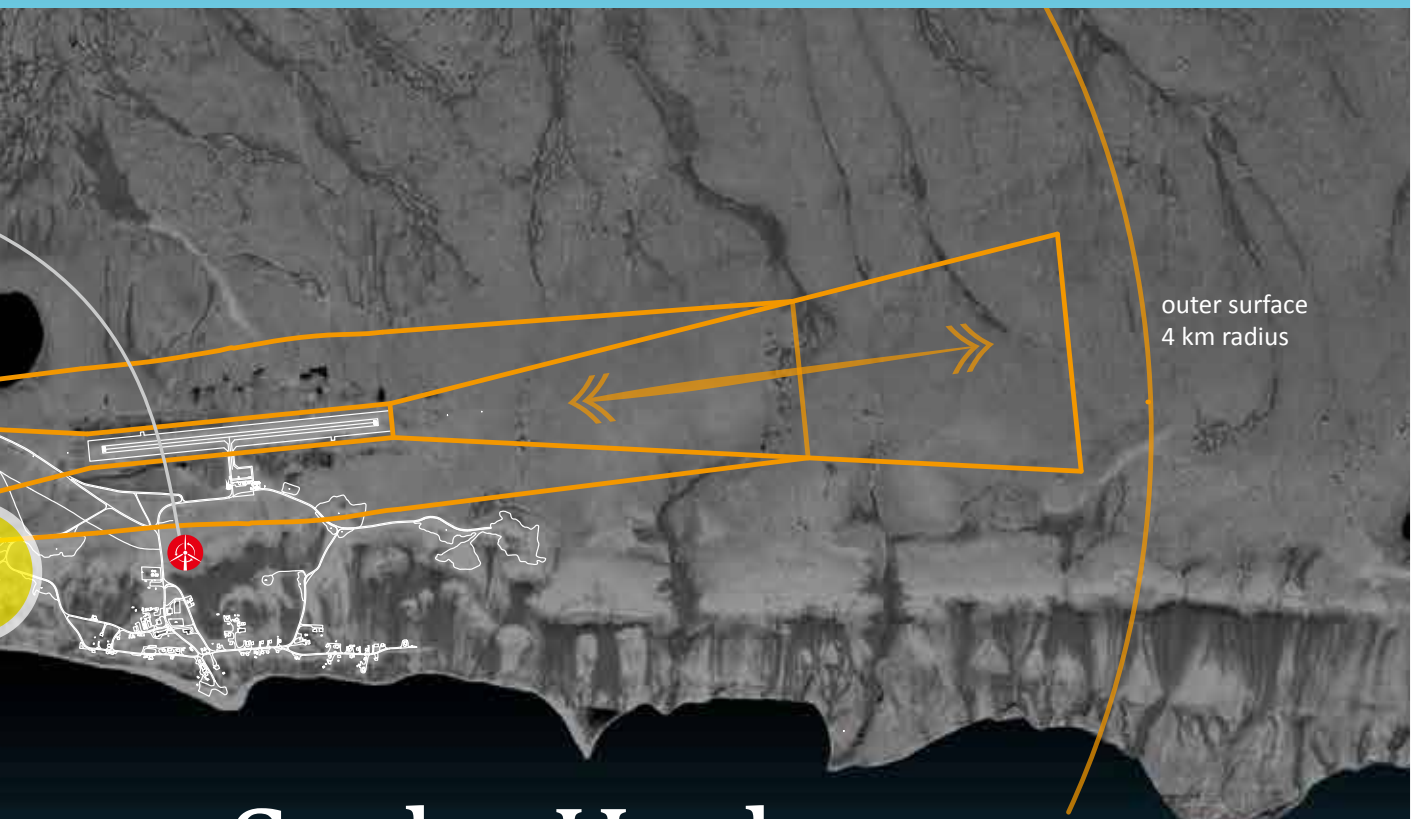
Wind Turbines

- Consultations to ensure that site meets with local approval.
- Avoid sites with any known cultural significance.
- Avoid blocking access to any site with known cultural significance.

Cultural

- Turbines have been known to impact birds.
- Will do study to understand impacts and mitigation measures.
- Baseline environmental will be completed.

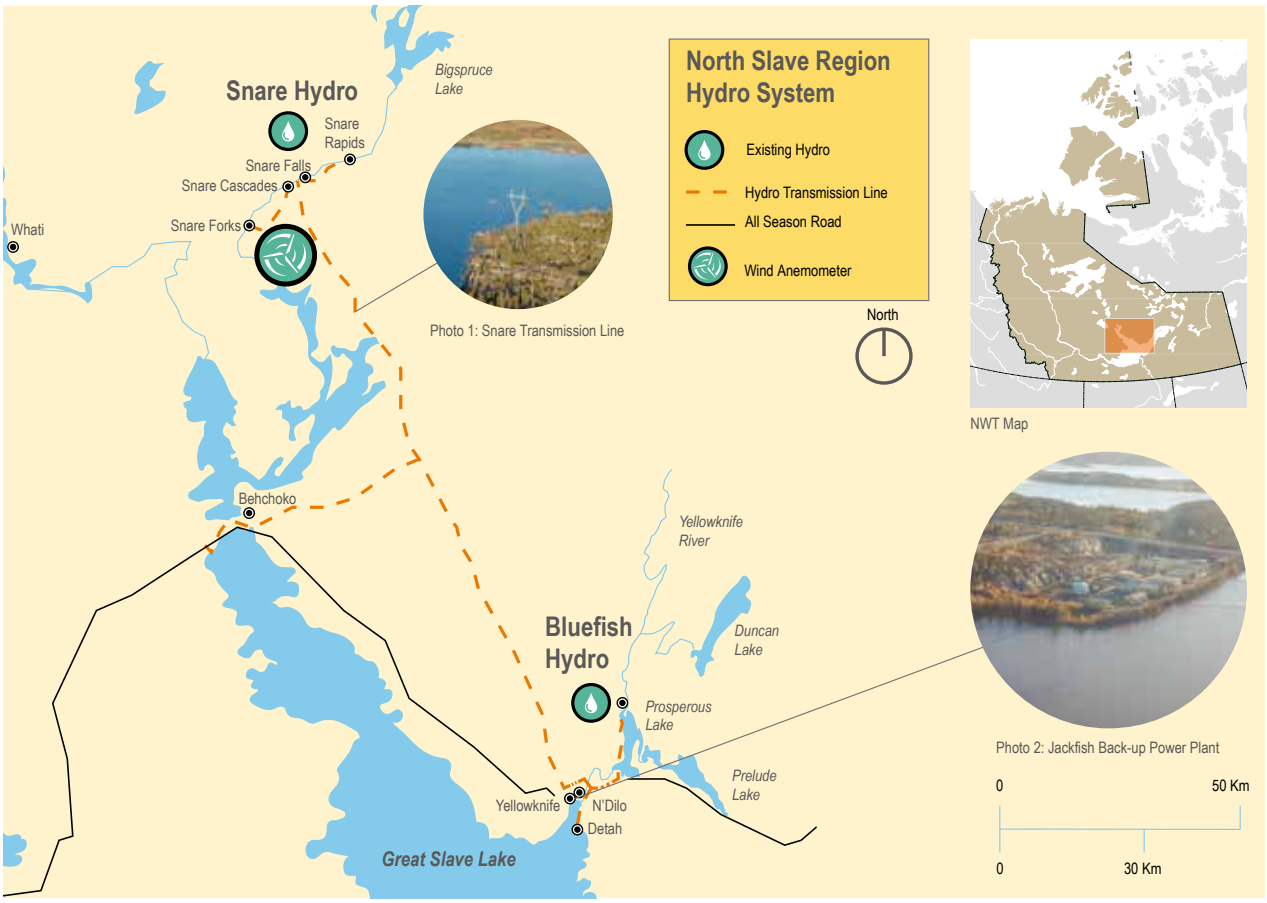
Wildlife



Sachs Harbour Wind Energy

NORTH SLAVE

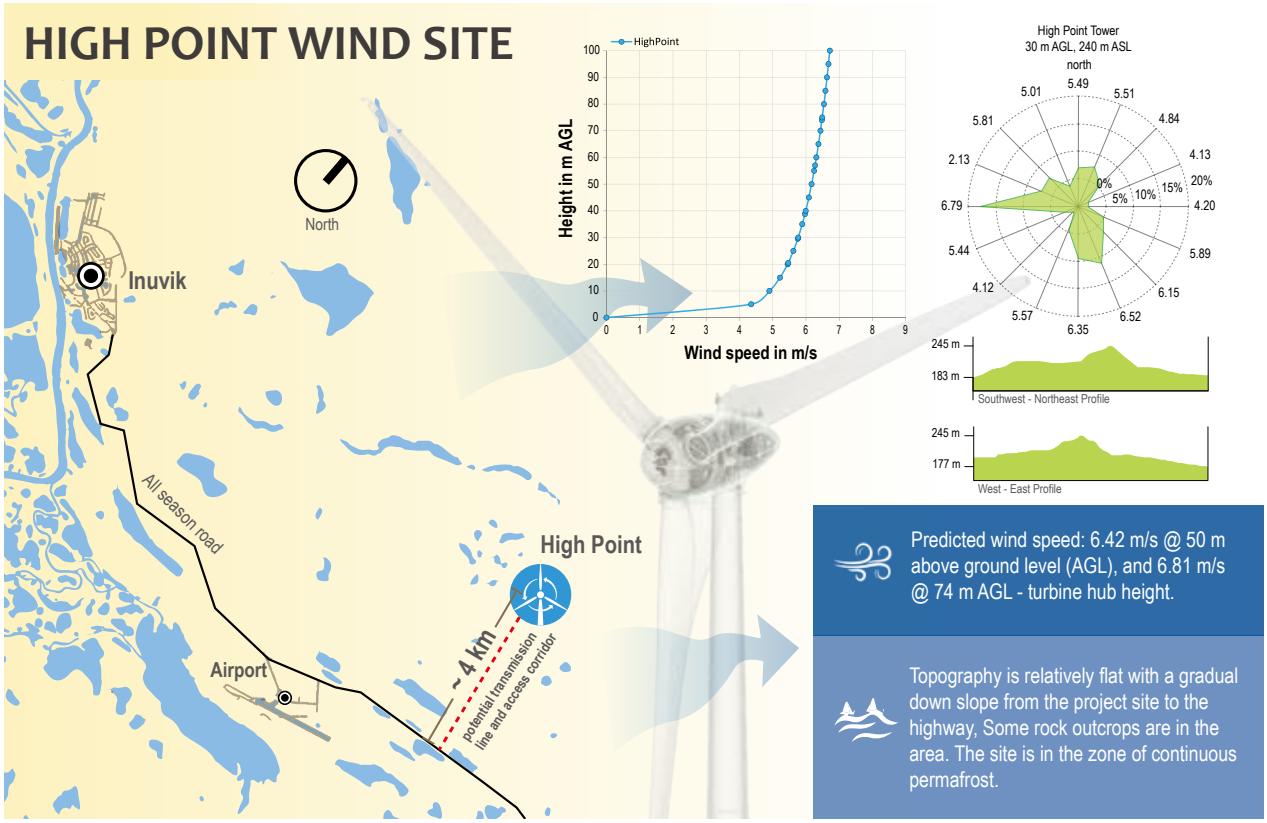
In a typical water year, the Snare Hydro System has surplus electricity. However, as power demands outgrow the existing hydro surplus, wind energy could be an important part of our renewable energy capacity. Wind energy could help to support new power customers like a large mine on the Snare Hydro System. As part of planning for load growth, the GNWT and NTPC are investigating the potential wind resource in the area. A wind-monitoring program began in December 2015 using wind-speed sensors mounted on a Northwestel communications tower (CN Hill) near the Snare hydro facility. The program has collected 15 months of wind data that shows a promising average wind speed of 6.9 metres per second at a height of 53 metres, and will continue until at least 24 months of data is collected.

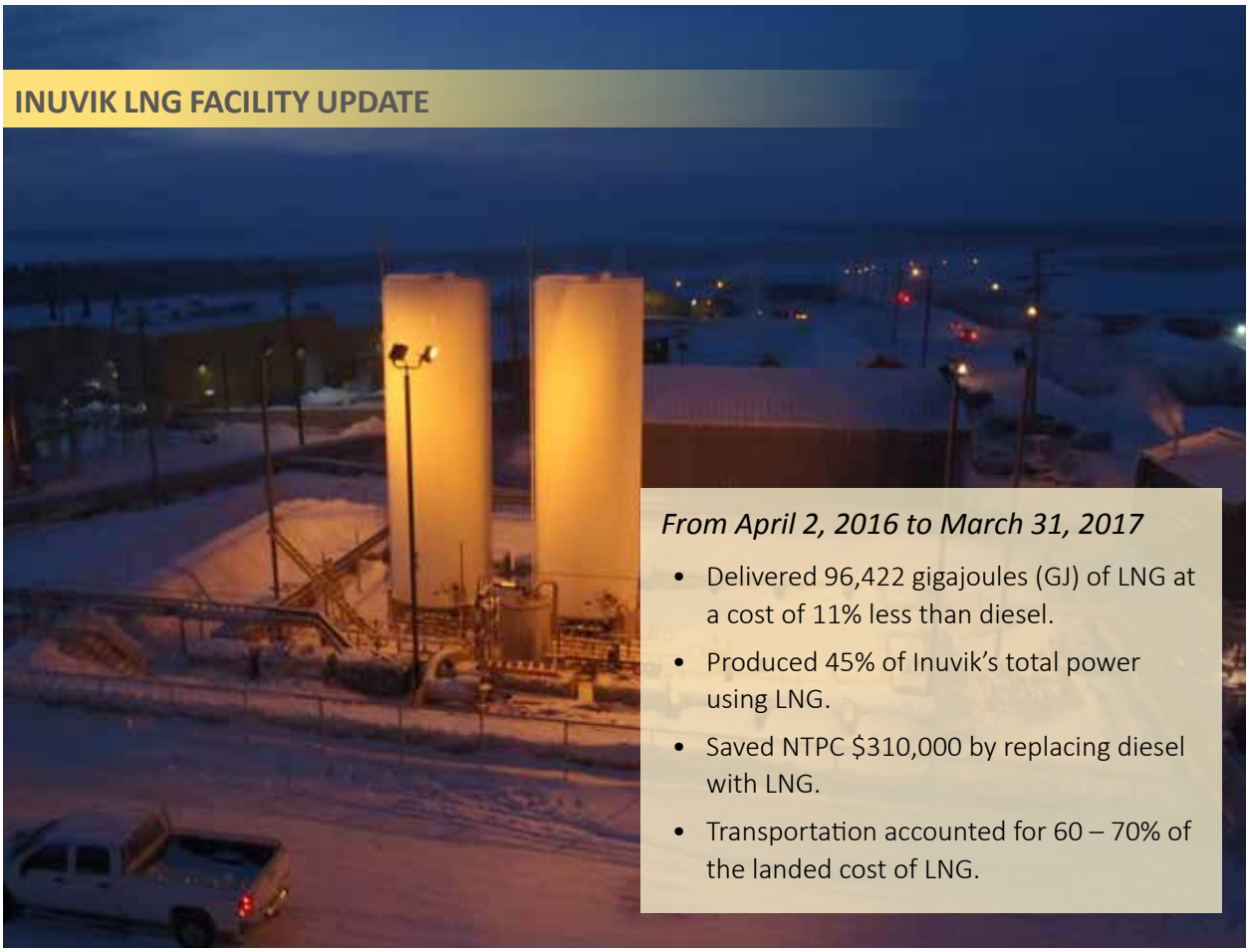


INUVIK HIGH POINT

As the NWT's largest thermal community, Inuvik could benefit substantially from wind power that could be used to displace millions of litres of diesel fuel each year. The Inuvik High Point site shows good wind potential and is only five kilometres from the highway and ten kilometres from a tie-in to the existing transmission line. Proximity to the highway and transmission line facilitates access and reduces project costs.

In December 2015, a 50-metre wind tower was installed at the site and measured average wind speeds of 6.42 metres per second. However, two years of data is needed to confirm wind resource quality, and unfortunately the first tower was lost during extremely high winds. Baseline information for a wind project was collected in 2016/17 including road and transmission line alignment, wind modeling and a review of wind turbines suitable for arctic applications. More detailed work including geo-technical testing will continue in 2017/18. A new 50-meter tower is being installed this summer.





NTPC's LNG facility in Inuvik.

LIQUEFIED NATURAL GAS (LNG)

TUKTOYAKTUK LNG STUDY

Early stage feasibility work was done in 2016/17 to see if LNG could provide cost savings and GHG emissions reductions in comparison to the existing plant used for power generation in Tuktoyaktuk. The project would also lay the foundation for a natural gas market, once the local gas resource is developed. The study found that an LNG solution in Tuktoyaktuk is technically feasible, and could reduce CO_2 emissions by up to 10%. The business case for investing in LNG in Tuktoyaktuk will improve as diesel prices rise relative to LNG. The current gap between landed diesel and landed LNG in Inuvik is not yet wide enough to justify a capital investment without a rate increase or unless a subsidy can be secured. This project will be one that is considered in future NTPC capital plans.

Energy Policy

NWT ENERGY STRATEGY PLANNING

With federal and provincial/territorial governments currently discussing emissions-reduction targets under the Pan-Canadian Framework on Clean Growth and Climate Change, and a federal carbon tax set to begin in 2018, the GNWT is outlining its vision for energy in the territories with a new 2030 Energy Strategy and a Climate Change Strategic Framework.

To help the NWT meet its climate change goals, the GNWT is planning its energy sector investments to implement effective programs and policies and develop alternative and renewable energy projects. These planning documents will help the Federal Government to see where Federal investments are needed over the next decade.

ENERGY STRATEGY ENGAGEMENT SESSIONS

INF and Environment and the Department of Natural Resources (ENR) held joint energy workshops and evening public sessions with Indigenous governments, municipal governments, First Nations, non-government organizations, utilities and other relevant organizations in regional communities across the NWT.

These sessions aimed to collect input from the general public and key stakeholders that can help the GNWT develop actions that meet climate change goals to be outlined in the Climate Change Strategic Framework.

Key energy themes that emerged included:

- Energy affordability.
- More community involvement and partnerships.
- Improving communication and community outreach.
- More support for biomass-based heating development.
- Upfront efficiency incentives, more programs and services.
- More support for local renewable energy resource development.
- Setting achievable emissions targets without increasing energy costs.
- Carbon tax revenue redistribution to local renewable energy projects.

Regional Engagement plennary in Fort Simpson.

ENERGY INFORMATION AND AWARENESS

In an effort to raise public awareness of energy issues in the NWT, INF collaborated with the AEA, NTPC, Environment and Natural Resources, and the Northwest Territories Housing Corporation to form an Energy Communications Working Group (ECWG). The ECWG developed projects aimed at showing the public how conserving energy and using it more efficiently can immediately reduce energy costs and our impact on the environment.

NTPC created a two-minute video called ***Power Generation in the Northwest Territories***, showing how power is generated in the NWT. The video was aired at the Capitol Theatre in Yellowknife and can be viewed on NTPC's website.

AEA and INF partnered with Education, Culture, and Employment (ECE) to coordinate the ***Solar Car Race Initiative*** for junior high students, where teams built their own solar cars. Extremely popular with students, parents and teachers, the project will continue in 2017.

INF and AEA partnered with NWT Territorial Libraries to show library patrons the costs associated with incandescent light bulbs versus LED light bulbs. INF and AEA supplied 21 libraries across the NWT with ***LED Light Display*** boxes for the demonstrations.

ECWG members provided information and photos to develop an Energy Calendar for remote diesel communities. The calendar supplied tips and information on how to reduce diesel use and save money throughout the year.

ENERGY INFORMATION DATABASE

Accurate information is critical to good decision-making. To ensure that decision-makers have access to relevant and up-to-date information, INF has been working on a database that will collect energy information and house it in one central, easily-accessible location. Reporting tools for the database are currently being developed. Once those tools are tested and proven accurate, the database will be made available to decision-makers and the general public.

Fort Simpson Regional Engagement Break-out Session with Youth.

A Look Ahead

NWT ENERGY STRATEGY

In 2017, the GNWT will release its new 2030 Energy Strategy, establishing principles and priorities that will guide the GNWT's short- and long-term approach to energy in the NWT. The strategy will focus on improving the affordability and reliability of energy while reducing its environmental impacts, specifically in the electricity, heating and transportation sectors. Key objectives in the strategy will attempt to:

- Reduce greenhouse gas emissions in thermal communities.
- Increase the amount of heat produced from renewable sources.
- Establish energy efficiency and transportation emission reduction targets to help meet national climate change objectives.
- Partner with Indigenous governments, communities and First Nations in developing energy projects and implementing energy initiatives and programs.

TALTSON HYDRO EXPANSION

The GNWT will continue to study electrical market opportunities outside of the NWT that would enable construction of the Taltson Hydro Expansion and an intertie to a southern jurisdiction.

INUVIK WIND DESIGN

Inuvik "High Point" has the potential to provide the highest cost benefit ratio for a wind farm in the Inuvik region. Work going forward will focus on stakeholder engagement, environmental review, interconnection and integration studies, design of civil works and linear infrastructure and procurement packages for equipment—supplying detailed information for the proposed 2-5MW wind farm to tie in with the NTPC power plant.

UTILITY-SCALE SOLAR PV ROLL-OUT

INF will continue to work with federal funding agencies, NTPC and Northwest Territories Housing Corporation to integrate solar PV technology into communities where diesel generation costs are highest.

NWT HYDROLOGY RESEARCH AND POWER GENERATION

Work will continue on the current long-term climate studies, including research to find valuable precipitation and stream flow data. This data could link the watersheds that supply our hydropower system with more global weather indicators, improve our understanding of water systems and contribute to more representative hydropower forecasting.

WIND MONITORING IN SACHS HARBOUR AND NORMAN WELLS

With its strong wind potential, Sachs Harbour is a favourable candidate for a wind project. Building on the preliminary work completed by INF, the potential for the installation of a wind-monitoring tower will be explored with the community. Discussions will begin on future steps and the shape of the project—with particular attention to working with and meeting community needs. Going forward, NTPC's power plant in Sachs Harbour is in need of replacement. A plant replacement is an excellent opportunity to plan for the potential integration of renewable energy like wind power.

INF will also be investigating potential wind monitoring sites around the community of Norman Wells. Norman Wells typically gets its power from a gas power plant operated by Imperial Oil Limited (IOL). When the oil well is not operating, NTPC relies on a standby power plant to meet the town's power needs. Capital investments will be required to upgrade the plant from standby to full-time supply in the future, and wind energy is a potential part of the supply mix to consider.

CARF PROGRAM

The Capital Asset Retrofit Fund (CARF) Program will reach a milestone in the 2017/18 fiscal year, marking 10 years of energy efficiency upgrades to GNWT assets. In the coming year these upgrades will include the first GNWT-owned pellet boiler operating north of the Arctic Circle, which will heat the East Three School in Inuvik.

ENERGY INFORMATION AND AWARENESS

INF will continue working with its partners to create opportunities and programs that improve awareness of the benefits of energy conservation and efficiency as well as alternative and renewable energy in the North.

For example, after listening to input from communities, the GNWT is supporting the development of a supplementary energy curriculum for teachers across the territories. The GNWT recognizes the importance of engaging northern youth early by creating regionally and culturally relevant energy material that depicts the NWT and its energy system.

Appendix A – Arctic Energy Alliance (AEA)

AETP RESULTS		
Metric	Commercial	Residential
Number of Rebates and Technology Type	3 Biomass Boiler 4 Solar PV 7 Total	3 Biomass Boiler 13 Solar PV 3 Wind 19 total
Total Rebate Amount	$81,487	$59,308

CREP RESULTS			
Project Type	Location	Installed kilowatts	Rebate Amount
Biomass Boiler	Yellowknife	28	$20,000
Biomass Boiler	Inuvik	80	$20,000
Solar PV	Inuvik	5	$5,450
Solar PV	Aklavik	3	$13,460
Solar PV	Inuvik	15	$20,000
Solar PV	Inuvik	2.5	$5,000
Solar PV	Fort Providence	Bring to code compliance	$15,000
Totals		133.5 kW	$98,910

EEIP RESULTS		
Region	Number of Rebates	Rebate Amount
North Slave	433	$97,908
South Slave	107	$39,937
Beaufort Delta	100	$12,318
Dehcho	69	$8,835
Sahtu	53	$4,033
Tlicho	10	$2,660
Other	26	$11,656
Total	798	$177,347

CECEP RESULTS	
Metric	Totals
Number of Rebates	15
Rebate Amount	$110,882
Estimated Energy Savings	$224,704
Avoided Greenhouse gases	195 tonnes
Estimated Simple Payback	1.6 Years

Appendix B
Energy Efficiency Projects

FACILITY	LOCATION	DETAILS
Headquarters Various	Yellowknife	Biomass Boiler Optimizations
Headquarters Various	Yellowknife	18/19 Design Services /Auditing
North Slave	Various	O&M Lighting Retrofits
Yellowknife Airport Terminal	Yellowknife	HVAC Controls Upgrades/Optimization for Biomass Boiler
Inuvik Region Various	Inuvik Region	O&M Lighting Retrofits
Chief T'Selehye School	Fort Good Hope	Energy Retrofit based on 15/16 audit
Chief Albert Wright School	Tulita	Energy Retrofit based on 15/16 audit
Angik School	Paulatuk	Energy Retrofit
Inualthuyak School	Sachs Harbour	Energy Retrofit (with deferred maintenance)
Nursing Station	Aklavik	Energy Retrofit
Mangilaluk School	Tuktoyaktuk	Lighting Upgrade and other HVAC upgrades in conjunction with mid-life retrofit
South Slave Various Upgrades	South Slave	O&M Lighting Upgrades
Woodland Manner	Hay River	Upgrades to Woodland Manner in Connection to Biomass
PWK Highschool	Fort Smith	Heat Plant Optimization
Trout Lake School	Trout Lake	Mid-Life Retrofit (HVAC Upgrades, Controls, Lighting)
Various Facilities	Fort Simpson	O&M Lighting Retrofits
Diamond Jenness School	Hay River	Mid-Life Retrofit (HVAC, Lighting, Envelope)
Chief Julius School Waste Heat	Fort McPherson	Residual Heat from NTPC
Echo Dene School Waste Heat	Fort Liard	Residual Heat from NTPC
Mezi School Waste Heat	Whati	Residual Heat from NTPC
NSRO	Yellowknife	HVAC Upgrades
Central Warehouse	Yellowknife	Boiler Upgrades
Steam Heating Plant Upgrades	Fort Simpson	Boiler Replacement
Northern Lights Extended Care	Fort Smith	405 kW ACME Electric Boiler
DOT Maintenance Garage	Fort Smith	400 kW Electric Boiler
JBT Elementary & Breynat Hall	Fort Smith	800 kW Electric Boiler
Mangilaluk School	Tuktoyuktuk	High Bay LED
Chief Julius School	Fort McPherson	High Bay LED

Appendix C
Completed Biomass Boilers

LIST OF COMPLETED GNWT BIOMASS BOILER INSTALLATIONS

FACILITY	LOCATION	DATE COMPLETED	SIZE (KW)	COMMENTS
School	Tulita	March 2017	150	
School	Fort Good Hope	March 2017	200	
Prince of Wales Northern Heritage Centre	Yellowknife	March 2016	300	
Airport Terminal Building	Yellowknife	November 2015	400	
Health Centre	Hay River	November 2015	1,200	
South Mackenzie Correction Centre	Hay River	October 2015	212	
Deninu School	Fort Resolution	October 2015	200	
Health Centre	Fort Providence	July 2015	75	
GNWT Office Building	Yellowknife	December 2014	650	
Combined Services Building	Norman Wells	October 2014	212	
Mackenzie Mountain School	Norman Wells	October 2014	212	
Airport Terminal Building	Norman Wells	October 2014	159	
*Health Centre	Fort McPherson	September 2014		Purchased Heat
*Behchoko Longterm Care Facility	Behchoko	March 2013	540	Purchased Heat

FACILITY	LOCATION	DATE COMPLETED	SIZE (KW)	COMMENTS
Deh Gah School	Fort Providence	March 2013	300	
Combined Services Building	Yellowknife	October 2012	540	
Central Heating Plant	Fort Simpson	October 2012	823	
Elizabeth Mackenzie School	Behchoko	October 2012	540	
St. Josephs Secondary School	Yellowknife	November 2011	540	
Health Centre	Fort Smith	November 2011	750	
Central Heating Plant	Hay River	November 2010	900	
Thebacha College	Fort Smith	November 2010	750	
Legislative Assembly Building	Yellowknife	October 2010	300	
Highways Maintenance Garage	Hay River	October 2010	300	
PWK School & Recreation Complex	Fort Smith	October 2010	750	
Chief Jimmy Bruneau	Behchoko	October 2009	750	
Kalemi Dene School	N'Dilo	September 2009	69	
*Sir John Franklin	Yellowknife	June 2005	750	Purchased Heat
*North Slave Correctional Facility	Yellowknife	November 2006	1,500	Purchased Heat

Appendix D – Utility-Scale Solar Projects

COMMUNITY	BUILDING	YEAR OF INSTALLATION	CAPACITY INSTALLED ON THIS SITE OR BUILDING (kW)	GNWT Contribution	OWNER
Inuvik – Housing Corporation	17-Unit Apartment Complex	2017	20	$180,000	Territorial Government
Aklavik-NTPC	Ground Mount	2017	50	$420,000	Utility
Inuvik	ARI	2017	25	$200,000	Territorial Government
Inuvik	INF Building	2017	20	$320,000	Territorial Government
Wrigley-NTPC	Ground Mount @ NTPC	2016	10	$160,000	Utility
Fort Liard-NTPC	Ground Mount @ Airport	2016	39	$300,000	Utility
Colville Lake-NTPC	Utility Solar-Diesel Hybrid (High penetration)	2015	136	$1,150,000	Utility
Lutsel K'e	Ground Mount (IPP)	2014	33	*$100,000 (GNWT Contribution)	Local Government
Hay River-Housing Corp	Wispering Willows Senior Centre	2014	60	$250,000	Territorial Government
Fort Simpson-NTPC	Ground Mount @ Airport	2010, 2012 (Expansion)	104	$1,070,000	Utility

*Total Project Cost: $350,000