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Save Energy and Save the Environment

PUBLIC WORKS AND SERVICES ENERGY CONSERVATION PROJECTS Annual Report 2011

Prepared By

Design and Technical Services
Public Works and Services
Government of the Northwest Territories
April 2012

Northwest Territories

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Biomass Heating Systems
in Northwest Territories Government Buildings

Minister's Message

The Department of Public Works and Services (PWS) is committed to helping the Government of the Northwest Territories achieve its energy efficiency, greenhouse gas, and sustainability goals. As part of its commitment to report yearly results from its energy investment activities, the Department is releasing the second annual PWS Energy Conservation Projects report for 2011 – and the results are impressive.

In 2011, PWS projects reduced the government's needs for heating fuel oil by 2 million litres, and greenhouse gas emissions by over 6,000 tonnes. With over 6 million litres of fuel oil saved since 2007, PWS energy conservation activities are on track to help the GNWT save close to 10 million litres of fuel oil and reduce greenhouse gas emissions by over 25,000 tonnes by the end of 2012.

While fuel oil and greenhouse gas emission reductions are impressive in their own right, it should be noted that 2011 marked a turning point for the GNWT in how it funds its energy conservation initiatives. Through alternative energy projects, building retrofits, and the biomass strategy, real savings of over $1.8 million have been achieved in the last two fiscal years. These savings are being reinvested by the GNWT to fund future energy projects, moving our capital energy investment program towards self-sustainability.

A key factor to these achievements has been the wide-spread support of PWS's biomass strategy of installing wood pellet boilers in GNWT facilities. As a result, the Northwest Territories is recognized as a leader in commercial wood pellet boiler installations across Canada.

The results outlined in the report show that ambitious, proactive government-wide energy conservation efforts are achievable, sustainable and are making a positive contribution towards meeting our goals to reduce energy consumption and greenhouse gas emissions.

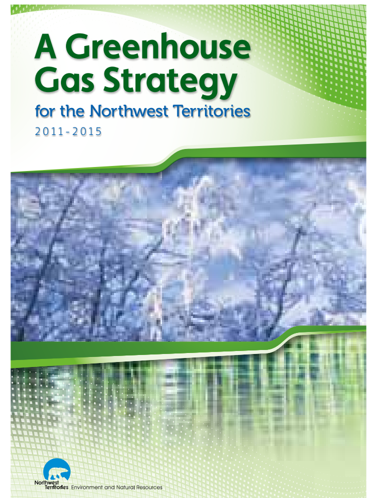
The Honourable

Glen Abernethy

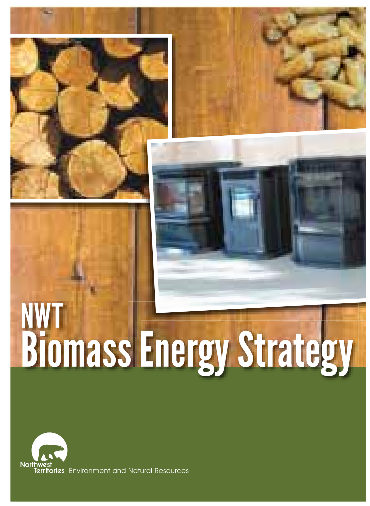
Minister of Public Works and Services

Overview

In 2008, The Government of the Northwest Territories (GNWT) released the Energy Priorities Investment Plan (Framework) to help achieve the energy goals set in the NWT Energy Plan and Greenhouse Gas Strategy. The NWT Energy Plan identified the GNWT's energy priorities: to reduce the use of imported diesel fuel for energy generation; reduce greenhouse gas (GHG) emissions; and reduce the cost of living in NWT communities. Clear targets for greenhouse gas emission reductions have since been set in the updated Greenhouse Gas Strategy - "A Greenhouse Gas Strategy for the Northwest Territories, 2011-2015" and, along with measures including the "NWT Biomass Energy Strategy" released in 2010, are providing direction to meet these goals.



Public Works and Services (PWS) has significantly helped reduce energy use and greenhouse gas emissions in the NWT. Cumulative savings from energy related projects since 2007 are equivalent to 6,220,419 litres of heating fuel oil, representing greenhouse gas emission reductions of 16,963 tonnes. Biomass technology has taken on a major role in achieving the GNWT's goals to reduce GHG emissions and accounts for approximately 85% of the total cumulative savings. PWS's commitment to biomass boiler installations in GNWT facilities has helped the NWT become a leader in commercial wood pellet boiler installations across Canada.



In support of the vision and goals set by the Government of the Northwest Territories, the Department of Public Works and Services continues to undertake energy efficiency activities in planning, designing, constructing, maintaining and operating government buildings in support of the Energy Plan and Greenhouse Gas Strategy. These activities include:

- Promoting the use of alternative sources of energy such as biomass, hydro and solar
- Increasing building energy performance with efficient design and construction
- Reducing energy usage in existing facilities with energy retrofits
- Developing a plan to track actual energy savings and reinvesting realized savings into more energy retrofits
- Developing, updating, and utilizing the *"Good Building Practice for Northern Facilities"* for the design and construction of GNWT facilities to reduce energy consumption and life cycle costs
- Commissioning construction projects with a focus on optimizing building energy consumption, operation and end user satisfaction
- Promoting public awareness of energy use and conservation, community energy planning, participating in energy fairs, and sharing information and expertise with other groups and Territories

The NWT has set greenhouse gas targets of stabilizing GHG emissions at 2005 levels by 2015, limiting increase in emissions by 66% above 2005 levels by 2020 and returning GHG emissions to 2005 levels by 2030.

PWS is pleased to bring this report forward as an annual review and update to the energy conservation actions and initiatives the department has taken and continues to make. Savings achieved from the installation of biomass boilers, electric boilers and energy retrofits show that PWS continues to make positive steps to reduce the GNWT's greenhouse gas emissions, operating costs and dependency on imported fossil fuels.

Energy Savings Projects

The NWT is highly dependent on fossil fuels as a primary source for heating and electricity. The desire to reduce GHG emissions from fossil fuels, along with the volatility in fuel prices and the potential for rising fuel costs, makes present energy saving initiatives a sound investment for the future.

As Figure 1 shows, in the fiscal year of 2011-2012, GNWT assets managed by PWS consumed the equivalent of 157,172 MWH for heating and power. PWS activities in energy efficiency focus on reducing these annual figures.

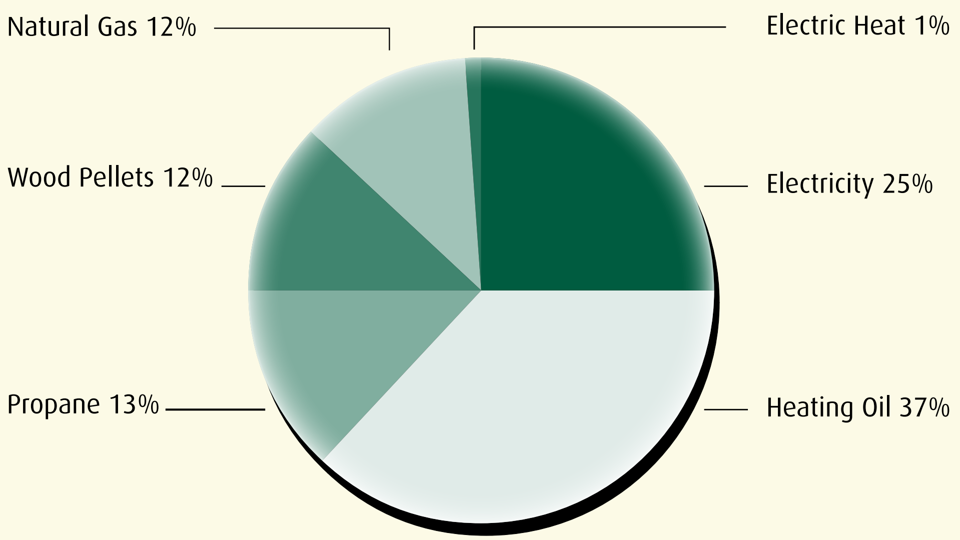


Figure 1: Total Energy Usage of GNWT Assets Managed by PWS = 157,172 MWH

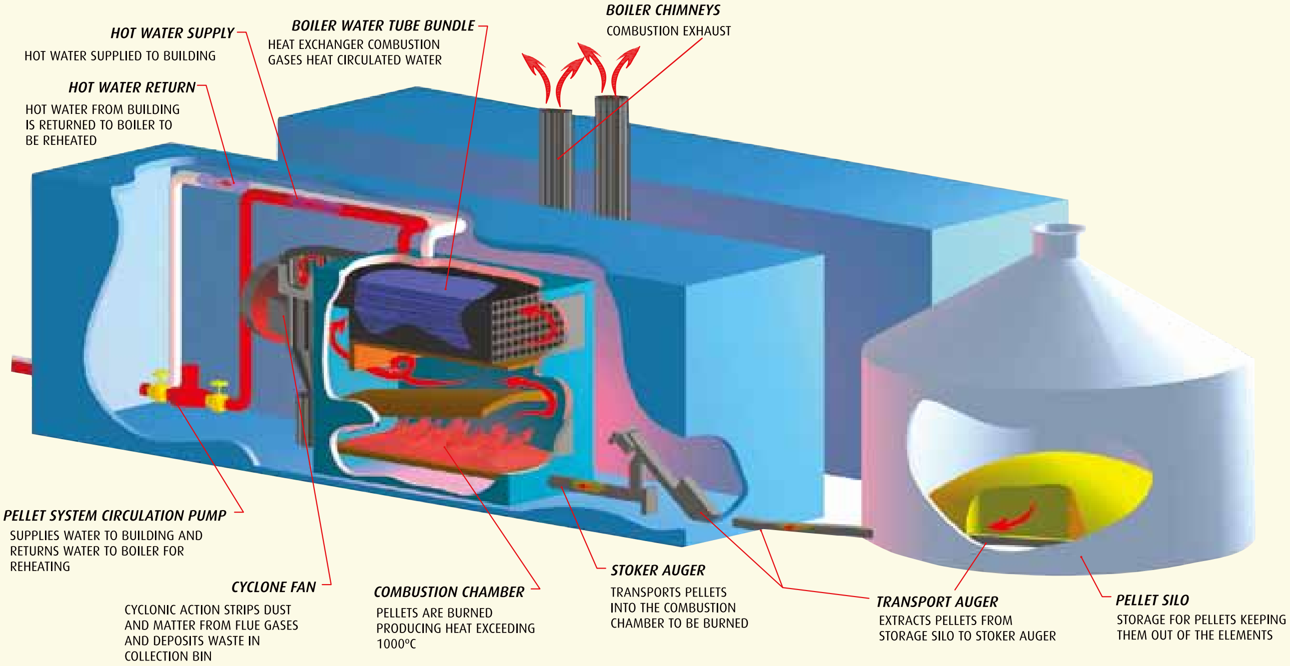
Biomass

The use of wood pellets in the NWT is attractive because of its relatively low cost and low GHG emissions, compared to that of heating fuel oil and propane. Commercial pricing for bulk delivery of wood pellets in the North and South Slave regions ranges from $225-$321/tonne. On a per unit of energy basis, this pellet cost is equivalent to paying $0.45-$0.65/L of oil, resulting in significant heating cost reductions.

PWS looks for facilities with large annual heating usage, which have commercial wood pellets readily available, for biomass boiler installations. Annual heating usages in the range of 100,000 litres of fuel oil or more yield favourable payback periods from biomass boiler installations and allow PWS to select commercial wood pellet boilers of capacity 300 kW and greater.

Boiler sizing is a critical step to optimize the efficiency of a wood pellet system. Wood pellet boilers are typically sized for 50% of the peak winter heating demand. This allows a wood pellet boiler to provide adequate heat for up to 90% of the year and optimizes the efficiency of the plant by minimizing wasteful cycling of the boilers (which occurs more frequently if boilers are oversized). Limiting the size of a wood pellet boiler also minimizes the up-front costs for construction and improves the project payback period. It is a PWS practice to ensure that existing fossil-fuelled boiler systems remain in operation to meet peak demands and act as back-up heat systems to wood pellet boilers, ensuring reliability in our extreme northern climate.

Conceptual Layout of a Typical Biomass Heating System



Biomass Projects Completed

Several major GNWT facilities have been retrofitted with biomass boilers to reduce the fossil fuel consumption and greenhouse gas emissions.

Major assets retrofitted to date with biomass heating systems include:

- North Slave Correctional Facility – Yellowknife
- Sir John Franklin High School – Yellowknife
- K'alemi Dene School – N'Dilo
- Chief Jimmy Bruneau School – Behchokò̜
- École St. Joseph School – Yellowknife
- Highways Maintenance Garage – Hay River
- PWK School and Recreation Centre – Fort Smith
- Thebacha College – Fort Smith
- Central Heating Plant (Harry Camsell School, Princess Alexandra School, École Boreale, Diamond Jenness Secondary School & Trade Shop) – Hay River
- Health Centre – Fort Smith

North Slave Correctional Facility – Yellowknife (2006)

The biomass boiler installation at the North Slave Correctional Facility in Yellowknife consists of two 750 kW wood pellet boilers. It was commissioned in November 2006. Since it was commissioned to December 31, 2011, the wood pellet boilers have displaced approximately 2,852,847 litres of fuel oil, resulting in greenhouse gas emission reductions of 7,789 tonnes. In the Calendar year of 2011, the biomass boiler system displaced approximately 564,836 litres of fuel oil, representing 1,542 tonnes of GHG emission reduction or 308 cars off the road.

North Slave Correctional Facility

Boiler Type: ....Binder
Size: ....2 x 750 kW
Silo Capacity: ....80 Tonnes

The wood pellet boiler installation at the North Slave Correctional Facility was the first of its kind in the Northwest Territories, and one of the first such installations in Canada. The success of this installation proved that biomass technology was economically and technologically viable in the North, and paved the way for future installations of wood pellet boilers.

Sir John Franklin High School – Yellowknife (2008)

Through a contract between the Yellowknife Education District No. 1 and an energy service provider, a 750 kW wood pellet boiler was brought into operation in February of 2008 at the Sir John Franklin High School in Yellowknife. Cumulative savings for this installation total 741,400 litres, representing a 2,024 tonne reduction of GHG emissions.

In the 2011 calendar year, this wood pellet boiler displaced approximately 234,100 litres of fuel oil, resulting in greenhouse gas emission reductions of 639 tonnes or the equivalent of removing 127 cars from the road.

Sir John Franklin High School

Boiler Type: ....Binder
Size: ....750 kW
Silo Capacity: ....40 Tonnes

K'alemi Dene School – N'Dilo (2009)

The new K'alemi Dene School in N'Dilo was designed with three small 23 kW residential wood pellet boilers to serve the heating needs of the school. One of these boilers is capable of offsetting 10,000 litres of fuel oil annually. The three boilers were installed inside a sea container adjacent to the building. Two 142 kW oil-fired boilers were also installed to meet peak demands, and provide backup to the wood pellet boilers.

K'alemi Dene School

Boiler Type: ....Bosch
Size: ....3 x 23 kW
Silo Capacity: ....15 Tonnes

The school was commissioned in September of 2009, and has since been operating with the wood pellet boilers as the primary source of heat. In 2011, the wood pellet boiler system displaced approximately 19,831 litres of fuel oil. This represents a greenhouse gas emission reduction of 54 tonnes or 10 cars from the road. Under-utilization of the wood pellet boilers from maintenance down-time and a reduced energy load on the building resulted in a lower-than-anticipated savings. Cumulative savings from this project are 48,312 litres of heating fuel and 132 tonnes of GHG emissions.

Chief Jimmy Bruneau Regional High School – Behchokǫ̀ (2009)

In 2009, a 750 kW boiler was installed at the Chief Jimmy Bruneau Regional High School to offset the use of heating fuel oil. Heating fuel savings of 155,000 litres per year and greenhouse gas emission reduction by 423 tonnes per year were anticipated. The boiler has been in operation since October 2009.

Chief Jimmy Bruneau Regional High School

Boiler Type: ....KOB
Size: ....750 kW
Silo Capacity: ....100 Tonnes

In 2011, this biomass boiler installation displaced 155,224 litres of fuel oil, representing a reduction in greenhouse gas emissions of 424 tonnes or a removal of 84 cars from the road. Cumulative savings from this project total 329,138 litres of fuel oil, reducing GHG emissions by 899 tonnes.

École St. Joseph School – Yellowknife (2009)

This 540 kW wood pellet boiler installation was part of a renovation project at the École St. Joseph School in Yellowknife. The wood pellet boiler was commissioned in October 2009. Annual fuel oil savings were estimated at 102,770 litres, with a greenhouse gas reduction of 281 tonnes a year.

École St. Joseph

Boiler Type: ....KOB
Size: ....540 kW
Silo Capacity: ....50 Tonnes

In 2011, the biomass boiler displaced 87,970 litres of heating oil. This represents a greenhouse gas emission reduction of approximately 240 tonnes, equivalent to removing 48 cars from the road. Since commissioning to the end of 2011 cumulative savings are 160,685 litres of fuel oil and 439 tonnes of GHG emissions.

Legislative Assembly Building – Yellowknife (2010)

The Legislative Assembly Building had a 300 kW wood pellet boiler installed and commissioned in October 2010. Cumulative savings to the end of 2011 are 133,661 litres of fuel oil, reducing GHG emissions by 365 tonnes.

In 2011, the biomass boiler displaced 99,161 litres of heating oil. This represents a reduction in greenhouse gas emissions of 270 tonnes, equivalent to removing 54 cars of the road, and the plant is performing as anticipated.

Legislative Assembly Building

Boiler Type: ....Binder
Size: ....300 kW
Silo Capacity: ....40 Tonnes

Highways Maintenance Garage – Hay River (2010)

A 300 kW wood pellet boiler was installed in the 4-bay Highways Maintenance Garage in Hay River and was commissioned in October 2010. This boiler installation was anticipated to offset fuel oil consumption by approximately 100,000 litres per year. Greenhouse gases would be reduced by 273 tonnes annually.

In 2011, this biomass boiler displaced 63,033 litres of heating oil. Greenhouse gas emissions were reduced by 172 tonnes, equivalent to removing 34 cars from the road. Cumulative savings from this biomass boiler installation total 97,978 litres of fuel oil and GHG reduction of 267 tonnes.

Highways Maintenance Garage

Boiler Type: ....KOB
Size: ....300 kW
Silo Capacity: ....50 Tonnes

P.W. Kaeser High School and Recreation Centre – Fort Smith (2010)

A 750 kW wood pellet boiler was installed to provide heating for the PWK School and Recreation Centre in Fort Smith. It was commissioned in October 2010.

In 2011, the biomass boiler displaced 211,845 litres of heating oil. Greenhouse gas emissions were reduced by 578 tonnes, equivalent to 115 cars taken off the road. These reductions are in keeping with what was originally projected for the system, and brings fuel savings to date to 296,140 litres and GHG reductions to 808 tonnes.

PWK High School

Boiler Type: ....KOB
Size: ....750 kW
Silo Capacity: ....50 Tonnes

Thebacha College – Fort Smith (2010)

A 750 kW wood pellet boiler was installed in the Thebacha College in Fort Smith and was commissioned in the fall of 2010.

In 2011, the biomass boiler displaced 164,102 litres of heating oil. Greenhouse gas emissions were reduced by 448 tonnes, equivalent to removing 89 cars from the road. Cumulative savings to the end of 2011 total 244,082 litres and 666 tonnes of GHG emissions reductions.

Thebacha College

Boiler Type: ....KOB
Size: ....750 kW
Silo Capacity: ....50 Tonnes

Central Heating Plant – Hay River (2010)

A 1 MW wood pellet boiler was installed in a central heating plant in Hay River. The heating plant serves Harry Camsell School, Princess Alexandra School, École Boréale, Diamond Jenness Secondary School and Trades Shop. This boiler installation was commissioned in November 2010 and was estimated to displace fuel oil by 318,340 litres annually. Greenhouse gas emission reductions were estimated at 869 tonnes.

In 2011, the biomass boiler displaced 270,881 litres of heating oil and greenhouse gas emissions were reduced by 740 tonnes, equivalent to removing 148 cars from the road. Cumulative savings from the project total 349,781 litres of fuel, equal to reducing GHG emissions by 955 tonnes.

Central Heating Plant

Boiler Type: ....KOB
Size: ....1 MW
Silo Capacity: ....50 Tonnes

Harry Camsell School

Princess Alexandra School

DJSS Trades Shop

Diamond Jenness Secondary School

École Boréale School

Health Centre – Fort Smith (2012)

A 750 kW wood pellet boiler was installed in the Fort Smith Health Centre during the fiscal year of 2010/2011. The installation was commissioned in early 2012, after necessary mid-life retrofits to the Health Centre's heating system were completed. The estimated fuel oil savings will total 200,000 litres annually with GHG emissions expected to be reduced by approximately 546 tonnes. Savings will be reported at the end of 2012.

Health Centre

Boiler Type: ....KOB
Size: ....750 kW
Silo Capacity: ....50 Tonnes

Current Biomass Projects

Central Heating Plant – Fort Simpson

PWS operates the Central Heating Plant (CHP) in Fort Simpson. The CHP is a low-pressure steam generation facility presently providing heat to three buildings: Fort Simpson Recreation Complex, Bompass Elementary School, and Thomas Simpson School. The original oil-fired steam boilers were replaced in October 2009, with more efficient and more appropriately-sized boilers to reduce overall plant size.

Central Heat Plant

Boiler Type: ....Combustion Experts
Size: ....980 kW
Silo Capacity: ....50 Tonnes

PWS is installing a 980 kW low-pressure steam wood pellet boiler at the CHP. The system is designed for potential expansion to service future government infrastructure projects. This wood pellet boiler will displace approximately 356,000 litres of fuel oil annually, representing a greenhouse gas emissions reduction of 971 tonnes, equivalent to removing 194 cars from the road.

The CHP installation is the first steam biomass boiler PWS has installed, and it is also the first commercial wood pellet boiler to be installed in the town. The boiler will be in operation for the beginning of the 2012 heating season.

Combined Services Building – Yellowknife

The newly constructed Combined Services Building (Department of Transportation) at the Yellowknife Airport, has had a 540 kW wood pellet boiler installed to offset the use of onsite propane. The biomass heating system will displace approximately 389,000 litres of propane or the equivalent of 255,618 litres of heating fuel oil. Greenhouse gas emissions will be reduced by 698 tonnes per year, equivalent to removing 140 vehicles from the road.

Combined Services Building

Boiler Type: ....KOB Pyrot
Size: ....540 kW
Silo Capacity: ....50 Tonnes

Elizabeth MacKenzie Elementary School – Behchokǫ̀ (Rae)

A 540 kW wood pellet boiler is being installed at the Elizabeth Mackenzie Elementary School. Each year the school uses an average of 87,400 litres of fuel oil for space heating. It is estimated that a wood pellet boiler system would displace approximately 78,700 litres of fuel oil at the school once installed. Greenhouse gas emissions would be reduced by 215 tonnes per year, equivalent to removing 43 cars off the road.

Elizabeth Mackenzie School

Boiler Type: ....KOB Pyrot
Size: ....540 kW
Silo Capacity: ....50 Tonnes

Originally the design called for a 300 kW wood pellet boiler, but so much interest was generated by the community of Behchokǫ̀ and the Northwest Territories Housing Corporation, that it was decided to size the pellet boiler so it could also serve the community recreation complex and a new apartment complex. The boiler was upsized to a 540 kW boiler in order to accommodate the increased heating load of the two facilities. PWS will provide heat to the two additional facilities when they connect to the installation.

Deh Gah School, Fort Providence

PWS is seeking funding for a wood pellet boiler installation at the Deh Gah School in Fort Providence. This project will involve installing a 300 kW wood pellet boiler to supplement the school's oil fired boilers. This will be the first commercial wood pellet boiler installation in Fort Providence. When the wood pellet boiler is brought online it will displace approximately 95,000 litres of fuel oil annually. This represents a greenhouse gas emissions reduction of 259 tonnes, equivalent to removing 52 vehicles off the road.

Deh Gah School

Boiler Type: ....???
Size: ....300 kW
Silo Capacity: ....50 Tonnes

Summary – Biomass Projects

Wood pellet boilers are providing substantial operational savings for the GNWT. In 2011, the nine wood pellet boilers in operation displaced approximately 1,885,742 litres of fuel oil, resulting in reductions of approximately 5,148 tonnes of GHG emissions. In many cases these wood pellet boilers are operating much more efficiently than existing oil boilers, reducing the total annual heat energy usage of their facility. As seen in figure 2, with four additional biomass projects coming online for the 2012/2013 heating season, PWS is anticipating that annual heating fuel reductions will increase to approximately 2,400,000 litres.

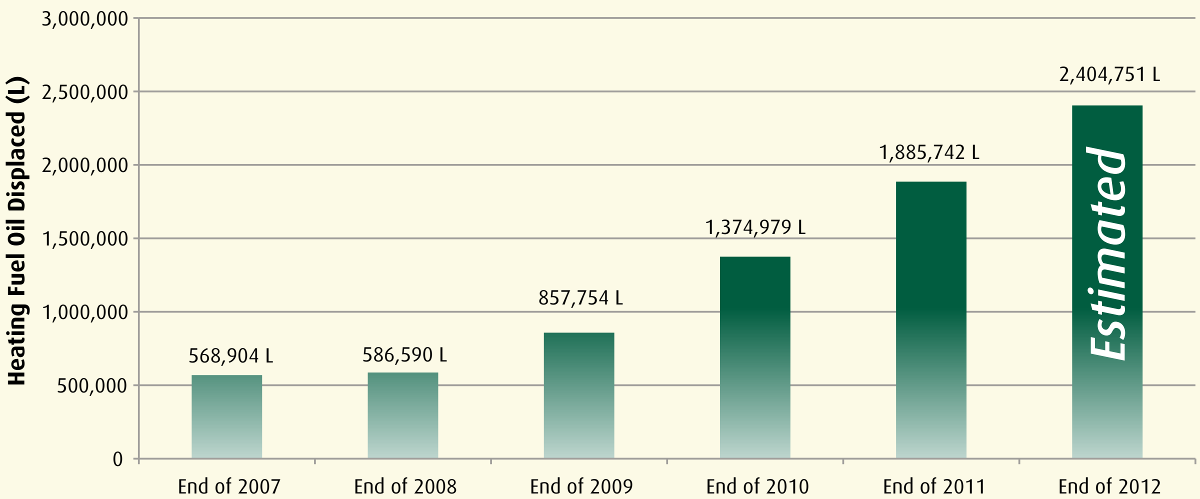


Figure 2: Actual and Estimated Annual Heating Fuel Displaced from the Use of Biomass in GNWT Facilities

Of all the initiatives PWS is working on to help reduce the GNWT's GHG emissions, biomass is having the largest impact. Annual GHG reductions in 2011 totalled 5,148 tonnes. As seen in figure 3, PWS anticipates that GHG emissions reductions will top 6,500 tonnes by the end of 2012.

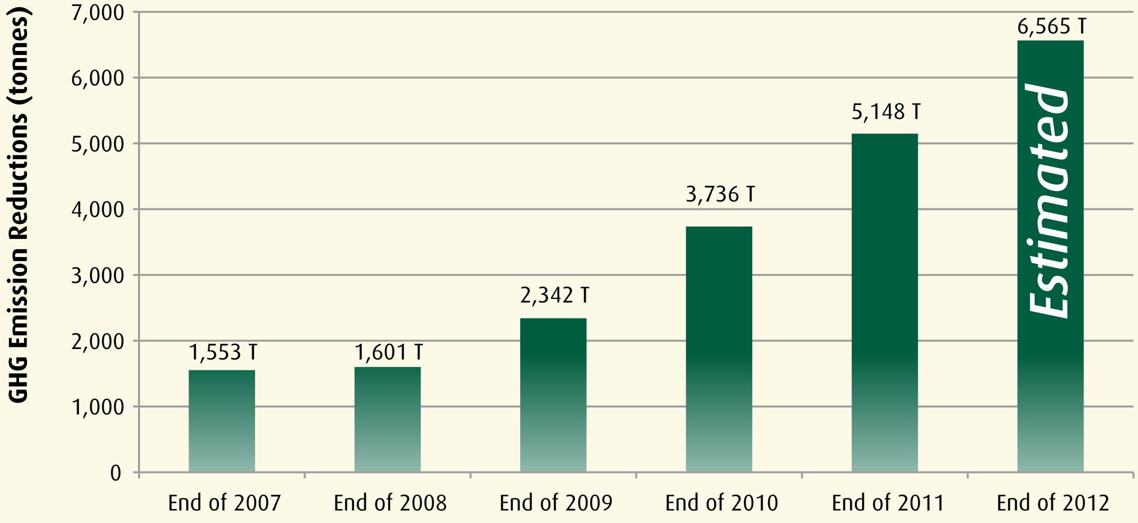
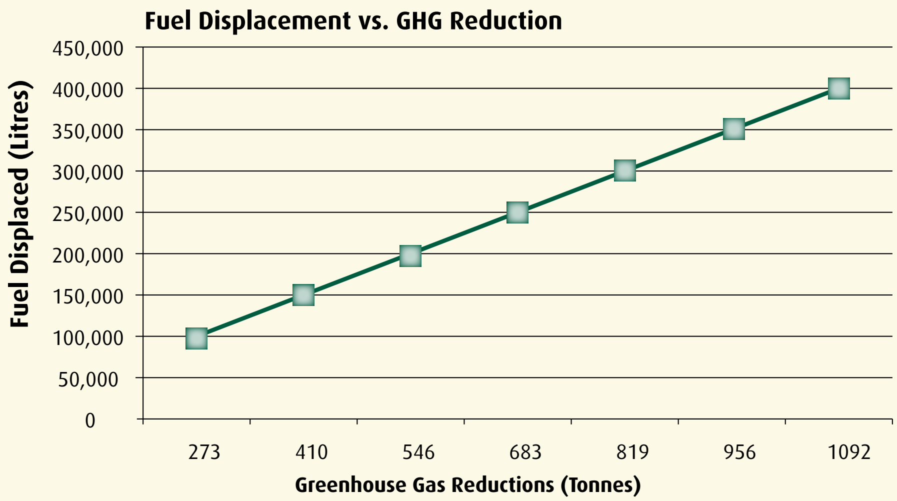


Figure 3: Actual and Estimated Annual GHG Emissions Reductions from Biomass Boiler Installations

The nine biomass systems (excluding the Fort Smith Health Centre) in operation in 2011 are responsible for heating approximately 74,278 m^2 of GNWT space in the North and South Slave regions. When wood pellet and fuel oil consumptions are totalled in 2011, the Building Heating Cost Index (BHCI) is approximately $18.73/$m^2$. By comparison, if these buildings had operated for the entire year on heating fuel oil, the BHCI would have been $26.14/$m^2$ to heat the same space. The use of biomass heat in the nine facilities reduced the BHCI by 28% in 2011.

Wood pellet boilers have made a significant impact on operational costs and GHG emission reductions. Looking forward, PWS is planning to install wood pellet boilers in new facilities such as the new GNWT Office Building in Yellowknife, the new Health Centres in Hay River and Fort Providence and the new Long Term Care Facility in Behchokǫ̀. In addition, PWS is also looking at providing heat to municipal buildings close to biomass installations, to maximize GHG reductions. Examples of this include the wood pellet boiler installation at PWK School in Fort Smith, which also provides heat to the community recreation complex, and the new boiler installed at Elizabeth Mackenzie School in Behchokǫ̀ which will provide heat to the Community Recreation Complex and the Housing Corporations new 9-plex building currently under construction.



Fuel oil is the major contributor of greenhouse gas emissions in the NWT. Typically one litre of fuel will release 2.73 Kg of CO_2 when burned.

Price of Wood Pellets ($/T)	50	100	150	200	250	300	350	400	450
Heating Cost Equiv. Oil ($/L)	.102	.204	.305	.407	.509	.611	.712	.814	.916

Case Study 1

Chief Jimmy Bruneau High School Biomass, Behchokǫ̀

Prior to the installation of a 750 kW wood pellet boiler at the Chief Jimmy Bruneau (CJB) High School in Behchokǫ̀ (Edzo), this facility consumed, an average of approximately 172,000 litres of fuel oil annually and 604,600 kWh of electricity. Total Building Energy Intensity (BEI) was equal to 291.6 kWh/m^2 and Building Energy Cost Index (BECI), at 2011 energy rates, would have been equal to \$47.53/m^2.

In the calendar year of 2011, CJB High School consumed 310 tonnes of wood pellets, 28,653 litres of heating fuel oil and 563,400 kWh of electricity. Throughout this period, the wood pellet boiler provided 84% of the total annual heat load in the building, reducing GHG emissions by 424 tonnes.

Electricity usage is expected to rise slightly with the installation of a wood pellet boiler since equipment to operate these boilers consumes more electricity than an oil-fired boiler with the same heat output rating. In 2011, electricity consumption at the school was less than baseline consumption, suggesting there were other factors which reduced electricity usage. Due to a colder winter compared to the baseline year, the BEI was higher at 302 kWh/m^2. At a rate of \$212/tonne of wood pellets, the total BECI in 2011, was reduced to \$33.88/m^2, representing a 29% reduction in annual utility costs, despite the colder weather.

Electric Heat Conversions – Hydro

In 2001, PWS and the Northwest Territories Power Corporation (NTPC) assessed the feasibility of using surplus hydroelectric power from the Taltson Hydro facility to heat GNWT buildings in Fort Smith. The Taltson facility has a hydroelectric generating potential of approximately 18 MW, of which 8 MW is surplus. This surplus provided an opportunity to utilize electricity, on an interruptible basis, to heat GNWT buildings. When hydro electricity from the Taltson Dam is not being produced in excess, these facilities will have the interruptible power cut and will revert to heating the facility with their original boiler plant.

Taltson Hydro Dam

Three buildings, J.B. Tyrell Elementary School, Breynat Hall, and a Department of Transportation Highways Maintenance Garage, were connected to this interruptible power supply with separate electrical service connections. Provided that the Taltson facility was producing electricity in excess, these buildings would be able to utilize electric boilers for 100% of their respective heating loads.

Completed Projects

J.B. Tyrell Elementary School – Fort Smith (2008)

J.B. Tyrell Elementary

Boiler Type: ....Acme
Size: ....810 kW

Average annual heating fuel oil consumption for the J.B. Tyrell Elementary school was 166,208 litres. Based on peak heating requirements for the school, an 810 kW electric hot water boiler was installed to provide 100% of peak demand heating with interruptible electricity. The existing oil-fired boilers remained as backup.

Installation of the electric boiler was completed and commissioned in November 2008. In the 2011 calendar year, the electric boiler displaced approximately 98,366 litres of fuel oil, reducing greenhouse gas emissions by 269 tonnes, equivalent to removing 53 cars from the road. Cumulative savings since November 2008 total 274,095 litres, equivalent to reducing GHG emissions by 749 tonnes. Savings targets are lower than expected because total annual heat usage in the building has been greatly reduced; this is likely due to the existing oil-fired boilers having a much lower efficiency than originally assumed, compared to the 100% efficiency of the electric boiler.

Breynat Hall – Fort Smith (year)

Breynat Hall

Boiler Type: ....Acme
Size: ....720 kW

One 720 kW electric hot water boiler was installed in Breynat Hall to offset heating fuel oil by approximately 132,000 litres a year. This electric boiler is large enough to meet the peak heating demands at the Hall, and was commissioned in November 2008. In the 2011 calendar year, the electric boiler displaced approximately 119,871 litres of fuel oil, reducing greenhouse gas emissions by 327 tonnes, the equivalent of removing 65 cars from the road. Cumulative savings total 266,461 litres of heating fuel oil, reducing GHG emissions by 728 tonnes.

Highways Maintenance Garage – Fort Smith (year)

Highways Maintenance Garage

Boiler Type:.............. Acme
Size:..........................83 kW

One 83 kW electric boiler was installed to serve the heating needs of the Highways Maintenance Garage. This boiler is sized to meet the peak heating load of the garage. The existing oil-fired boilers remain as backup in case the interruptible power is shut off.

The electric boiler was installed and commissioned in the winter of 2009–2010. In the calendar year 2011, the electric boiler displaced approximately 28,299 litres of fuel oil, reducing greenhouse gas emissions by 77 tonnes, equivalent to removing 15 cars off the road, which is on target for projected savings. Cumulative savings since commissioning total 44,691 litres of fuel oil, reducing GHG emissions by 122 tonnes.

Looking Forward...

Northern Lights Special Care Home – Fort Smith

NTPC and PWS are currently exploring the possibility of adding the Northern Lights Special Care Home onto interruptible power for the purpose of supplementing the existing fuel oil boilers. The installation would include a 400 kW electric boiler to carry 100% of the heating load in the facility. If funding for the project is approved, design and construction for this project will would in the beginning of the 2012-2013 fiscal year, with a completion date in time for that year's heating season. This electric boiler would help offset approximately 77,000 litres of fuel oil annually, and reduce GHG emission by approximately 210 tonnes, equivalent to removing 42 cars from the road.

Northern Lights Facility

Electric Heat Summary

The collaboration between NTPC and PWS to use excess hydroelectricity from the Taltson Dam has displaced approximately 585,247 litres of fuel oil since the commissioning of the three projects to the end of 2011. This represents an offset of greenhouse gas emissions of approximately 1,599 tonnes. Respective cumulative savings for each installation are shown below in Table 1.

Table 1:

Electric Heat Cumulative Savings from Date of Commissioning to end of 2011

Facility	Date Commissioned	Total Consumption (kWh)	Heating Fuel Oil Saved (L)	GHG Savings (Tons)
JBT School	November 2008	2,261,280	274,095	749
Breynat Hall	November 2008	2,198,307	266,461	728
DOT Maintenance Garage	April 2009	368,699	44,691	122
	Total	**4,828,286**	**585,247**	**1,599**

Solar

Solar technology in the form of photovoltaics for the production of electricity is emerging in the NWT as a way to help offset greenhouse gas emissions in communities where electricity is currently produced from diesel fuel (Thermal communities). Another form of solar energy technology is solar hot water heating, which can be used effectively to provide domestic hot water in remote areas.

In the past, PWS has assisted with the installation of both solar electric and solar hot water systems in the NWT. ITI has taken the initiative to have photovoltaics and solar hot water systems installed at a few of the parks in the North Slave Region (Fred Henne, Reid Lake and Prelude Lake Territorial Park) to power and heat water in shower facilities. PWS assisted with the commissioning of these systems as the projects neared completion.

PWS is currently assisting an initiative with the Department of Environment and Natural Resources to develop a NWT Solar Energy Strategy which will aim to promote the use of solar energy in the North. As installation costs decrease and equipment quality and efficiency increase, PWS will look at the potential to add these systems to facilities in Thermal communities to offset the use of diesel-produced electricity.

Heat Recovery Projects

Heat recovery is an excellent conservation measure to help reduce heating costs and GHG emissions. Heat energy can be recovered in many ways. PWS has typically recovered energy from internal heat gains in facilities and heat generated from electricity generators.

Data Centre – Yellowknife

Data Centre – Yellowknife

The new GNWT Data Centre in Yellowknife was commissioned in January 2011, and is currently heated by oil-fired hot water boilers located in the adjacent GNWT Central Warehouse. Heating water travels in underground heating mains. Two heat pumps were installed in the mechanical room of the Data Centre to reuse the heat generated from servers and other computer equipment that would otherwise be exhausted outside. Initially, this excess heat will be used to heat the Data Centre's space heating needs.

Ultimately, after a full build-out of servers in the Data Centre, the amount of recoverable waste heat will be such that not only will the total heat load of the Data Centre be provided for, but also a portion of the load for GNWT Central Warehouse will be available.

After the initial build-out of server units, annual fuel savings for the Data Centre are estimated to be 19,207 litres. After the five-year build out plan, additional annual savings of 15,938 litres of fuel oil are estimated by reducing the consumption at the Warehouse using heat transferred from the Data Centre. At full build-out, this heat recovery system will reduce GHG emissions by 170 tonnes per year.

Residual Heat Projects

In a number of communities PWS has worked with NTPC to use residual heat from power generation plants to heat GNWT facilities. These residual heat systems typically use heat from generator cooling water. This system is in place in Fort McPherson and WhaTi to heat the Chief Julius School and Mezi Community School respectively.

Most recently, the Department of Industry, Tourism and Investment (ITI) and NTPC have installed a district heat system in Fort Liard which provides residual heat to the Echo Dene School and the Hamlet Office, garage and fire hall. In the first year of operation, this system provided almost all of the heat necessary for the Echo Dene School, eliminating almost 113 tonnes of greenhouse gas emissions.

The new GNWT Multi-Use Office building and Records Storage facility in Inuvik was constructed so that it could be eventually connected to a residual heat system. Heat from the NTPC power generation facility could supplement the existing boilers. This project has been put on hold until the natural gas issue in Inuvik is addressed.

Miscellaneous Energy Conservation Projects

Energy Upgrades - Ventilation North Slave Regional Office (PWS), Yellowknife

Besides specific energy savings projects such as biomass, electric heat or energy retrofits, many projects that PWS undertakes to update/upgrade facilities in need of mid-life retrofits or capital upgrades result in significant energy savings.

Reviews of the central steam plant in Fort Simpson led to the conversion of the aging inefficient high-pressure steam boiler system to a new low-pressure network. This included replacing the old high-pressure boiler and ancillary equipment with new low-pressure boilers. Significant savings as a result of this project were realized as overall plant efficiency was increased. In 2011, this conversion displaced approximately 56,000 litres of heating fuel oil, generating a savings of $64,600 and reduction in greenhouse gas emissions by 153 tonnes.

Facilities such as the GNWT's Central Warehouse (Yellowknife), North Slave Regional Office (Yellowknife) and the N'Dilo Gym were reviewed in Technical Status Evaluations to identify deficiencies in the buildings and to suggest ways to upgrade the facilities. This resulted in replacement of the existing central control systems in each of the buildings with direct digital controls (DDC).

In the calendar year of 2011, the Central Warehouse energy retrofit project resulted in 9,853 litres of fuel oil savings, equivalent to approximately $9,630 in savings to the GNWT and a GHG emission reduction of 27 tonnes.

ENR Warehouse – Yellowknife

Before

After

The North Slave Regional Office (PWS) energy retrofit displaced 9,882.27 litres of fuel oil in the 2011 calendar year. This reduction in fuel oil is equivalent to approximately $9,789 in savings and a GHG emission reduction of 27 tonnes.

The N`Dilo Gym energy retrofit displaced 7,853 litres of fuel oil in 2011. This is equivalent to approximately $7,789 in operational savings and a GHG emission reduction of 21 tonnes.

Capital Asset Retrofit Fund (CARF)

The Capital Asset Retrofit Fund (CARF) was established to upgrade existing GNWT buildings that are not energy efficient. The program assists the government in reducing building operating costs and greenhouse gas emissions in the Northwest Territories. Without retrofits, these assets could continue to deteriorate, increasing operation and maintenance costs and shortening their overall service life.

Data collected through energy benchmarking, infrared thermal scanning, preliminary technical evaluations, energy consumption monitoring, mechanical and electrical system analyses, detailed energy audits, technical status evaluations, facility condition assessments and other on-site or background research is used to select optimum buildings for energy upgrades/retrofits. Upgrades/retrofits reduce energy consumption and greenhouse gas emissions as well as operational maintenance costs to GNWT assets.

In 2011-2012, many energy retrofit projects were completed to help improve building energy efficiency. Large projects included control upgrades in facilities such as Thebacha Campus (Fort Smith), Elizabeth MacKenzie School (Behchokǫ̀), and Moose Kerr School (Aklavik), ventilation upgrades to Deh Gah School (Fort Providence), Moose Kerr School (Aklavik) and the Stuart Hodgson Building (Yellowknife). Other activities improving energy efficiency included lighting upgrades to T-5 lighting in gyms and LED exit light installations, efficient plumbing fixture installations, motor replacements and building envelope upgrades.

Pre-Audit Study

PWS gathers utility information from numerous buildings to assess and compare building energy and cost intensities. This benchmarking allows PWS to compare similar buildings such as schools, health facilities, and commercial spaces to determine which buildings have a larger than average energy intensity. Energy usage statistics such as total energy intensity in kWh/m^2, utility cost intensity in \$/m^2, energy intensity normalized by degree days (kWh/1000 HDD/m^2) and the total cost of utilities (fuel oil, propane, natural gas, electricity, etc.) help PWS identify candidates for energy audits and/or upgrades. As shown in figure 4. Buildings with high energy intensities and utility costs are prime targets for energy retrofits as they offer the greatest opportunity for energy savings, cost savings and overall greenhouse gas emission reductions.

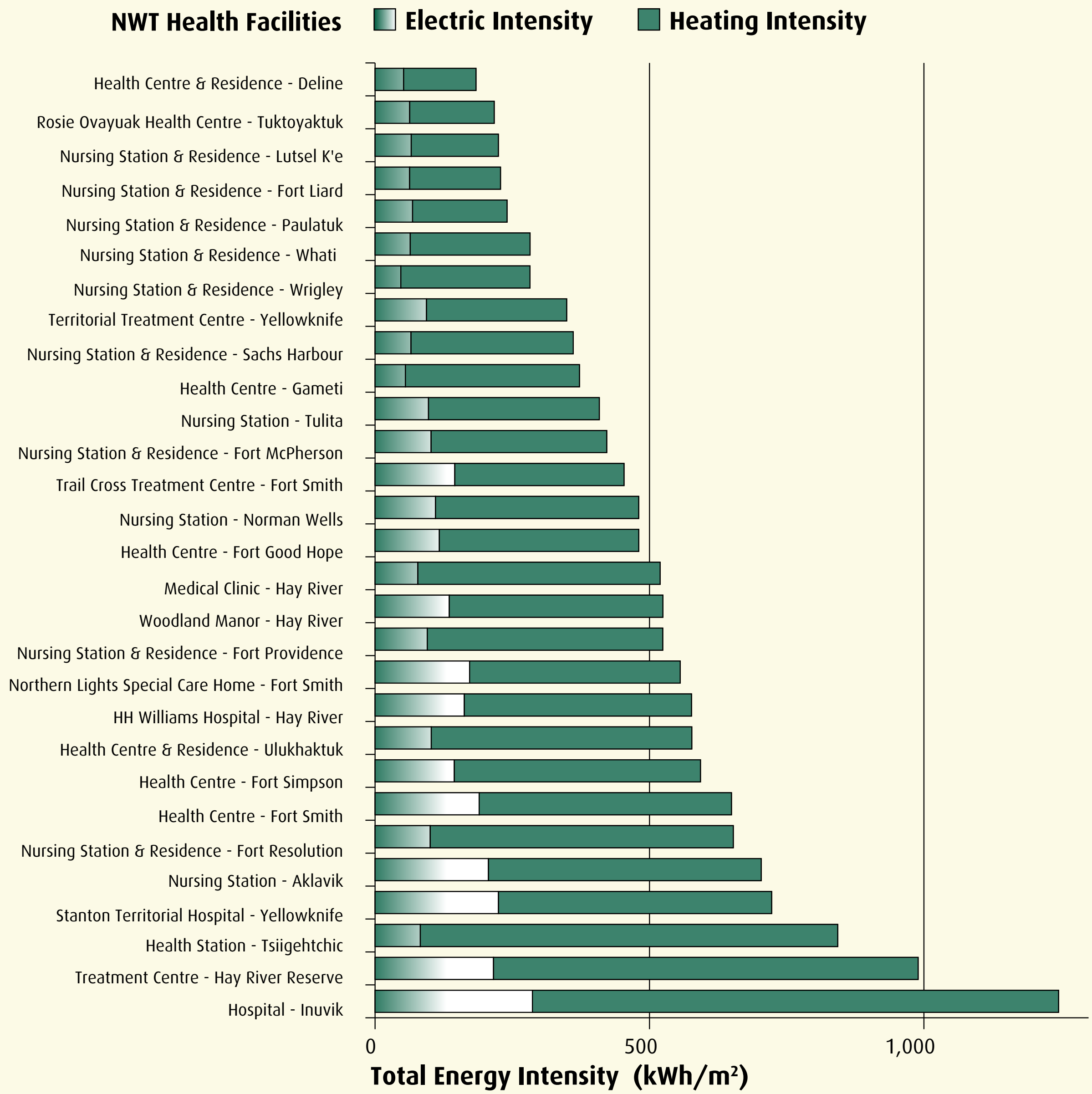
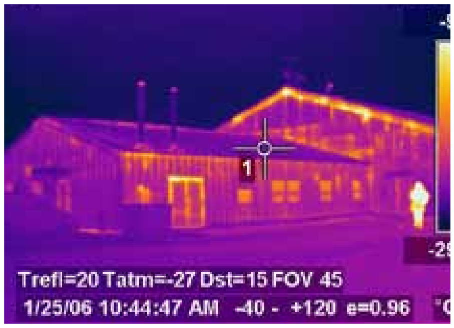


Figure 4: 2006/07
Heating and Electricity Cost Indices of GNWT Health Care Facilities

PWS has completed energy benchmarking studies on large schools, health facilities and office buildings of sizes greater than 250 m^2. The large schools benchmark was completed for the 2006-2007 fiscal year and included 35 schools in 20 communities. The health facilities benchmark was completed in 2007-2008 and included 29 buildings in 26 different communities. A further seventeen Office buildings greater than 250 m^2 were benchmarked in the 2010-2011 fiscal year.



Thermal Analysis

Public Works and Services conducts site visits to perform thermal imaging on buildings identified by a pre-assessment for their high energy intensity. Thermal images help to assess the condition of a building's envelope and can immediately identify energy saving opportunities. In addition, thermal scanning of a building can identify issues such as glycol leaks in radiant floor slabs, pinpoint poor electrical connections, and find leaks in roof and wall assemblies.

Since the implementation of thermal scanning in 2006, over 410 GNWT and municipal buildings have been scanned in the communities of Hay River Reserve, Buffalo River, Dory Point, Kakisa, Enterprise, Fort Providence, Fort McPherson, Tsiigehtchic, Tuktoyaktuk, Fort Resolution, Tulita, Deline, Fort Good Hope, N'Dilo, Behchokǫ̀, Norman Wells, Fort Smith, Inuvik, Aklavik, Paulatuk, Sachs Harbour, Fort Simpson and the Yellowknife regions. A breakdown of building scanned by region is given in figure 5.

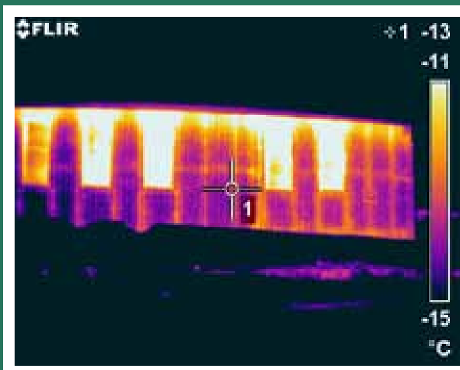
In conjunction with thermal scanning, PWS also conducted 250 building mechanical and electrical system surveys. These surveys identified out of date mechanical and electrical systems based on PWS building guidelines, and helped identify the required retrofitting measures.

Case Study 2
ENR Office Envelope Upgrade, Fort Simpson

Original Thermal Scan of Fort Simpson Office shows lots of heat loss from thermal bridging and fenestrations.

Based on a previous thermal scan analysis of the ENR Office Building in Fort Simpson, it was determined that the building would benefit from an envelope upgrade. In 2011-2012, the Capital Asset Retrofit Fund assisted with funding an envelope upgrade as part of a major renovation project at the ENR Office. Pre-sized Modular Neopor thermal insulation was used to increase the building's envelope insulation. As the figures show, the heat loss from the envelope has been effectively reduced.

A thermal scan following the envelope upgrade shows no thermal bridging and low levels of heat loss at window penetrations.



Before

After

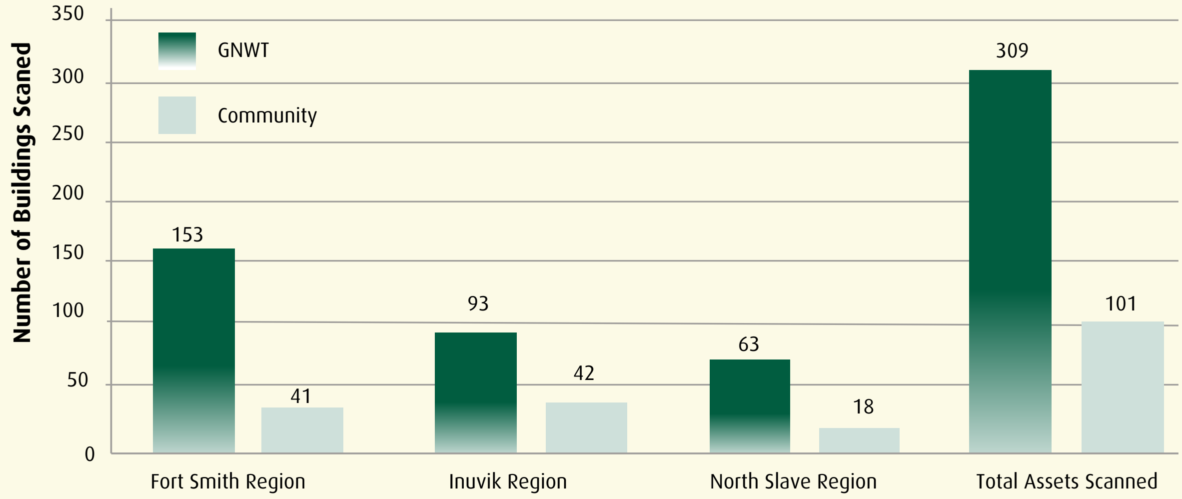


Figure 5: Infrared Thermal Scanning Surveys Completed to March 31, 2012

Detailed Energy Audits

Detailed energy audits are conducted on buildings that have been identified by PWS as high energy users, compared to others. Deliverables from an energy audit include a complete building and system description, a comparison of historical energy usage with weather data, an outline of energy usages by type (i.e., lighting, space heating, domestic hot water, etc.) identification of potential energy saving measures and operating benefits, cost estimates and returns on investments, and forecast modelling of energy usage with implemented energy saving measures.

PWS has completed 48 energy audits on GNWT buildings. Audits have been completed in a number of communities such as: Aklavik, Buffalo River, Deline, Enterprise, Fort Good Hope, Fort McPherson, Fort Providence, Fort Simpson, Hay River, Hay River Reserve, Inuvik, Lutsel K'e, Nahanni Butte, Norman Wells, Paulatuk, Tsiigehtchic, and Tuktoyaktuk.

In 2011, PWS had three energy audits completed in Fort Simpson on the Thomas Simpson School, Bompas Hall and the Milton Building. Additionally, PWS completed in-house walkthrough audits on the Legislative Assembly Building and the Laing Building in Yellowknife.

Energy Retrofit Projects

Following a preliminary and detailed energy audit, Public Works and Services develops a full scope of work for an energy retrofit project. Energy saving measures are selected based on the recommendations from a detailed energy audit. Typically, energy retrofit projects are combined with operation and maintenance and deferred maintenance projects. Consolidating these projects based on location and a common scope of work helps reduce costs for project management and provides economies of scale for a best price option.

Typical energy saving measures that PWS would undertake as part of an energy retrofit include: the conversion of old magnetic ballast T12 fluorescent fixtures to electronic ballast T8 lighting, exit light conversion from incandescent to LED type, indoor incandescent lighting converted to compact fluorescents, outdoor incandescent lighting converted to high pressure sodium (and, recently, LED lights), installation of occupancy sensors for lighting operation, variable frequency drive installations on air handling units and pumps, replacement of large electric water heaters with propane or oil fired instantaneous water heaters in diesel communities, refining run schedules on domestic hot water pumps and air handling units, re-balancing of AHUs, installation of controllers on large boilers, addition of heat recovery on air handling units, installation of building automation systems (BAS), efficient plumbing fixture installations, and building envelope upgrades such as the replacement of windows and doors, siding and roof repair, re-insulation in problem areas.

After the completion of energy retrofit projects, PWS monitors the utility information to track real savings of the energy retrofit. Real savings are then used in future years for energy retrofit projects, creating a self-perpetuating fund. These energy retrofit projects assist in reaching the goals set by the GNWT in the 2007 Energy Plan and the new 2011 Greenhouse Gas Strategy.

In 2011, completed CARF projects helped reduce energy usage by over 7,000 GJ (includes heating and electricity savings). Greenhouse gases were reduced by approximately 482 tonnes. Many facilities have shown significant energy reductions from energy retrofits. For example, prior to an energy retrofit at the Deh Gah School in Fort Providence, the total energy intensity averaged 413 kWh/m^2. After a boiler optimization and lighting retrofit project, total energy intensity in the school reduced to 294 kWh/m^2.

Moving Forward with CARF

In the past, CARF was directly funded by the Energy Priorities Investment (EPI) Plan. This framework was created to help address the goals of the Northwest Territories Energy Plan to reduce the use of imported heating fuel, mitigate environmental impacts and reduce the cost of living in the NWT. CARF funding has enabled PWS to complete many energy retrofits in the last three years. Actual savings from biomass, CARF, electric heat and miscellaneous projects are now used to fund future year energy retrofit projects.

In 2011-2012, PWS is looking at retrofits in the Helen Kalvak School (Ulukhaktok), Chief Jimmy Bruneau School (Behchokǫ̀) and the Prince of Wales Northern Heritage Centre (Museum). The two schools involve building automation and ventilation upgrades and the Museum will be looking at a total retrofit of their incandescent display lights to LED.

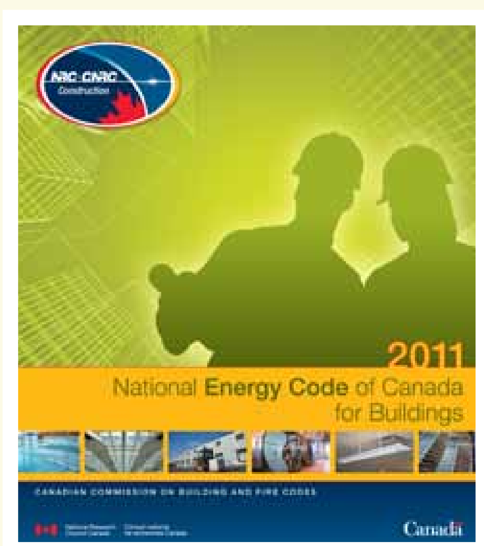
Initiatives in Energy Efficient Design and Construction

PWS is involved in many areas of energy efficient design and construction. From national code development to commissioning of northern facilities, many of the day to day activities and mandates of PWS have a direct impact on the use of energy and how buildings are designed and constructed in the North.

National Code Development

PWS's technical staff continues to participate in national energy-related code development committees. PWS has one representative on the Canadian Commission on Building and Fire Codes, one on the Building Energy Codes Collaborative, and one on the National Energy Code for Buildings (NECB) Committee who provided technical input, with a northern perspective, for the development of the 2011 edition. PWS staff will continue to sit on these committees for the next code cycle (2014). PWS is also involved in the Public Infrastructure Engineering Vulnerability Committee (PIEVC), which studies the impact of climate change on northern engineered infrastructure, and with the Building Technology Transfer Forum (BTTF), which meets to share new technology information across many jurisdictions.

The original Model National Energy Code for Buildings (MNECB) was released in 1997, and has since been replaced in 2011, by the National Energy Code for Buildings (NECB 2011). It is used as a guideline for design and construction with prescriptive and performance paths which help a facility meet energy performance targets. The 2011 edition of the NECB has raised the energy performance for commercial buildings by approximately 25% when compared to the original MNECB.

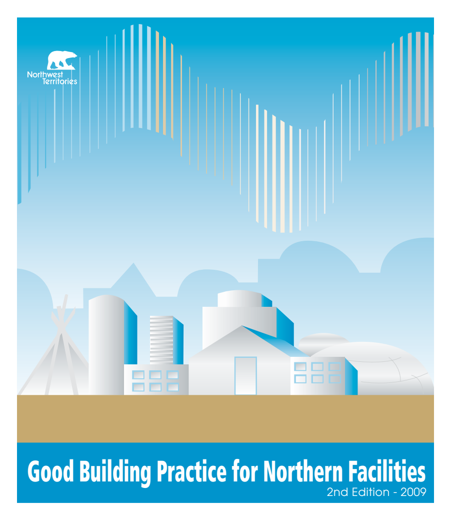


Energy Modelling

PWS requires that the design for all large facilities follow a review process, which, in part, requires an energy modelling workshop. This energy modelling workshop brings energy modellers, designers, PWS technical staff and the end user together to discuss the intended use of the building and how it can be constructed to perform as efficiently as possible, while still meeting all functional requirements of the end users.

In the past, designs were required to meet the requirements of the Eco-Energy Validation Program for energy usage. In general, this meant that facility designs needed to perform, at a minimum, 25% better than a comparable base building designed to MNECB standards. The Eco-Energy Validation Program was discontinued in March 2011 but PWS continues to conduct energy modelling on large projects with the intentions to meet exceed by 10%, the performance criteria of the new NECB.

Typical items that are modelled include various types of insulation, its thickness, heating systems (high temperature, low temperature), boiler plant options (condensing boilers, biomass, geothermal), window glazings, control strategies and a number of other items that all have an effect on the performance of the building. Each individual measure is modelled to determine savings and the impact on up-front capital costs are analyzed. The outcome of the energy modelling workshop assists the designers, PWS technical staff and end users in selecting a design that optimizes both energy performance and capital costs.



Good Building Practice for Northern Facilities (GBP)

The Second Edition of "Good Building Practice for Northern Facilities" (GBP) was published in May 2009, and is posted on the PWS website. An updated 2011 version is now available electronically. This guideline is a best practice guide to designing and constructing efficient and reliable buildings in the North. A building designed using the GBP guidelines will meet the energy performance standards of the old Eco-Energy Validation Program, meaning that it will perform at minimum, 25% better than a comparable MNECB base building.

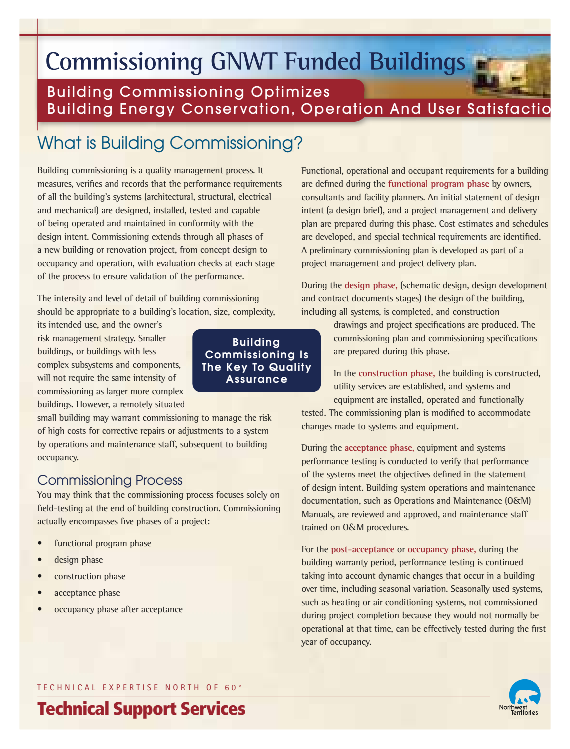
With the release of the new NECB, a recent energy modelling study was completed on a newly constructed school to compare the energy performance of the school, which was adhering to GBP guidelines, to the new NECB targets. The results of this exercise showed that a facility built with the GBP guidelines will perform approximately 10% better than a similar type of building based on the new NECB.

Since the publishing of the original GBP content, PWS has assisted with the design and construction of a number of buildings that have been designed and constructed according to the "Good Building Practice for Northern Facilities". Additionally, there are a number of facilities which are currently in design or under construction that utilized the GBP guidelines, they include: the new Inuvik Schools building - Inuvik, the Diamond Jenness School renovation – Hay River, the Health Centre renovation – Fort Smith, the New GNWT Office Building – Yellowknife, the new Long Term Care Facilities – Behchokǫ̀ and Norman Wells, and the new Health Centres in Norman Wells, Hay River and Fort Providence.

All new and renovated GNWT buildings incorporate the GBP guidelines during their design and construction. PWS has an active role in ensuring that all designers and contractors follow these guidelines by reviewing design submissions at various stages of completion, by conducting site walkthroughs, and follow-up visits during construction and commissioning of new facilities.

Performance Verification & Commissioning

The performance verification and commissioning process ensures that the GNWT is provided with a building which meets all design requirements and operates as intended. This ensures a code-compliant, healthy, and comfortable environment for occupants and a building that operates at peak efficiency to reduce energy consumption, operating costs, and greenhouse gas emissions. When building systems function as designed, and O&M staff are well prepared to operate and maintain the buildings, long lasting efficiency is achieved.



Commissioning GNWT Funded Buildings

Building Commissioning Optimizes Building Energy Conservation, Operation And User Satisfactio

What is Building Commissioning?

Building commissioning is a quality management process. It measures, verifies and records that the performance requirements of all the building's systems (architectural, structural, electrical and mechanical) are designed, installed, tested and capable of being operated and maintained in conformity with the design intent. Commissioning extends through all phases of a new building or renovation project, from concept design to occupancy and operation, with evaluation checks at each stage of the process to ensure validation of the performance.

The intensity and level of detail of building commissioning should be appropriate to a building's location, size, complexity, its intended use, and the owner's risk management strategy. Smaller buildings, or buildings with less complex subsystems and components, will not require the same intensity of commissioning as larger more complex buildings. However, a remotely situated small building may warrant commissioning to manage the risk of high costs for corrective repairs or adjustments to a system by operations and maintenance staff, subsequent to building occupancy.

Building Commissioning Is The Key To Quality Assurance

Commissioning Process

You may think that the commissioning process focuses solely on field-testing at the end of building construction. Commissioning actually encompasses five phases of a project:

- functional program phase
- design phase
- construction phase
- acceptance phase
- occupancy phase after acceptance

Functional, operational and occupant requirements for a building are defined during the functional program phase by owners, consultants and facility planners. An initial statement of design intent (a design brief), and a project management and delivery plan are prepared during this phase. Cost estimates and schedules are developed, and special technical requirements are identified. A preliminary commissioning plan is developed as part of a project management and project delivery plan.

During the design phase, (schematic design, design development and contract documents stages) the design of the building, including all systems, is completed, and construction drawings and project specifications are produced. The commissioning plan and commissioning specifications are prepared during this phase.

In the construction phase, the building is constructed, utility services are established, and systems and equipment are installed, operated and functionally tested. The commissioning plan is modified to accommodate changes made to systems and equipment.

During the acceptance phase, equipment and systems performance testing is conducted to verify that performance of the systems meet the objectives defined in the statement of design intent. Building system operations and maintenance documentation, such as Operations and Maintenance (O&M) Manuals, are reviewed and approved, and maintenance staff trained on O&M procedures.

For the post-acceptance or occupancy phase, during the building warranty period, performance testing is continued taking into account dynamic changes that occur in a building over time, including seasonal variation. Seasonally used systems, such as heating or air conditioning systems, not commissioned during project completion because they would not normally be operational at that time, can be effectively tested during the first year of occupancy.

TECHNICAL EXPERTISE NORTH OF 60°

Technical Support Services

Northwest Territories

PWS's Technical Services and Support (TSS) staff are occasionally used as a "third party" commissioning agent. TSS staff complete functional performance checks to ensure that all equipment is installed and operates in accordance with original design documents. In the 2012-2013 fiscal year, PWS will be involved with the commissioning of the new Inuvik Schools building, the Diamond Jenness School Renovations, the MacKenzie Mountain School retrofit, the Inuvik Hospital Retrofit, the Elizabeth MacKenzie Wood Pellet Boiler, the Water Treatment Plants in Lutsel K'e, Jean Marie River, Wrigley and Fort Good Hope, the Chief Sunrise School Upgrades (Hay River Reserve) and a 19-unit NWT Housing Corporation apartment complex in Yellowknife.

Case Study 3
Active commissioning at Diamond Jenness Secondary School

Throughout the 2011-2012 fiscal year, an ongoing mid-life retrofit of the Diamond Jenness Secondary School in Hay River was underway. As part of this retrofit, the building was to receive a new envelope. PWS technical staff provided commissioning review on the architectural and structural portions of the building renovation which included thermal insulation, air-vapour barrier upgrading, and replacements of windows and doors with ones that conform to current energy efficiency standards. Particular attention was paid to the continuity of the new wall systems air vapour barrier at connections to the foundation, the roof at the parapet and to the new windows and doors.

At the beginning of the exterior retrofit installation, a prototype of the finished product was completed on the North face of the West wing. This mock-up was inspected by the commissioning team and accepted as the standard for acceptance for the exterior wall retrofit of the entire building. This upfront commissioning ensures quality and performance of the exterior retrofit. Owner, contractor and commissioning agent are clear on expectations for this work, and potential issues with the installation are caught early on to avoid time delays and re-working.

When the entire building envelope has been retrofitted, a thermographic survey of the envelope with building interior air pressure of 35 pascals and a temperature difference across the envelope of at least 30°C will be performed to examine the air-tightness and thermal resistance performance of the retrofitted exterior wall. The portions of the retrofitted building envelope will be compared to the thermal and air-vapour barrier performance of the initially commissioned prototype portion of the envelope comprising the "West Wing" portion of the school.

Contractors have removed the existing "skin" of the building and are beginning to apply the spray foam to the prototype section of the school.

Prototype section of the building has been spray foamed and strapped, exterior cladding is being applied.

Particular attention was paid to how the new envelope was constructed at corners and fenestrations and how connections were made at parapets and footings.

Consolidation of Utilities

In 2010–2011, the responsibility for utility payments for all GNWT assets was transferred to PWS. Certain assets were not included such as YK No. 1 & Catholic School Board schools, Territorial Parks, the Legislative Assembly Building, etc.

In 2011-2012, as shown in figure 6, PWS-managed assets had utility expenditures of $26,625,808. Of this total, electricity consumption made up a large portion of this utility expenditure costing the GNWT approximately $13,966,000 (53% of total utility expenditures). Heating fuel oil is the primary source for heating in the NWT, and accounts for 24% of PWS utility expenditures, a total of $6,352,000.

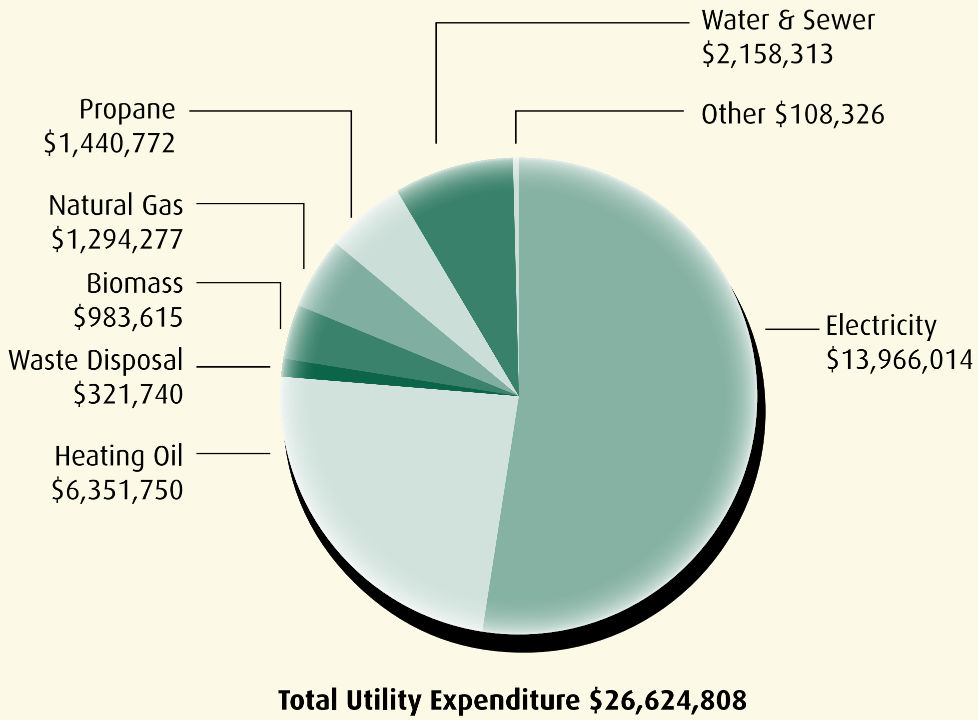


Figure 6: 2011/2012 PWS Utility Expenditures by Utility Type

Reduction of water and sewer usage is often overlooked as a way to reduce costs in a facility. In 2011-2012, water and sewer costs accounted for 8% ($2,158,000) of the total utility expenditures, making it the third most costly expenditure in the utilities budget. This is one reason why PWS uses efficient plumbing fixtures in design and retrofit projects.

Utility budgets are initially split into five regions, the North Slave Region, the Fort Smith Region, the Fort Simpson Region, the Sahtu Region and the Inuvik Region. 2011-2012 regional utility expenditures are displayed in Figure 7.

By making PWS responsible for utility payments, the GNWT can better track utility budgets, expenditures and consumption data in the GNWT's financial system.

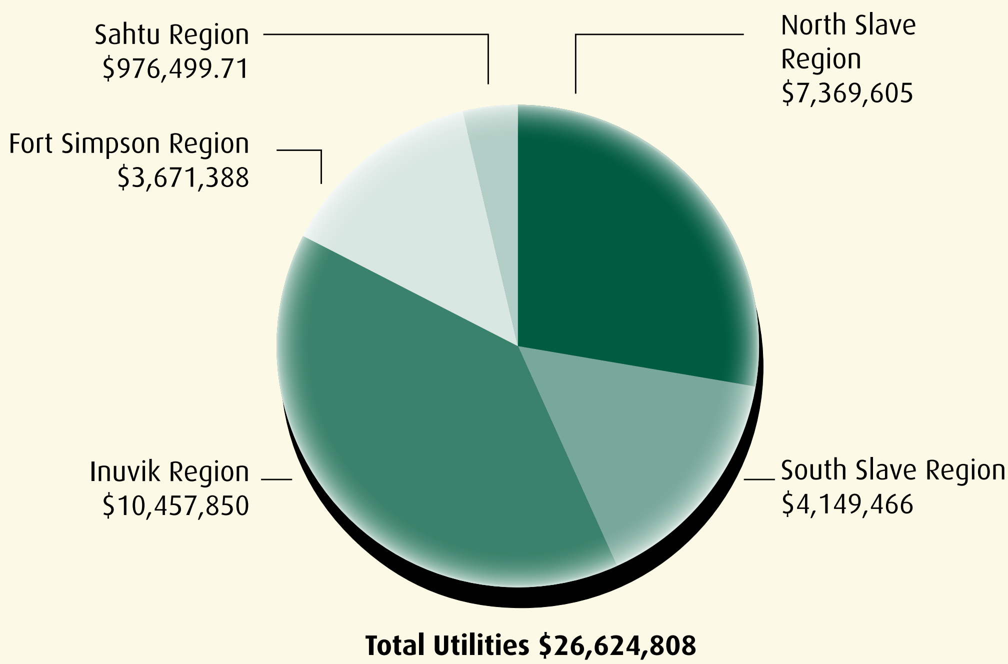


Figure 7: Shows Utility Expenditure Distribution by Region

Utilities tracking software also allows PWS to sort utility information by department. Figure 8 shows the respective utility expenditures for all the GNWT departments. Education, Culture and Employment shares the largest portion of utility expenditure in 2011-2012 with Health and Social Services being the second largest – this is to be expected as these departments have the largest amount of floor space in the NWT.

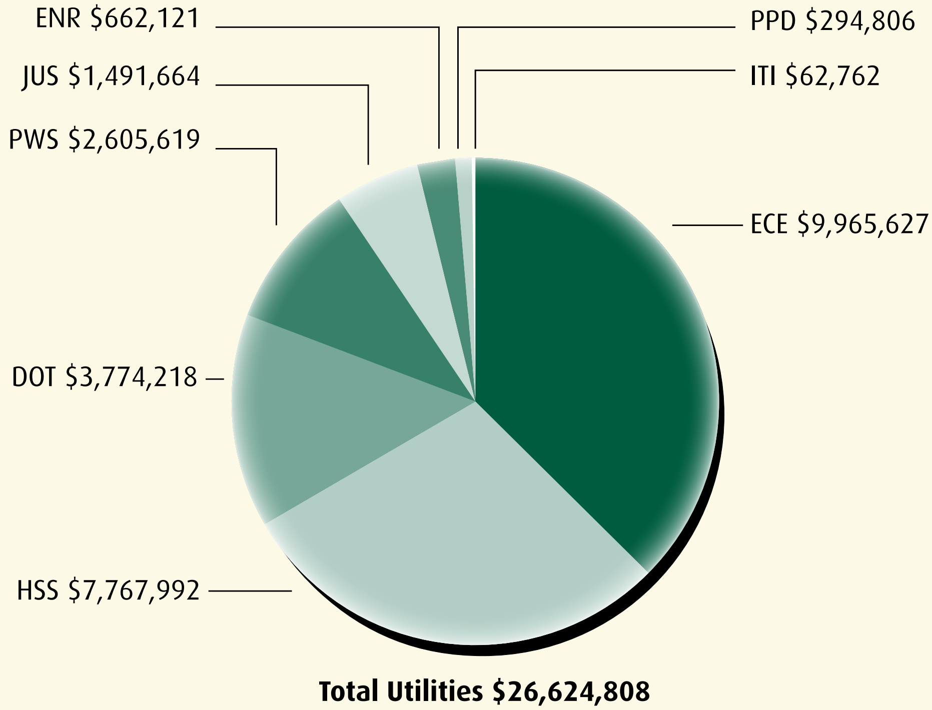


Figure 8: Shows Utility Expenditure Distribution by Program

Biomass installations in the NWT have significantly reduced the amount of imported heating fuel and propane utilized for space heating. As seen below in Figure 9, biomass heating accounted for 16% of the total heating load of PWS-managed assets in 2011-2012. Heating fuel oil still accounts for half of the fuel type utilized to heat PWS assets, but initiatives in alternative energy sources are making important steps towards further reducing the GNWT's dependency on imported heating fuel.

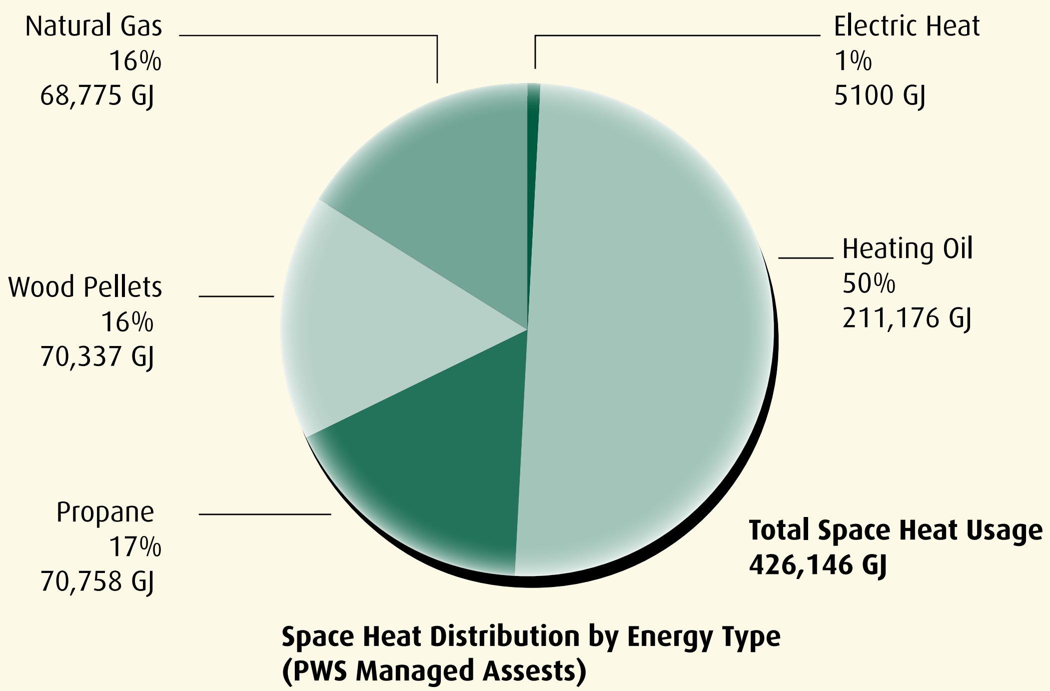


Figure 9: Space Heat Distribution by Energy Type (PWS Managed Assets)

Report Summary

GNWT energy-related projects have made a significant impact in reducing costs and greenhouse gas emissions in the last few years. Biomass boiler installations, energy retrofits, electric heat conversions and additional projects displaced the equivalent of 2,377,000 litres of fuel oil in 2011. As Figure 10 shows, PWS's energy related projects have saved a cumulative total of 6,220,419 litres of fuel oil since 2007. PWS is anticipating cumulative savings to reach approximately 9,221,057 litres by the end of 2012.

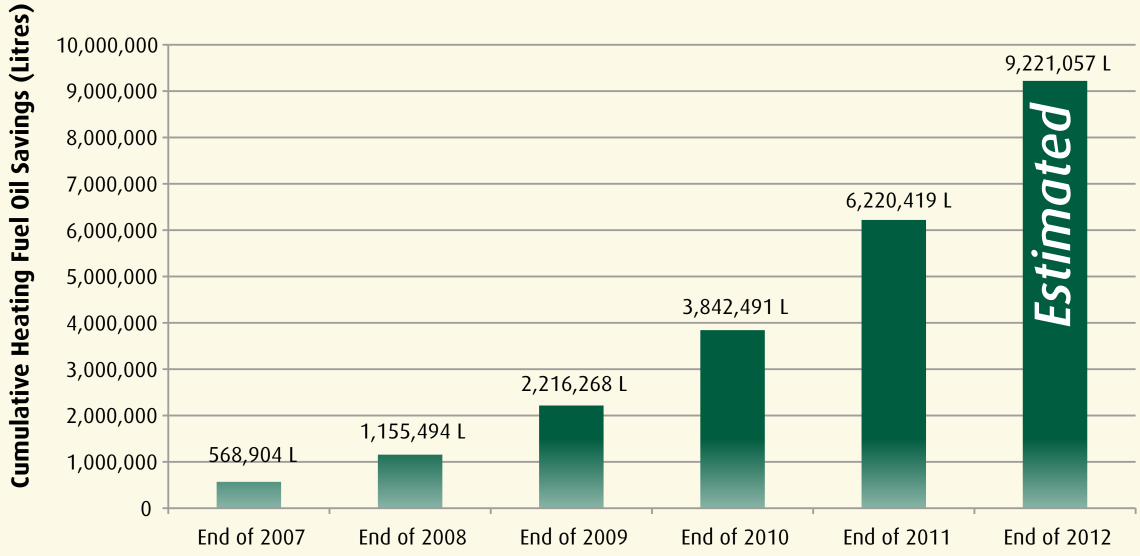


Figure 10: Actual and Estimated Cumulative Heating Fuel Displaced

Energy efficiency projects have greatly reduced the release of greenhouse gases into the atmosphere by GNWT facilities. In 2011, these projects reduced 6,491 tonnes of greenhouse gas emissions. The cumulative total of greenhouse gas emissions reduced since 2007 has totalled 16,963 tonnes. As shown in Figure 11, additional energy-related projects from 2011-12, should increase cumulative GHG savings over 25,000 tonnes by the end of 2012.

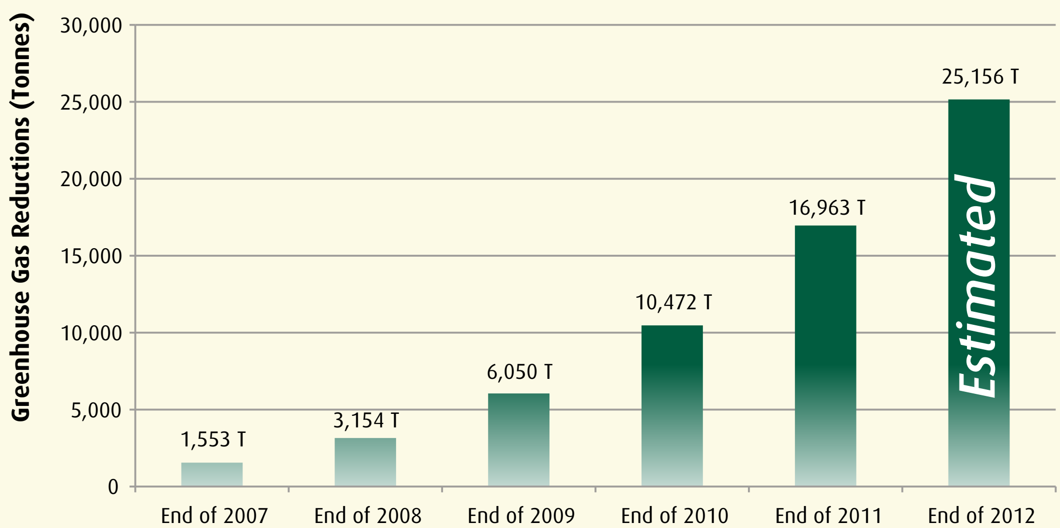


Figure 12: Actual and Estimated Cumulative Total Reduction in Greenhouse Gas Emissions

Emissions from Biomass Heating, Electric Heat and Energy Retrofits

GNWT energy efficiency projects have yielded significant energy savings. Table 2 below gives an idea of how the total energy cost intensities in facilities have been reduced from energy efficiency projects. The "Facility Cost Index Before" is a metric used to show how much electricity and heating fuel per m^2 would have cost in 2011 (if the project was never completed). Re-commissioning, energy retrofits, electric heat and biomass projects all help to reduce operational costs.

Table 2: Examples of Facility Cost Index Reductions from Energy Related Projects

Facility	Location	Project	Facility Cost Index Before* ($/m²)	Facility Cost Index After ($/m²)	Energy Cost Reduction (%)
Deh Gah School	Fort Providence	Boiler Optimization, Lighting Retrofit	$ 74.01	$ 47.42	36%
Inuvik Hospital	Inuvik	Re-commissioning	$ 192.76	$ 182.82	5%
JBT School	Fort Smith	Electric Boiler	$ 45.00	$ 16.04	64%
Breynat Hall	Fort Smith	Electric Boiler	$ 39.16	$ 16.34	58%
Chief Jimmy Bruneau	Behchokǫ̀	Biomass Boiler	$ 47.53	$ 33.88	29%
PWK School	Fort Smith	Biomass Boiler	$ 59.78	$ 42.41	29%
* Costs before use 2011 utility rates for electricity and heating fuel					

GNWT activities such as code reviews and development, energy modelling, energy retrofits, alternative/renewable energy projects, promotion of energy awareness, and commissioning, help the GNWT reach the goals set in the 2007 NWT Energy Plan and the 2011 NWT Greenhouse Gas Strategy. These activities help to reduce the GNWT's operational costs and imported heating fuel oil usage by reducing facility energy usage, utilizing cheaper fuel sources such as biomass and electric heat and reducing maintenance costs by designing and constructing better buildings in the North. All these activities mitigate the GNWT's impact on climate change by reducing greenhouse gas emissions.

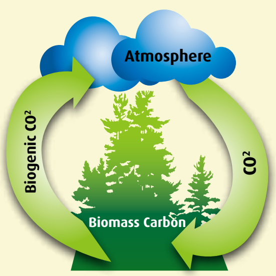
End

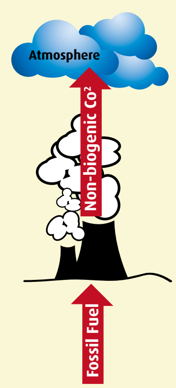
Biomass Heating Systems
in Northwest Territories Government Buildings

A Brief History

The first wood pellet boilers for a Territorial Government building were installed at the North Slave Correctional Centre in 2006. A private company owns and installed the boiler, and sells heat to the Government of the NWT (GNWT). Thanks to the success of that project, the GNWT is now investing in its own wood pellet boilers for other facilities, where economically viable.

Since the cost to transport wood pellets is higher than that of other fuels, the most viable locations for wood pellet boilers are those closest to the source of wood pellets. Currently, these sources are in Northern Alberta and British Columbia. As the Pellet industry continues to grow the GNWT will continue to look for biomass heating opportunities throughout the Northwest Territories.





Carbon Neutral?

By international greenhouse gas accounting protocols, the burning of biomass is considered carbon neutral and sustainable when forest management practices are employed. Carbon dioxide produced by the burning of wood pellets is offset by the carbon dioxide consumed by the trees throughout their life cycle. In this way the carbon cycle is "balanced" and there is no net increase in carbon dioxide production. By comparison, the burning of fossil fuels such as oil or natural gas releases carbon dioxide which was captured underground millions of years ago. It is because of this that the use of fossil fuels is considered a one-way release of carbon dioxide.

Maintenance of Biomass Boilers

Biomass boilers are relatively new in the NWT but the technology itself is not. In Europe, the number of successful commercial biomass systems installed is in the thousands. Improvements in biomass technology have made biomass boilers more efficient, easier to operate and much less labour intensive to maintain.

Maintenance on installed wood pellet boilers is always an item for discussion. Wood pellet boilers do require additional maintenance when compared to a typical oil or gas boiler. Cleaning intervals vary depending on the type of biomass that is consumed (pellets, chips, hog fuel, etc.). The GNWT burns a premium wood pellet in its biomass boilers which burns more efficiently, producing less ash by weight. This results in a reduction in the frequency of ash removal and boiler cleaning.

Proper commissioning and training helps to set up boiler controls and ensures that maintenance staff are familiar with the equipment and comfortable for the O&M requirements. Training, commissioning and regularly followed maintenance schedules promote the smooth operation of the boiler and maintain efficiency, increasing operational savings.

BEHCHOKǪ̀

Chief Jimmy Bruneau School
Boiler Type: KOB, 750 kW
Silo Capacity: 100 Tonnes
Status: Active since October 2009
Anticipated Savings: 155,000 L of fuel oil

Elizabeth Mackenzie Elementary School
Boiler Type: KOB, 300 kW
Silo Capacity: 50 Tonnes
Status: In Construction (2011)
Anticipated Savings: 78,700 L of fuel oil

YELLOWKNIFE

North Slave Correctional Facility
Boiler Type: 2 x Binder Underfed Style, 750 kW
Silo Capacity: 80 Tonnes
Status: Active since November 2006
Anticipated Savings: 587,000 L of fuel oil

Sir John Franklin High School
Boiler Type: Binder Underfed Style, 750 kW
Silo Capacity: 40 Tonnes
Status: Active since February 2008
Anticipated Savings: 212,454 L of fuel oil

K'alemi Dene School
Boiler Type: Bosch, 3 x 23 kW (Residential)
Silo Capacity: 15 Tonnes
Status: Active since September 2009
Anticipated Savings: 30,000 L of fuel oil

Ecole St. Joseph School
Boiler Type: KOB, 540 kW
Silo Capacity: 50 Tonnes
Status: Active since November 2009
Anticipated Savings: 102,770 L of fuel oil

Legislative Assembly Building
Boiler Type: Binder Step Grate Style, 300 kW
Silo Capacity: 40 Tonnes
Status: Commissioned in October 2010
Anticipated Savings: 82,800 L of fuel oil

Combined Services Building
Boiler Type: KOB, 500 kW
Silo Capacity: 50 Tonnes
Status: In Construction (2011)
Anticipated Savings: 256,000 L of fuel oil (equivalent)

FORT SMITH

P.W. Kaeser High School
Boiler Type: KOB Pyrotec, 750 kW
Silo Capacity: 50 Tonnes
Status: Commissioned in October 2010
Anticipated Savings: 200,000 L of fuel oil

Thebacha College
Boiler Type: KOB Pyrotec, 750 kW
Silo Capacity: 50 Tonnes
Status: Commissioned in October 2010
Anticipated Savings: 200,000 L of fuel oil

Fort Smith Health Centre
Boiler Type: KOB Pyrotec, 750 kW
Silo Capacity: 50 Tonnes
Status: In Construction (2011)
Anticipated Savings: 200,000 L of fuel oil

FORT SIMPSON

Central Heating Plant, Fort Simpson
Boiler Type: Combustion Expert Inc., 800 kW (steam)
Silo Capacity: 60 Tonnes
Status: In Construction (2011)
Anticipated Savings: 356,000 L of fuel oil

FORT PROVIDENCE

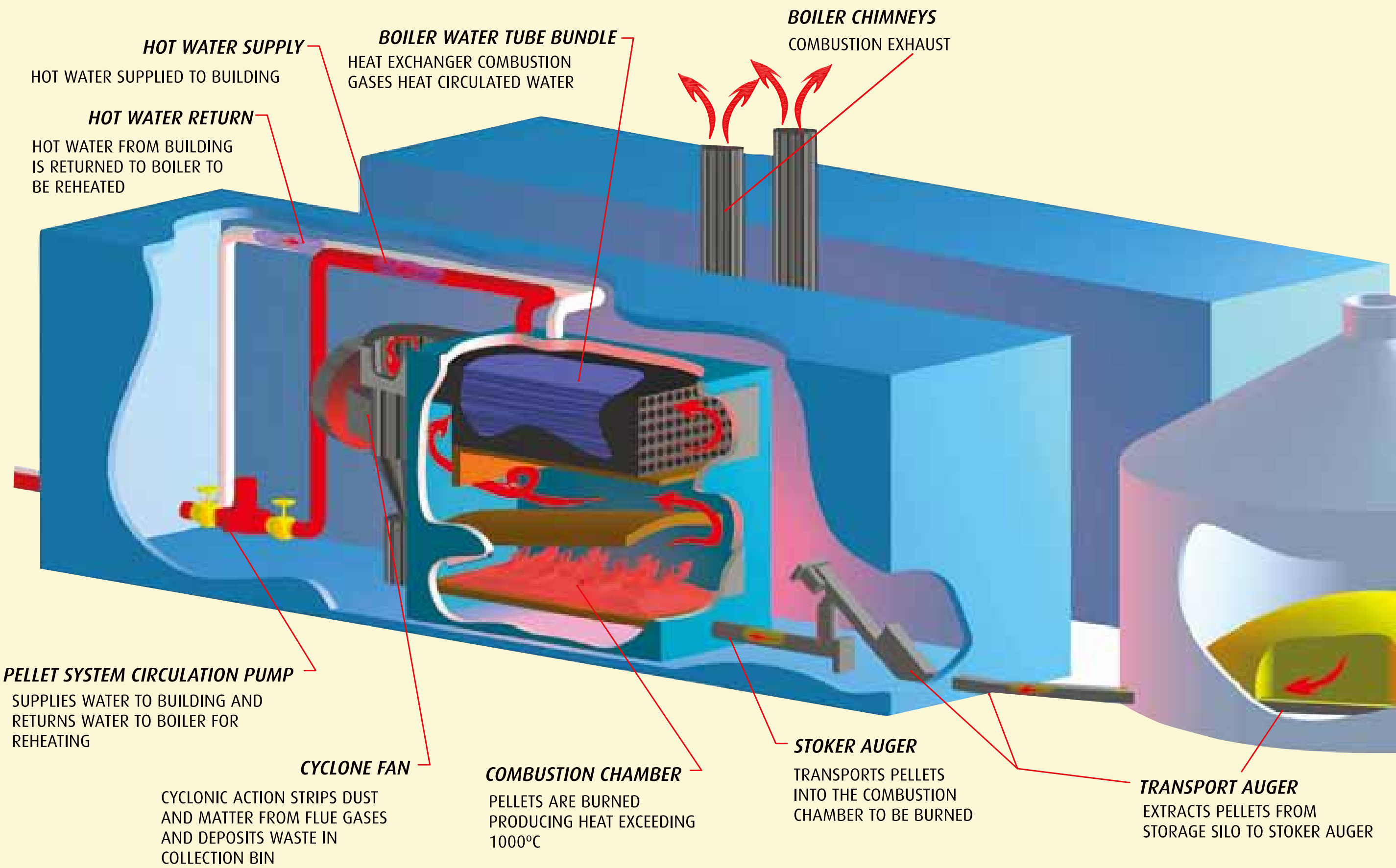
Deh Gah School, Fort Providence
Boiler Type: TBD (300 kW)
Silo Capacity: TBD
Status: In Design Study
Anticipated Savings: 98,000 L of fuel oil

HAY RIVER

Highways Maintenance Garage
Boiler Type: KOB Pyrot, 300 kW
Silo Capacity: 50 Tonnes
Status: Commissioned in October 2010
Anticipated Savings: 100,000 L of fuel oil

Central Heating Plant for Hay River Schools
Boiler Type: KOB Pyrotec, 1 MW
Silo Capacity: 50 Tonnes
Status: Commissioned in November 2010
Anticipated Savings: 318,340 L of fuel oil

Biomass Heating Systems
in Northwest Territories Government Buildings



Things to Consider When Selecting a Biomass Heating System

- Undertake a preliminary feasibility study to determine whether the wood pellet heating will be cost effective. This study will include the preliminary analysis of specific data such as building heating load, building size and location, cost of wood pellets, cost and availability of back-up heating fuel and electricity, initial investment required, return on investment, rate of cost escalation for wood pellets, back-up fuel and electricity, amount of heating fuel displaced, reduction in greenhouse gas emissions, project delivery options (buy biomass heating system or buy heat), etc.
- Ensure the size of the boiler system will suit your requirements. Recommend sizing wood pellet boiler to meet 50% of peak load. This will meet building heating requirements for approximately 90% of the year.
- Since the materials in the hot sections of the boiler are exposed to severe stress, check the quality and temperature limits of the refractory lining, the wall thickness, and serviceability of parts.
- Boilers must be approved by the Canadian Standard Association (CSA) and must meet the GNWT regulatory requirements.
- Learn about the air quality permitting requirements in the area and work with air quality regulators (i.e., ENR) to determine whether any special design features would be required, i.e., Cyclone System.

Pellet Boiler Operation

There are many models and styles of biomass boilers. The GNWT has been involved with the installation many styles of wood pellet boilers. Different boiler manufacturers have benefits and draw backs but essentially operate in the same manner.

Start-up

A pre-set amount of pellets is augured into the fire box for initial fire. An electric heat gun heats the pellets until combustion occurs.

Heat Up

When combustion is detected, the boiler heats up to achieve optimal internal temperatures for the most efficient burn.

Normal Mode

The feed auger pulses and feeds the firebox with pellets based on demand. Actual boiler output is controlled by the amount of air injected into the firebox. More air for combustion results in higher heat output from the boiler.

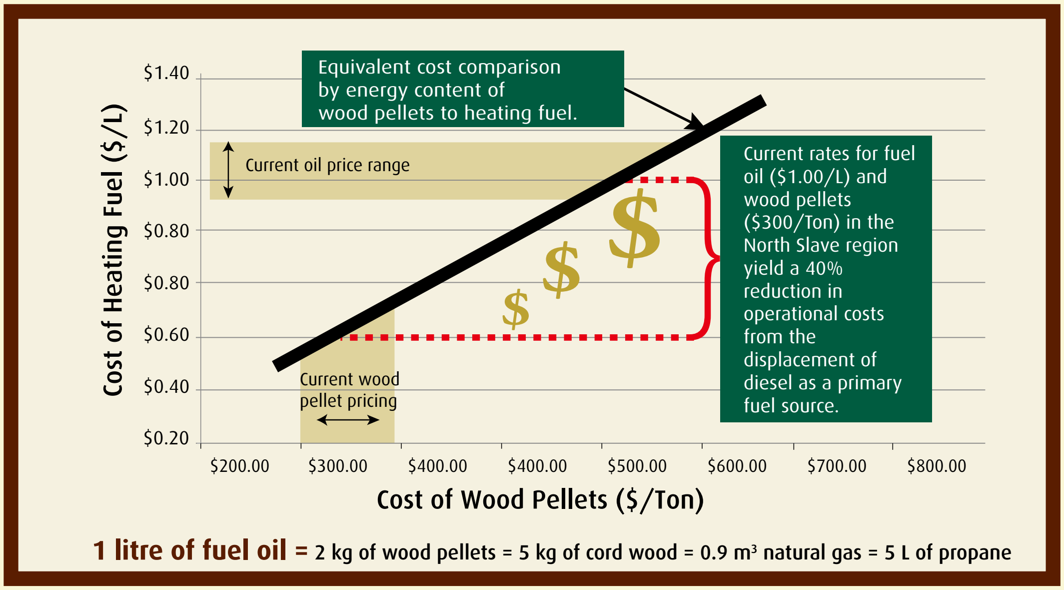
Stand by

The boilers will typically try to maintain a fire in a "stand-by" mode when there is no demand on the boiler. In this mode, if a demand arises, the boiler can quickly ramp up to supply heat as required.

Shut Down

When it is determined that the boiler is not required to run the supply air fan stops, the supply of pellets from the storage hopper stops, remaining pellets in the feed auger are pushed into the fire box. The draft fan is left running to keep the firebox in negative pressure and the remaining pellets are left to burn down.

PELLET SILO
STORAGE FOR PELLETS KEEPING THEM OUT OF THE ELEMENTS



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