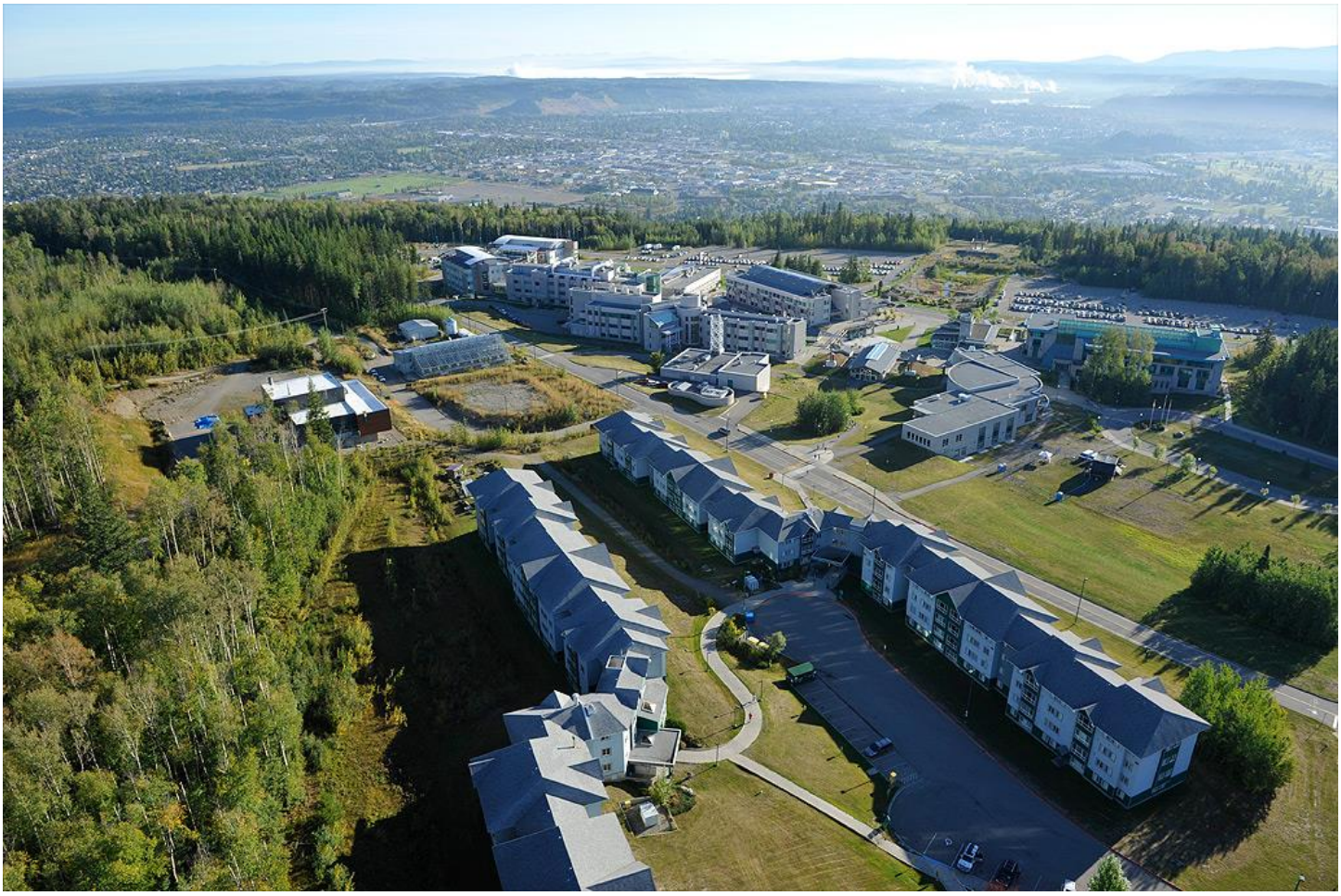
UNBC UNIVERSITY OF NORTHERN BRITISH COLUMBIA

BC Hydro Power smart

FY2022 Strategic Energy Management Plan



November 30, 2021

Senior Management Support: _____

Rahim Somani, Vice-President, Finance and Administration

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1. OVERVIEW

As Canada's Green University™, the University of Northern British Columbia (UNBC) is committed to minimizing its environmental impact and operating costs by reducing energy consumption through energy efficiency projects, student and staff engagement, and energy awareness campaigns. Not only are we bound to this through social responsibility, but from a strategic priorities standpoint:

> ***Ensure financial accountability, sustainability, and operational effectiveness.***
>
> - UNBC Strategic Road Map, 2018

The cornerstone of UNBC's energy management program is renewable and efficient energy systems that are of particular interest to northern and remote communities. Through the expansion of an award-winning bioenergy system, and the ongoing efforts of the Energy Management (EM) team, UNBC has achieved a 45% reduction in electricity use, a 39% reduction in natural gas consumption (and greenhouse gas emissions), and a 38% reduction in utility costs compared to 2010 baseline levels. When compared to FY2020, natural gas consumption in FY2021 has decreased by 19%. This is as a result of increased operation of the Bioenergy Plant after significant maintenance downtime in FY2020.

The EM program at UNBC has been strongly supported by BC Hydro for the past 12 years. They currently provide 50% of the funding for a dedicated Energy Manager, as well as incentives to implement energy efficiency and conservation projects. BC Hydro has contributed over $1.54 million to UNBC's EM program, which has facilitated numerous projects that have helped to save roughly $4.1 million in electricity costs. This year, UNBC intends to claim at least 500,000 kWh towards their BC Hydro Energy Manager target. Alongside the projects, we will continue to engage the UNBC community through the Energy Wise Network to maximize conservation and awareness efforts.

In addition to the BC Hydro targets, UNBC previously outlined long-term energy reduction targets: a 25% reduction in energy use and an 85% reduction in natural gas use by 2020 (compared to 2010 levels). These targets are in the process of being updated as part of a broader renewal of the University's Energy Policy and long term GHG reduction planning. As of March 31st 2021, UNBC saw a 26% reduction in energy use and a 39% reduction in natural gas use compared to 2010. While the previous energy reduction target was met, there was higher use of natural gas than targeted. This was due to maintenance related downtime for the Bioenergy Plant in FY2021. However, natural gas consumption was lower than in FY2020 as a result of gradually increasing use of the Bioenergy Plant, and this is expected to continue as the Bioenergy Plant is returned to more stable operation.

Through the EM program, and the switch from fossil fuels to bioenergy, UNBC has avoided the purchase of roughly $6.9 million worth of energy since 2010. Add to that the over $2 million brought in through incentives and salary reimbursements, and UNBC's commitment to sustainable operations can be valued at over $8.9 million.

2. ENERGY MANAGEMENT AT UNBC

The energy management portfolio includes all facilities where UNBC has direct operational control. This enables changes to the operating procedures, equipment upgrades, and other capital expenditures. In total, the energy management scope covers 22 buildings over four sites: The Prince George Campus, Terrace Campus, the Wood Innovation Research Lab (WIRL) in downtown Prince George, and the Quesnel River Research Centre (QRRC). Of the 22 buildings, 16 are located at the Prince George Campus and account for 98% of the total energy consumption, and accommodates roughly 95% of the population.

2.1. ENERGY CONSUMPTION AND COST

UNBC uses a mix of different energy sources, primarily electricity, bioenergy, and natural gas. Diesel and propane represent less than 1% of the total UNBC energy consumption and cost. Fuel for vehicles and mobile equipment is not included within the scope of the energy management program. Table 1 lists the actual consumption and cost for each utility based on invoiced amounts.

Table 1 – FY2021 Utility Breakdown

	Annual Consumption		Annual Consumption		Annual Cost
Electricity	10,663,875	kWh	10,663,875	kWh eq	$945,350
Bioenergy (Hog Fuel)	1,393	bdt	7,293,466	kWh eq	$118,651
Natural Gas	64,668	GJ	17,963,366	kWh eq	$603,732
Bioenergy (Pellets)	203	bdt	1,084,234	kWh eq	$5,845
Propane	5,342	L	37,841	kWh eq	$5,507
Total			37,042,782	kWh eq	$1,679,085

Figure 1 shows the breakdown of energy consumption from Table 1 for FY2021. Electricity accounted for 29% of total energy consumption, and heat generated from hog fuel (sawmill wood waste), natural gas, and wood pellets accounted for the remaining 71%. Of the heat, 48% was generated from natural gas, and 23% from bioenergy. The Prince George campus operates two bioenergy systems: a 4.4 MW Bioenergy Plant that uses hog fuel to make hot water for the main campus district heating loop; and a 0.4 MW Pellet Plant that uses wood pellets to produce low-temperature water for on-campus student housing and the Enhanced Forestry Lab (EFL). Natural gas is used to back-up the bioenergy systems on the Prince George campus, and to heat buildings not served by the district heating loops.

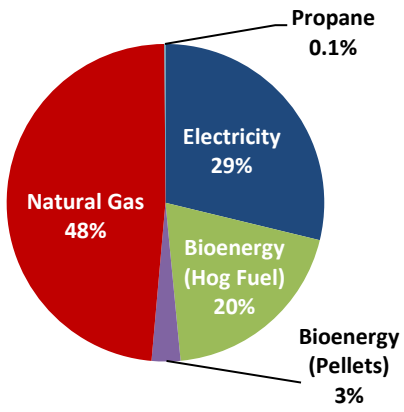

Figure 1 - Energy Use Breakdown

Although electricity accounted for only 29% of the energy consumption, it represented 56% of total energy costs, due to the relatively high marginal rate of electricity, see Table 2. Electricity costs 2 to 3 times the cost of natural gas per unit of energy, and over 10 times the cost of pellets. This, however, is based on primary energy and does not take into account efficiency losses when converting natural gas or bioenergy into useable heat.

Table 2 – FY2021 Marginal Energy Rates

Energy Source	Account(s)	Marginal Rate (¢/kWh)
Electricity	Prince George Campus	6.14
	Bioenergy Plant	10.06
	Northern Sports Centre	6.30
	QRRC	9.93
	WIRL	10.17
	Terrace	11.08
Natural Gas	Prince George Campus	3.22
	Northern Sports Centre	3.25
	EFL	3.71
	Bio Plant	3.71
	Agora	3.71
	WIRL	3.71
	Terrace	6.72
Bioenergy (Hog Fuel)	Prince George Campus	1.63
Bioenergy (Pellets)	Prince George Campus	0.54

2.1.1. BIOENERGY AND DISTRICT HEATING

The Prince George Campus has two district heating systems:

1. The main district heating (Main DH) system, which serves 9 buildings, anchored by the Bioenergy Plant and backed up by the natural gas boilers in the Power Plant, and
2. The Low-temperature district heating (Low-temp DH) system, which serves 4 buildings, anchored by the Wood Pellet Plant and backed up by the Main DH.

The Low-temp DH system was commissioned in September 2016, and the Wood Pellet Plant was re-commissioned in November 2016. The Low-temp DH system delivers heat to both student residence buildings, the Daycare Centre, and the Enhanced Forestry Lab.

The two DH systems are integrated at the Bioenergy Plant allowing the new Low-temp DH system to use excess capacity from the Bioenergy Plant as back-up. If capacity from the Bioenergy Plant is not available, the extra heat is provided by the back-up natural gas boilers in the Power Plant.

A fuel breakdown for the Main DH and Low-temp DH systems for FY2021 is shown in Figure 2. In total, 3900 GJ of wood pellets was used by the Wood Pellet Plant, 26,280 GJ of hog fuel was used by the Bioenergy Plant, and 56,630 GJ of natural gas was used by the natural gas boilers. When compared to FY2020, natural gas use decreased by 20%. This is a result of the increased output of the Bioenergy Plant after major mechanical repairs were completed in 2020. While there are still some maintenance issues that are being resolved at the Bioenergy Plant, its operational time is expected to increase and that should further reduce the use of natural gas in the future.

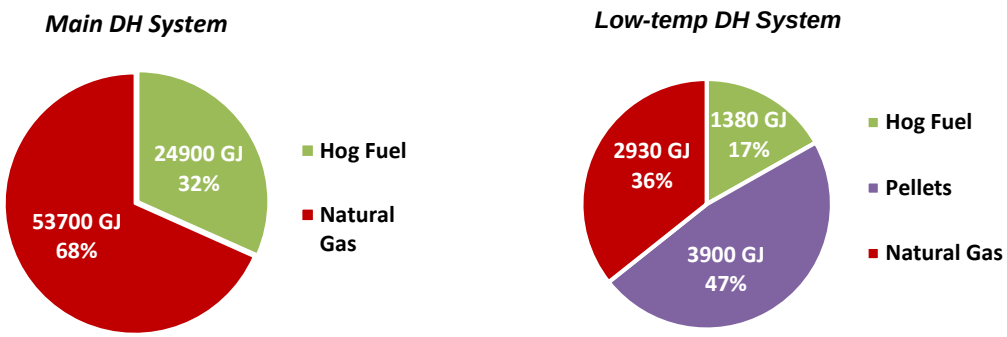

Figure 2 – FY2021 District Heating Fuel Breakdown

2.1.2. ENERGY CONSUMPTION AND INTENSITY BY BUILDING

In 2012, UNBC installed sub-meters throughout the Prince George Campus to measure electricity, hot water, chilled water, natural gas, and domestic water at the building level. The sub-metered data allows us to monitor energy consumption, identify areas of improvement, and verify savings from implemented projects.

Figure 3 shows the breakdown of energy consumption by building. The energy sources include electricity, the Main DH system, cooling from the central chillers, direct natural gas combustion, the Low-temp DH system, and propane.

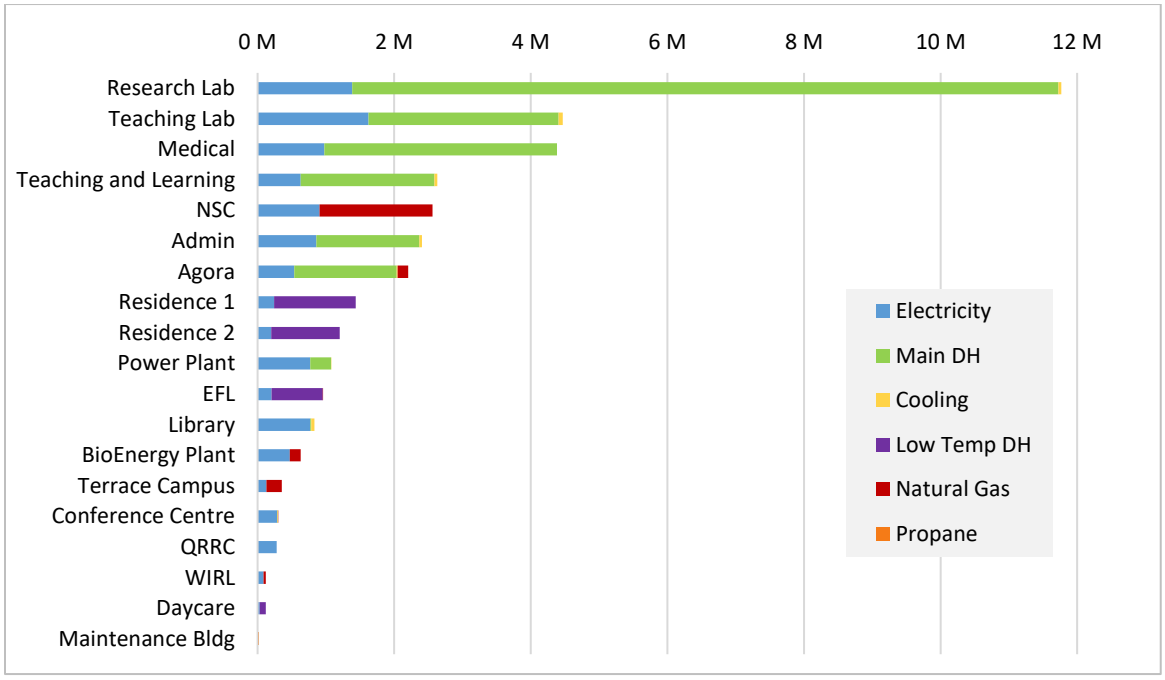

Figure 3 – FY2021 Annual Energy Breakdown (kWh_{eq}/year)

For information on how heat is generated for the two district heating systems, reference Section 2.1.1. It should be noted for both Figure 3 and Table 3 that the heating data for the Library and Conference Centre were affected by thermal meters that were not tracking energy consumption effectively. This resulted in unrealistically low heat consumption data for both buildings. These

issues are being resolved as part of an ongoing thermal meter review to ensure that all meters are working correctly.

Though Figure 3 shows the magnitude of the energy used by each building, it does not account for the size of the buildings. In order to determine performance of the buildings relative to one another, we correct for floor area and group them according to function; see Table 3 below.

The term 'energy intensity' may also be referred to as Building Energy Performance Index (BEPI) or Energy Use Intensity (EUI) – both are measured in units of energy use per area such as ekWh/m^2 or GJ/m^2. In 2021, Energy Star Portfolio Manager, a Canadian utility usage and energy benchmarking software, reported the median BEPI at Canadian colleges/universities to be between 1.01-1.44 GJ/m^2, or 280-400 ekWh/m^2; the range represents whether transmission of energy is included or not. Though this benchmark is current, it does not distinguish between the different building functions (laboratories, administrative, etc.), whether an institution is research intensive or not, or account for variances in climate. All of these factors can make comparing any BEPI challenging. Statistics Canada is completing an extensive *Survey of Commercial and Institutional Energy Use* using 2019 data, but findings are yet to published. With this difficulty in cross-institutional comparison in mind, UNBC can instead be compared against its own track record.

By evaluating the information in Figure 3 and Table 3, one can see that laboratory buildings are the largest consumers of energy both in terms of total energy and BEPI. They account for more than half (57%) of UNBC's annual energy consumption, but only one fifth (21%) of the total floor space. This high demand is a result of lab buildings operating 24 hours/day and conditioning 100% outdoor air – since recirculation of air is prohibited.

Despite its small footprint, the EFL traditionally has a very high BEPI as a result of significant heating requirements (year-round operating greenhouse) for the small space, and poor insulation due to the amount of single-pane glass. However, recent energy efficiency measures, such as the completion of a lighting upgrade in November 2019, are providing noticeable results. A 14% BEPI improvement for the EFL is noted between FY2021 and FY2020.

Table 3 – FY2021 Energy, Green House Gas (GHG), and Cost Intensity by Building

	Building Area	Annual Consumption	Annual Cost	Energy Intensity	GHG Intensity	Cost Intensity
	m^2	kWh/yr	$/yr	ekWh/ m^2/yr	kg $CO2_{eq}$/ m^2/yr	$/$m^2$/yr
Laboratories						
EFL	931	954,766	$67,606	1,026	54	$73
Medical	4,468	4,382,753	$159,821	981	95	$36
Research Lab	7,581	11,768,535	$353,387	1,552	169	$47
Teaching Lab	7,921	4,469,971	$205,896	564	45	$26
Subtotal	**20,901**	**21,576,025**	**$786,710**	**1,032**	**101**	**$38**
Industrial						
Bioenergy Plant	1,046	632,854	$57,138	605	32	$55
Power Plant	1,253	1,080,560	$72,575	862	36	$58
WIRL	921	122,020	$16,546	133	8	$18
Subtotal	**3,220**	**1,835,434**	**$146,259**	**570**	**27**	**$45**
Administrative						
Conference Centre	3,253	302,771	$25,378	93	1	$8
Agora	8,556	2,205,672	$86,802	258	25	$10

Teaching & Learning	10,130	2,632,853	$101,230	260	24	$10
Library	11,754	833,295	$70,271	71	1	$6
Terrace Campus	1,314	353,021	$30,424	269	32	$23
Childcare Centre	639	120,272	$8,551	188	9	$13
QRRC	812	281,040	$30,334	346	4	$37
Admin	9,161	2,405,904	$110,316	263	21	$12
Subtotal	**45,619**	**9,134,828**	**$463,306**	**200**	**16**	**$10**
Recreation/Accommodation/Other						
NSC	13,485	2,563,519	$143,960	190	23	$11
Residence 1	7,425	1,436,935	$99,682	194	11	$13
Residence 2	7,425	1,201,999	$83,402	162	9	$11
Maintenance Bldg	352	26,737	$5,507	76	17	$16
Subtotal	**28,687**	**5,229,190**	**$332,551**	**182**	**16**	**$12**
Total	**98,427**	**37,775,479**	**$1,728,825**	**384** [1]	**34** [2]	**$18** [3]

[1] This is an average Energy Intensity calculated via Total Annual Consumption divided by Total Building Area.

[2] This is an average GHG Intensity calculated via Total CO_2 Emissions divided by Total Building Area.

[3] This is an average Cost Intensity calculated via Total Annual Cost divided by Total Building Area.

In FY2021, the overall BEPI for UNBC increased to 384 kWh/m^2/yr from 367 kWh/m^2/yr in the previous year – a 4.6% increase. This is indicative of the increased use of the Bioenergy Plant, which has a lower efficiency than the natural gas boilers. As a result of the increased use of the Bioenergy Plant, the GHG intensity decreased by 19% compared to FY2020. Additionally, despite the higher energy intensity, the cost intensity decreased compared to FY2020 by 5%. This is also indicative of a reduction in the use of natural gas which has a higher cost than bioenergy.

2.2. ENERGY MANAGEMENT BUDGET

Partial funding for the EM program at UNBC is provided by BC Hydro. Up to $50,000 of the Energy Manager salary is funded by BC Hydro's Energy Manager Program. In addition, UNBC regularly applies for incentive funding from BC Hydro to help implement electricity efficiency projects. UNBC also receives funding from the Ministry of Advanced Education and Skills Training Carbon Neutral Capital Program (AEST CNCP) to implement greenhouse gas reduction projects. The remainder of the project funding comes primarily from UNBC's Energy Conservation Revolving Loan Fund and Routine Capital funding.

2.2.1. ENERGY CONSERVATION REVOLVING LOAN FUND

The Energy Conservation Revolving Loan Fund (Loan Fund) was created in 2012 when $250,000 was made available to fund energy efficiency upgrade projects. After an energy reduction project is implemented, a portion of the energy cost savings are used to repay the loan, and then used to provide a sustainable source of funding for the energy management program including future upgrade projects and eventually the Energy Manager salary.

Most energy projects are financed through the UNBC Energy Conservation Revolving Loan Fund, with incentives and outside funding being added to the fund as they are received.

By the end of FY2021, the Loan Fund facilitated over $3 million of spending towards energy efficiency projects. A summary of the Loan Fund cash flow can be seen in Figure 4. The implemented projects have saved roughly $2.61 million in utility costs, with net utility savings of approximately $1.19 million after loan repayments.

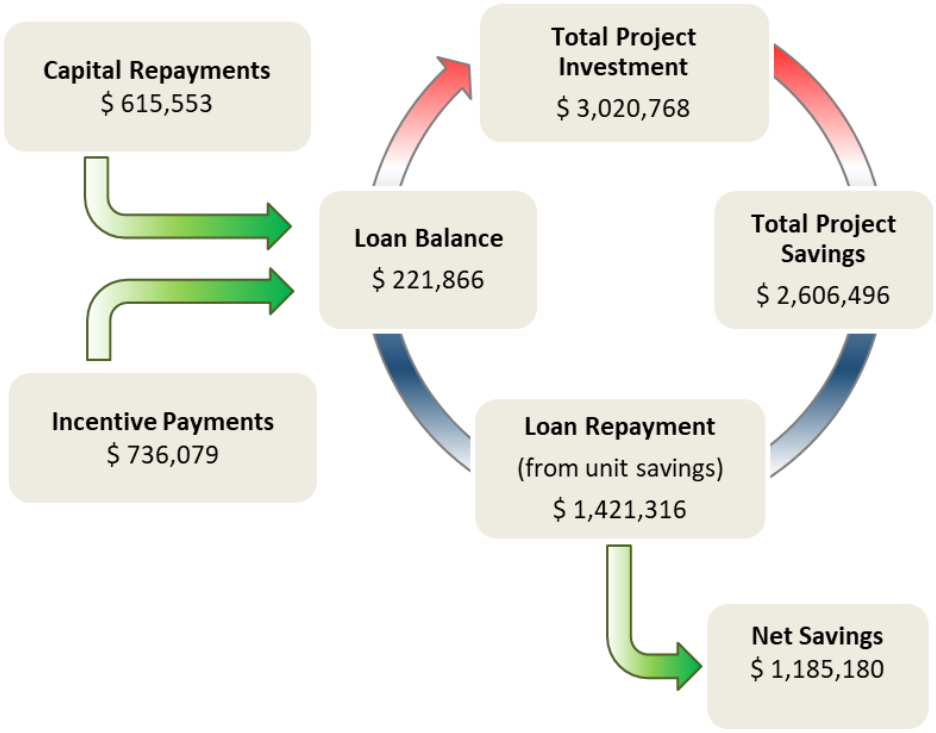

Figure 4 - Revolving Loan Summary

2.3. ENERGY COMMITMENTS AND TARGETS

UNBC's former Energy Policy set the following targets:

1. Reduce electrical and thermal energy consumption (combined) by 25% by 2020;
2. Reduce fossil fuel consumption for heating by 85% by 2020.

Reduction are based on a comparison with the 2009/2010 baselines, corrected for building floor space and variations in weather. To reach these targets UNBC had to implement a wide variety of energy efficiency projects over the last decade, as well as gain the attention, support, and participation of students, staff, faculty, and senior administration.

New targets are being developed as part of renewed long term planning for the energy management program, which includes establishing a long term Greenhouse Gas Emissions Reduction Plan. UNBC commits to aggressive energy conservation through advanced technological and material improvement to all of our campuses. Furthermore, continued community engagement for our students, staff, and faculty will play a major role in knowledge sharing with the next generation and empowering everyone to 'do their part'.

Through the energy management program, and with BC Hydro's ongoing support, UNBC will endeavor to remain a responsible and accountable community leader with respect to minimizing our use of precious environmental resources.

3. ENERGY INITIATIVES

The energy management program keeps a detailed list of past and future conservation projects to meet its energy reduction targets. The list is updated and prioritized regularly to address the operational issues and requirements of the campuses from which they arise. In addition, projects

are planned and scheduled based on internal capacity and the availability of funding. A full list of completed and current projects and studies is included in the appendices.

The following sections of the report detail the multi-angled approach UNBC takes in energy management, as well as community engagement and training. There are many ways to affect change in an organization, so by tackling the issue of UNBC's resource consumption through various avenues, we give ourselves the greatest chance for success.

3.1. ENERGY WISE

UNBC is an active participant in the BC Hydro Energy Wise Network. As a network member we host an engagement campaign for our campus community each year, promoting energy use awareness and conservation. In FY2021, the campaign was geared towards specific tasks or actions for participants to complete over a two-week period through a bingo-styled game. The appeal of this type of campaign was that it could work for anyone, anywhere, in the era of COVID-19. Due to its popularity and potential for further engagement, a similar campaign is being undertaken in FY2022. It is our hope that these campaigns bring both a sense of togetherness and purposeful action for our students, staff, and faculty.

3.2. ENERGY MANAGEMENT ASSESSMENT (EMA)

UNBC completed its most recent EMA session on November 22 2021. The EMA report is due in December 2021 and will outline areas for improvement to be pursued over the coming years. Based on the discussion during the EMA, some of the areas that were identified included better communication and engagement, as well as more integrated long term planning.

Since the findings of the most recent report are yet to be published, listed below are the priorities and opportunities identified during the prior EMA in December 2017:

> *Vision & Strategy*
>
> Align energy management program with Integrated University Action Plan. Understand key business drivers, and define new (broader) objectives.
>
> *Target-setting*
>
> Set reduction targets (and stretch targets) that account for capital projects, and non-capital activities for key operating areas. Ensure understanding and buy-in from key operating areas.
>
> *Operational Integration*
>
> Leverage building champions to increase participation in energy conservation. Create check-lists or leverage existing check-lists for maintenance, janitorial, H&S.
>
> *Asset Management*
>
> Predictive maintenance for key-consuming assets. Review operating and maintenance procedures for key energy consuming systems.
>
> *Messaging & Communication*
>
> Improve understanding of energy saving opportunities with different key stakeholder groups. Phased approach focusing on conservation goals, campaigns, and projects underway.

3.3. CONTINUOUS OPTIMIZATION

UNBC enrolled in the BC Hydro Continuous Optimization (C.Op) Program in 2012. At the outset of the program and with the help of Prism Engineering, 9 different buildings were identified on the

Prince George campus as having significant energy and cost saving opportunities. A plan was developed to deliver upgrades and retrofits to key systems, equipment, and controls in each of the 9 buildings over 3 Phases, starting with the buildings that had the highest savings potential. We are referring to this as Round 1 of C.Op.

In FY2019, C.Op Phase 3/Round 1 fully wrapped up with the completion of the Q4 Coaching Reports for the Conference/NUSC, Library, and Teaching & Learning buildings. Over $140,000/year will be saved as a result of these efforts for the 9 buildings in Round 1 of C.Op.

In FY2020, Round 2 of C.Op was proposed by BC Hydro for customers who had gone through Round 1 and for whom it had been at least 5 years since the completion of the buildings in a given phase. As such, UNBC qualified to revisit the buildings that participated in Round 1, Phase 1. These buildings include Agora, Research Lab, and Teaching Lab. Investigations into the continued functionality of previously instituted measures, as well as any new possible measures, were completed in FY2021.

In FY2022, the second phase for Round 2 is being carried out. This includes two buildings: the Northern Sports Centre and the Administration Building. Implementation of this phase is expected to be completed within FY2022. The third and final phase of Round 2 will be carried out in FY2023. This includes three buildings: the Conference Centre, Library, and Teaching and Learning building.

This work is being conducted by Prism Engineering, with guidance and collaboration from the UNBC EM team, providing continuity to the process.

3.4. LED LIGHTING RETROFITS

The Prince George campus underwent extensive lighting upgrades in FY2020 to replace magnetic-ballasted linear fluorescent fixtures from the original campus build. With the conclusion of these projects, partial or complete retrofits have been accomplished in all of the original buildings.

In FY2021, LED lighting upgrades were pursued for select fixtures in the process area of the Bioenergy Plant at a cost of approximately $3000. Estimated electrical savings for this project were calculated to be around 9,700 kWh/yr. While this was not enough to qualify for BC Hydro incentives as a stand-alone project, this upgrade still improved safety, operations, and electrical efficiency of the space, with a simple payback of less than 5 years.

3.5. LOW CARBON ELECTRIFICATION

The purpose of low carbon electrification (LCE) at UNBC is to decrease the carbon emissions while still providing cost effective and energy aware energy services to the campuses. Predominantly hydroelectrically generated electricity presents an opportunity to reduce the carbon intensity of heating demands if it is used as an enabler for low carbon heating. Merely converting heating loads from natural gas to electric resistive heating is neither cost effective nor sensible from an energy best use perspective.

UNBC has reduced its carbon emissions by 80% through adoption of two biomass heating systems. Although not intended as electrification initiatives, these have increased the electrical demand of the University by about 900,000 kWh annually.

The remaining carbon intensive energy services include heating at the NSC and Terrace campus, diesel for backup electricity generation, and the vehicle fleet.

In fiscal year 2018 the University ordered a new electric vehicle for the Facilities department to service the new WIRL building in downtown Prince George. This is expected to reduce carbon emissions by 2.1 tonnes CO2e/yr, while adding 2200 kWh to the annual electrical consumption.

As mentioned in Section 3.8, a future project is proposed in FY2023 to gather data on the effectiveness of heat pumps in a cold climate. Key data related to cold weather coefficients of performance and the overall electrical consumption is required to inform the design of a large air source heat pump system that has the potential to offset the majority of natural gas consumption at the NSC.

Upon the successful conclusion of a pilot heat pump project, UNBC proposes a full scale implementation of an air source heat pump installation to reduce the natural gas consumption of the NSC by 90%. This would be coupled with aggressive heat recovery and conversion to hydronic heat distribution within the building to enable future incorporation of district heating, geo-exchange or other renewable heating options. At present this project is cost-prohibitive however we anticipate additional work to revise the efficiency of the design and implementation. The goal of 90% reduction in natural gas consumption would equate to reducing gas consumption by 5200 GJ/year and avoiding 258 t CO2e/yr.

3.6. FY2021

UNBC completed seven energy projects in FY2021, estimated to reduce electricity consumption by at least 1,200,000 kWh/yr. This included the first phase of a new round of Continuous Optimization. In addition, maintenance was performed on 46 heating and cooling coils in three different buildings, which is expected to have a significant effect on electrical savings as heat transfer across those coils improves. The Bioenergy Plant received a targeted lighting upgrade in the process area of the plant. The primary heating loop saw an upgrade completed to its controls structure, whereby the sequence of feedback dictating flow demand was refined; the methodology applied to this is similar to what has been done in the past for the controls sequence for air flow through air handling units across the campus.

In addition, a project was completed to reduce electricity consumption for cooling of the main campus server room. This was achieved by using outdoor air for the majority of the year to cool the space, rather than the traditional electric air conditioning units. A secondary benefit of this project was the ability to redirect the 'removed heat' to a space in need – the nearby shipping /receiving area in the basement of the Administration building. Further to Table 4 below, see Appendix A for additional information on completed projects.

Table 4 – FY2021 Project List

Project	Electricity Savings	Project Cost	Cost Savings	Payback
	(kWh/y)	($)	($/yr)	(y)
Server Room HVAC	111,000	70,672	10,340	6.8
Primary Heating Loop - Static Pressure Reset (SPR)	35,000	2,000	3,150	1
Bioenergy Plant Lighting	9,700	3,000	620	4.8
C.Op Round 2 - Agora	251,744	1,200	32,468	0.1
C.Op Round 2 – Research Lab	319,661	23,900	44,341	0.5
C.Op Round 2 – Teaching Lab	512,332	117,500	82,414	1.4
Air Handling Unit – Coil Cleaning	- [1]	25,000	-	-
Subtotal [2]	1,239,437	243,272	173,333	2.4 (avg.)

[1] When this work was completed for 27 coils in 2012, savings were ~240,000 kWh/yr. In FY2021, UNBC cleaned 46 coils. Potential cost savings were estimated to be $25,000/yr, giving a simple payback of 1 year.

[2] These subtotals do not include the Air Handling Unit coil cleaning project, with the exception of Project Cost.

3.7. FY2022

In the current fiscal year, UNBC has set out to complete the next phase of Continuous Optimization Round 2, which is supported by funding from BC Hydro. This entails the investigation and implementation of measures to further reduce energy use in two buildings: the Northern Sports Centre (NSC) and the Administration Building. The total electrical savings from these two projects is estimated to be at least 577,000 kWh per year, exceeding the target of 500,000 kWh for FY2022. C.Op investigations. Further to Table 5 below, see Appendix B for additional information.

Table 5 – FY2022 Project List

Project	Electricity Savings	Project Cost	Cost Savings	Payback
	(kWh/y)	($)	($/yr)	(y)
C.Op Round 2 – NSC	452,500	36,300 (max)[1]	64,700	0.6
C.Op Round 2 – Admin Building	124,500	24,600 (max)[1]	15,800	1.6
Subtotal	577,000	60,900 (max)[1]	80,500	1.1 (avg.)

[1] Project costs listed are the maximum investment responsibility for implementing measures.

3.8. FY2023 & FY2024

In FY2023, the EM team plans to take on a Low Carbon Electrification project for the Northern Sports Centre (NSC). As a first measure, this will likely entail the replacement of the existing DHW natural gas boiler system with a heat pump system (potentially as a hybrid system with natural gas as backup for peak loads). Though it would result in an increase in electrical consumption, the project could offset approximately 350 GJ per year of natural gas and 16 tonnes of CO_2 emissions per year. This project would also allow us to gather data on the effectiveness of heat pumps in a cold climate, and ideally help inform the design of larger scale heat pumps for use on this building or other UNBC assets. In addition, FY2023 will also include the third phase of Continuous Optimization Round 2, which will address three buildings: the Conference Centre, Library, and Teaching and Learning building.

It is anticipated that FY2024 will provide the opportunity for funding of larger projects, such as flue-gas heat recovery for the Bioenergy Plant, since the Loan Fund will be well established after being in operation for 10 years. Other long term projects being considered are the cooling tower replacement, campus heat balancing, building envelope audits, and further lighting upgrades. As part of long term GHG reduction planning, additional related projects may be identified in the coming year. Further to Table 6 below, additional information is also provided in Appendix C.

Table 6 – Potential Project List

Project	Electricity Savings	Project Cost	Cost Savings	Payback
	(kWh/y)	($)	($)	(y)
FY2023				
Secondary Loops – SPR	40,000	5,000	3,600	1.4
Chilled Loop – SPR	23,000	4,000	2,090	1.9
C.Op Round 2 – Conference Centre	61,500	8,750	5,950	1.5
C.Op Round 2 – Library	384,250	31,630	37,140	0.9
C.Op Round 2 – T&L Building	158,530	27,260	15,370	1.8
FY2024				
Chilled Water Loop - Heat Movement	140,000	150,000	12,600	12
EFL Shade Curtains	1,000	130,000	6,490	20
NSC Lighting Upgrade	50,000	55,000	4,950	11

4. ENERGY PERFORMANCE

To assess energy performance, we compare monthly energy consumption for each utility account to a FY2010 baseline. Baselines were developed comparing the FY2010 utility data to the degrees of heating and/or degrees of cooling required based on the outdoor air temperature. Outdoor air temperature is the largest driver of energy consumption at UNBC. Occupancy is a driver for the two Residence buildings, but has proven to be insignificant for the other buildings.

Figure 5 shows the annual energy intensities compared to the FY2010 baseline intensity which corrects for variations in weather. Overall, UNBC has achieved a 26% reduction in energy use compared to FY2010. Figure 5 also shows how UNBC has reduced its natural gas consumption by 39% compared to FY2010. The natural gas reduction started in FY2011 when the 4.4 MW Bioenergy Plant was commissioned and started providing heat to the Prince George Campus. The Bioenergy Plant now meets, on average, 85% of the annual heating requirements of the buildings connected to the main district heating loop.

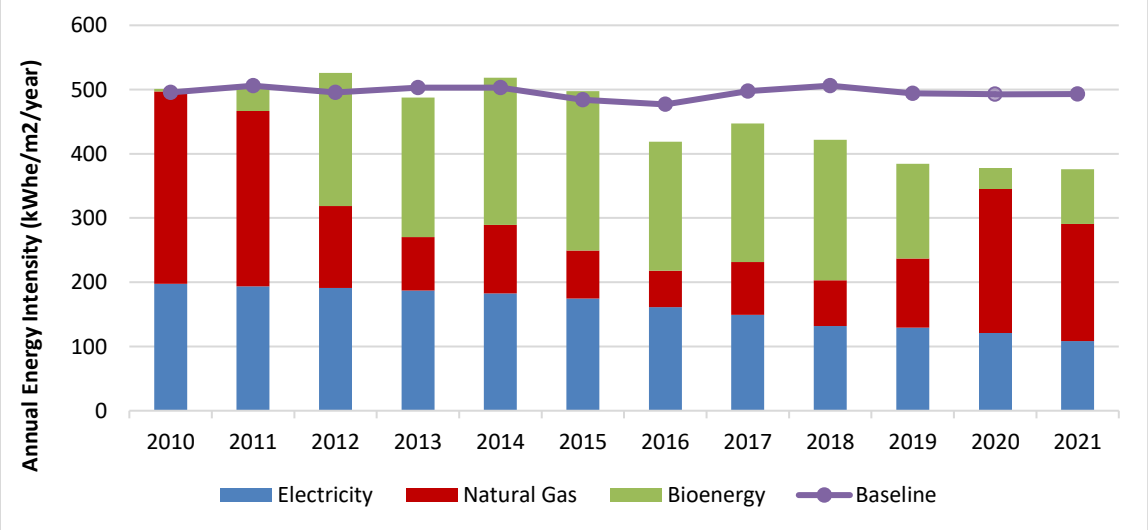

Figure 5 - Historical Energy Intensity by Financial Year

In FY2017, the Low-temp DH loop, anchored by the Wood Pellet Plant, was commissioned, displacing natural gas at the Neyoh Residence and the EFL greenhouse. In FY2018, the Keyoh Residence and Daycare centre were converted to hot water systems and connected to the Low-temp DH system. Now only 3 of UNBC's 22 buildings use natural gas or propane as their primary means of heating; the Maintenance Building, the Northern Sports Centre, and the Terrace campus.

By the end of FY2021, UNBC has seen an overall reduction of 21% in utility costs since FY2010, as shown in Figure 6. When compared to the baseline energy cost, the cost savings is 38%. In other words, we've grown the University while simultaneously reducing energy consumption.

One of the core reasons for utility cost reduction has been the Bioenergy Plant. Hog fuel used by the Bioenergy Plant is lower in cost than natural gas. In more recent years, the lower-than-baseline energy costs can also be traced to two factors: (i) UNBC started purchasing natural gas for its two largest accounts from Shell Canada in FY2015, lowering the marginal rate on both, and (ii) there has been an extensive effort to reduce natural gas consumption through recommissioning building automation systems and various other energy management projects.

UNBC has achieved a 45% reduction in electricity use from baseline levels in FY2021, equivalent to $800,382 annually, and $4.1 million cumulatively since 2010.

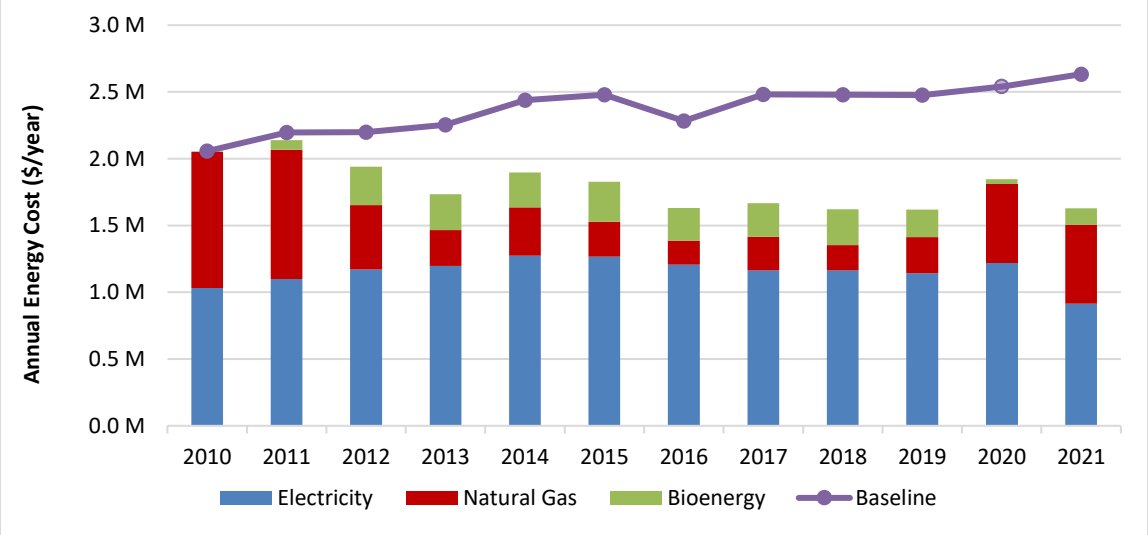

Figure 6 - Historical Energy Cost by Financial Year

4.1. ELECTRICITY SAVINGS

As previously mentioned, UNBC has reduced electricity consumption by 45% from 2010 baseline levels – shown in Figure 7. Compared to FY2020, consumption in FY2021 dropped by 1,284,000 kWh or 11%. This substantial decrease in electrical consumption is due in part to the effects of COVID-19 wherein there was significantly reduced occupancy and use of spaces. Additionally, recently completed electrical savings projects such as the server room free cooling project have contributed to the reduction in electrical consumption.

The cumulative sum of our efforts have resulted in the avoided purchase of $4.1 million worth of electricity.

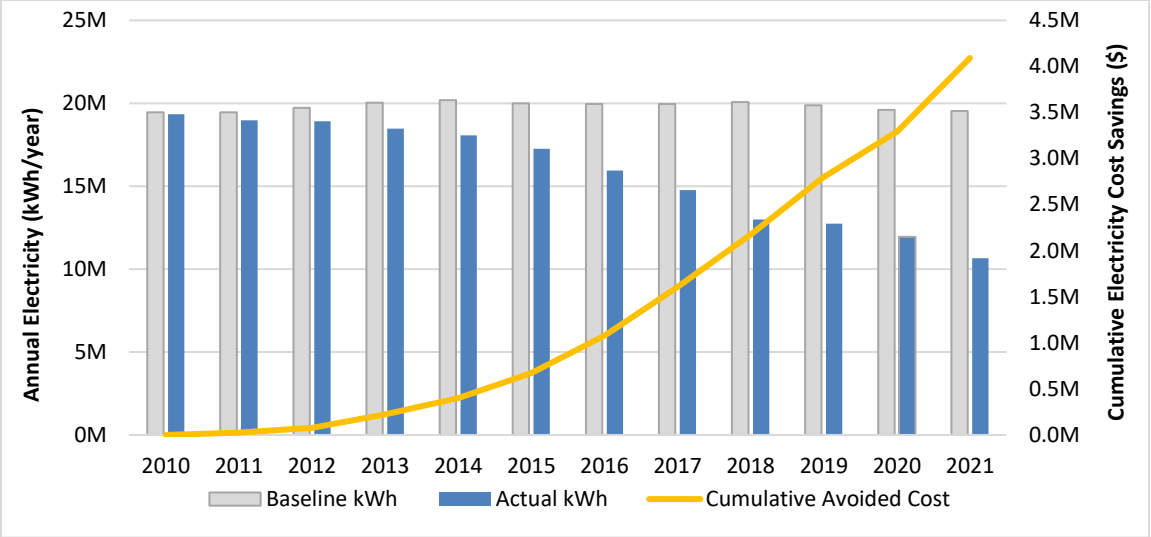

Figure 7 - Historical Electricity Consumption by Financial Year

4.2. HEAT SAVINGS

Since FY2010, UNBC has reduced natural gas consumption by 39% through the conversion to bioenergy on the Prince George Campus. However, with the start-up of the Bioenergy Plant the total purchased heat increased slightly as seen in Figure 8. The term *purchased heat* refers to the energy content of the purchased natural gas, hog fuel and wood pellets used to produce heat. Note an energy density of 18.8 GJ/bdt is used to calculate energy content of wood biofuel.

The reason for an increase in purchased heat is due to the difference in efficiencies between the Bioenergy Plant and the natural gas boilers. In FY2010, the natural gas boilers provided all of the heat to the Main DH loop, and ran relatively efficiently. As bioenergy has replaced the use of the natural gas boilers, when the boilers are needed as back-up, they operate at a lower firing rate resulting in a lower efficiency. In addition, the efficiency of the Bioenergy Plant is slightly lower than that of the natural gas boilers at full capacity, and can vary widely depending on the moisture content of the fuel, the time between boiler cleanings, and operator interventions.

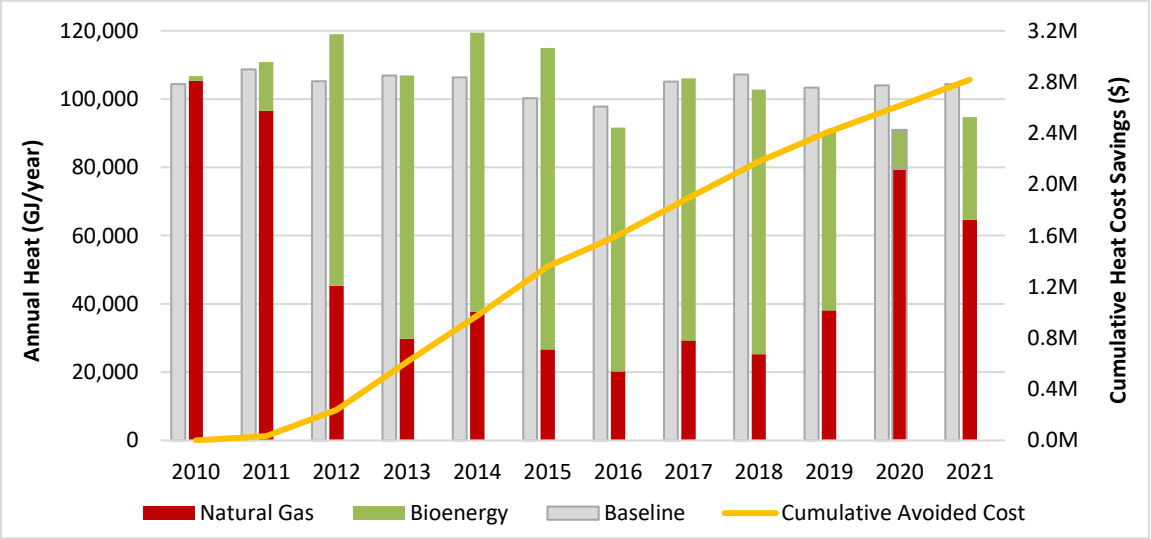

Figure 8 - Historical Heat Consumption by Financial Year

Comparing FY2021 to FY2012 when the Bioenergy Plant came fully online, we have seen a 20% decrease in purchased heat, equivalent to roughly 24,000 GJ. As a result of increased use of the Bioenergy Plant in FY2021, natural gas consumption reduced by 19% when compared to FY2020. This trend is expected to continue as the Bioenergy Plant returns to more stable operation.

In summary, despite recent operational challenges with the Bioenergy Plant, it has enabled UNBC to cut heating costs by over $2.8 million since it's commissioning 9 years ago. The hog fuel used by the Bioenergy Plant is roughly half the cost of the equivalent amount of natural gas and therefore still more economically viable than natural gas.

As the EM program continues to identify and deliver savings and efficiency improvements to our natural gas and bioenergy heating systems, we will continue to see the cumulative savings grow.

5. SUMMARY

Over the past 12 years, the UNBC EM program has brought in $1,227,400 in incentives, $774,400 in salary reimbursements, and has implemented 7.1 million kWh/yr worth of electrical conservation projects and 10,300 GJ/yr worth of natural gas conservation projects. When these savings are added to those attributed to the Bioenergy and Wood Pellet Plants, UNBC has saved a total of $6,910,000 in utility costs.

Figure 9 shows the breakdown of the $8,911,800 value of UNBC's energy management program and funding partnerships with BC Hydro, Fortis BC, and the Carbon Neutral Capital Program.

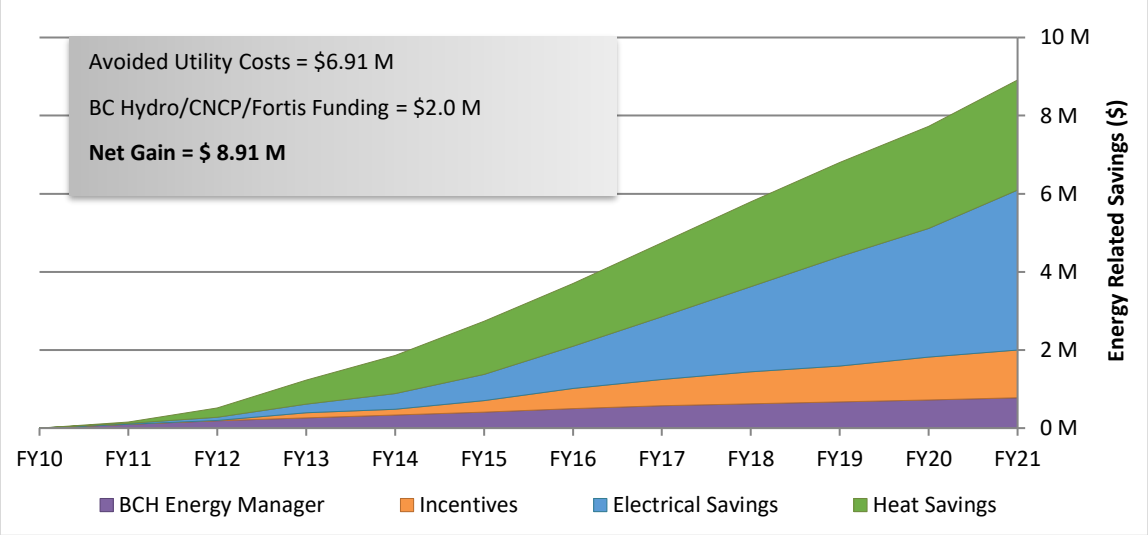

Figure 9 - Energy Management and Utility Savings

APPENDIX A – COMPLETED PROJECT LIST

	Project	Campus	BC Hydro Project Number	Electricity Savings (kWh/y)	Electricity Demand Savings (kW/month)	Natural Gas Savings (GJ/y)	District Heat Savings (GJ/y)	Cost ($)	BC Hydro Incentive ($)	Fortis Incentive ($)	CNCP Funding ($)	Revolving Loan Contribution ($)	Total Savings Last year ($)	Total Savings to-date ($)	Completion Date
1	Canfor Theatre Lighting (Round 1)	Main	-	3700	1	0	0	6000	0	0	0	0	401	2865	10-Aug
2	Terrace Boiler Replacement	Terrace	-	0	0	300	0	45000	0	0	0	0	5219	39447	10-Oct
3	Green Centre Lighting	Main	-	1240	0	0	0	640	0	0	0	0	135	942	11-Jan
4	Wintergarden Lights	Main	-	2630	1	0	0	640	0	0	0	0	245	1744	11-Jan
5	Agora North Entrance Lighting	Main	PSPX110586	999	0	0	0	476	218	0	0	0	60	448	11-Apr
6	Rotunda Gallery Lighting	Main	PSPX110587	5931	1	0	0	1987	1165	0	0	0	553	3848	11-May
7	Rotunda Gallery Ramp Lighting	Main	PSPX111364	2475	1	0	0	774	390	0	0	0	231	1606	11-May
8	Admin Chiller for electrical vault	Main	-	98600	11	0	0	70000	0	0	0	0	7569	51779	12-Mar
9	T&L Daylight Harvesting	Main	-	9519	2	0	0	0	0	0	0	0	862	5718	12-Mar
10	Medical AV free cooling	Main	-	22950	3	0	0	11000	0	0	0	0	1762	11940	12-Apr
11	NUSC Event Space	Main	PSPX110510	11344	7	0	0	6090	2474	0	0	6090	1710	10230	12-Jun
12	NSC Soccer Field and Gym	NSC	SUCH12-1103	182000	56	0	0	135188	41160	0	0	0	19533	118820	12-Sep
13	Agora Daylight Harvesting	Main	-	24600	6	0	0	0		0	0	0	2295	12883	13-Jun
14	Admin Daylight Harvesting	Main	-	33000	8	0	0	0		0	0	0	3079	17060	13-Jul
15	Workplace Conservation Campaign	Main	BCH-02090	304636	0	0	0	5311	4935	0	0	0	33641	72930	16-Jan
16	Workplace Conservation Campaign	NSC	BCH-02090	32222	0	0	0	0	0	0	0	0	3612	7831	16-Jan
17	Workplace Conservation Campaign	QRRC	BCH-02090	4303	0	0	0	0	0	0	0	0	480	1040	16-Jan
18	Workplace Conservation Campaign	Terrace	BCH-02090	2821	0	0	0	0	0	0	0	0	325	703	16-Jan
19	Workplace Conservation Campaign	Bio	BCH-02090	13240	0	0	0	0	0	0	0	0	1484	3218	16-Jan
20	NSC C.Op	NSC	BCH-03368	453000	0	1922	0	27028	0	0	0	22702	51602	288266	16-Mar
21	Energy Wise FY2017	Main	BCH-03654	0	0	0	0	270	267	0	0	0	0	0	16-Apr
22	Terrace exterior lighting (PSPX)	Terrace	PSPX111693	504	0	0	0	162	77	0	0	162	53	106	16-Apr
23	BMO Boiler Replacement	BMO	-	0	0	0	0	0	0	4050	0	0	0	0	16-Oct
24	Daycare Heating System conversion	DC	-	0	0	400	-400	-	0	0	0	0	243	486	17-Aug
25	Power Plant Boiler Bypass/DHW Tank	Main	-	0	0	0		98184	0	0	0	0	2800	10494	17-Sep
26	Residence Lighting	Main	SUCH11-965	284000	0	0	0	61547	24090	0	0	61547	15947	151607	12-May
27	Residence Lighting	Main	PSPX112054	14414	0	0	0	17216	3208	0	0	17216	9048	86020	12-Jul
28	Thirsty Moose Lighting	Main	PSPX101130	6034	2	0	0	2311	1412	0	0	0	0	5478	11-Sep
29	Bookstore/Cafeteria Lighting	Main	PSPX100434	20796	7	0	0	6684	3258	0	0	6684	1959	18624	11-Dec
30	Terrace Campus lighting upgrade	Terrace	PSPX153073	16599	0	0	0	14805	3994	0	0	14396	1489	13784	12-Jun
31	NUSC Event Space (Round 1)	Main	PSPX111455	960	1	0	0	402	160	0	0	0	1069	9893	11-May
32	Lecture Theatre Lighting	Main	PSPX113112	78705	26	0	0	22811	11988	0	0	22811	7414	68331	12-Jun
33	EFL Cold Storage Lighting	Main	PSPX130081	1181	0	0	0	578	139	0	0	0	111	964	13-Jan
34	QRRC Lighting Upgrade	QRRC	PSPX112392	7752	3	0	0	5129	1258	0	0	5129	741	6304	13-Mar
35	Coil Cleaning	Main	SUCH12-1077	195000	39	0	0	23523	9684	0	0	23523	0	92751	12-Aug
36	Canfor/Warehouse	Main	SUCH12-1112	99000	22	0	0	53046	21214	0	0	0	9302	81681	12-Dec

	Project	Campus	BC Hydro Project Number	Electricity Savings (kWh/y)	Electricity Demand Savings (kW/month)	Natural Gas Savings (GJ/y)	District Heat Savings (GJ/y)	Cost ($)	BC Hydro Incentive ($)	Fortis Incentive ($)	CNCP Funding ($)	Revolving Loan Contribution ($)	Total Savings Last year ($)	Total Savings to-date ($)	Completion Date
37	Exterior Lighting - globes	Main	BCH-00377	66000	0	0	0	106629	18152	0	0	42936	6310	51013	13-Nov
38	Teach Lab Pot lights/Agora exterior	Main	BCH-01166	59000	13	0	0	26433	2935	0	0	26433	7464	55110	15-Feb
39	Teaching Lab Penthouse Lighting	Main	PSPX142369	1022	0	0	0	781	105	0	0	781	79	529	15-Feb
40	Reef Tank Lighting	Main	-	2300	0	0	0	1664	0	0	0	700	191	1276	15-Feb
41	Teaching Lab C.Op	Main	BCH-02088	-	0	0	-	72290	0	0	0	72290	-	219048	15-May
42	Research Lab C.Op	Main	BCH-02086	-	0	0	-	58598	0	0	0	58598	-	126452	15-May
43	Agora C.Op	Main	BCH-02087	-	0	0	-	59694	0	0	0	59694	-	124701	15-May
44	Medical Humidifier	Main	BCH-01716	476000	66	0	-280	151240	74941	0	0	151240	47185	306899	15-Feb
45	Power Plant AHU controls	Main	-	40000	6	450	0	68430	0	25811	48661	19769	6708	44199	15-Mar
46	Conference Solar PV	Main	-	5000	5	0	0	30287	0	0	0	5986	400	2434	15-Sep
47	Main campus streetlights/wall packs	Main	BCH-02693	167000	0	0	0	164188	45160	0	44700	118107	13360	77964	16-Jan
48	NSC Exterior lighting	NSC	BCH-02694	86000	0	0	0	60027	20717	0	0	60027	6880	40149	16-Jan
49	Terrace Exterior Lighting	Terrace	-	4896	0	0	0	9073	0	0	0	1811	432	2377	16-Apr
50	Main campus wall packs	Main	BCH-03047	53000	0	0	0	20411	8073	0	0	10515	4240	21909	16-Aug
51	Neyoh Heating System Conversion	Main	Program Enabled	386700	69	3000	-4500	500000	0	0	0	100000	0	24938	16-Aug
52	Neyoh Heating System Conversion	Bio	Program Enabled	-37200	-4	0	0	0	0	0	0	0	-2870	-5740	16-Aug
53	Conf/NUSC Air Handler HW conversion	Main	-	0	0	846	-816	6368	0	0	6368	0	1774	10202	16-Jan
54	Residence Low-flow showerheads	Main	-	0	0	1400	0	696	0	0	0	696	0	45567	13-Jul
55	Corner Store Reno	Main	PSPX153444	1230	0	0	0	2047	333	0	0	0	98	508	16-Aug
56	Admin Lighting Upgrade	Main	Program Enabled	118000	17	0	0	103498	0	0	40952	0	8260	37883	17-Mar
57	Library Lighting -1st Floor	Main	BCH-04148	139000	46	0	0	70409	20013	0	35385	33242	9764	40686	17-Aug
58	Conf/NUSC Lighting	Main	BCH-04149	69000	12	0	0	52659	10768	0	29978	20354	5294	22060	17-Aug
59	D.C./Research Lab/PP Highbays	Main	BCH-04147	81000	14	0	0	36040	11394	0	0	12826	5670	21838	18-Jan
60	Soccer Field lighting controls	NSC	BCH-04240	55000	3	0	0	28288	8119	0	0	28288	3850	15073	17-Oct
61	Power Plant/Utilidor Lighting	Main	BCH-04146	94000	11	0	0	34718	9612	0	0	15699	6580	24661	18-Jan
62	Recycling Room Lighting	Main	PSPX170052	1030	0	0	0	878	0	0	0	504	72	270	18-Feb
63	Keyoh Heating System conversion	Res	BCH-04873	366000	67	2000	-3500	100000	0	0	0	0	17606	73366	18-Jun
64	Library - Wavelinks Lighting	Main	BCH-04866	122000	47	0	0	195000	21713	0	65385	173287	6935	22098	19-Jan
65	Library - Medical Lighting	Main	BCH-04867	64000	31	0	0	77000	11517	0	0	65483	13665	37065	18-Jul
66	Agora Lighting	Main	BCH-05420	135000	65	0	0	279000	23522	0	32692	222786	11452	22904	20-Feb
67	Research Lab Lighting	Main	BCH-05431	187000	82	0	0	395000	59734	0	32693	302573	17874	35747	20-Feb
68	Admin Lighting	Main	BCH-05405	71000	28	0	0	119500	12603	0	0	106897	4908	9816	20-Feb
69	EFL Lighting	Main	BCH-05406	77000	15	0	0	60000	13950	0	0	46050	4043	8086	20-Feb
70	Medical C.Op	Main	BCH-02089	48000	0	0	207	1284	0	0	0	0	8779	49041	16-Mar
71	Admin C.Op	Main	BCH-03370	144000	0	0	741	-13627	0	0	0	5119	16992	94924	16-Mar
72	Conf/NUSC C.Op	Main	BCH-04062	61000	0	0	1118	12542	0	0	0	4838	11147	51122	17-Sep
73	Library C.Op	Main	BCH-04061	384000	0	0	2366	31479	0	0	0	12303	41378	189770	17-Sep

	Project	Campus	BC Hydro Project Number	Electricity Savings (kWh/y)	Electricity Demand Savings (kW/month)	Natural Gas Savings (GJ/y)	District Heat Savings (GJ/y)	Cost ($)	BC Hydro Incentive ($)	Fortis Incentive ($)	CNCP Funding ($)	Revolving Loan Contribution ($)	Total Savings Last year ($)	Total Savings to-date ($)	Completion Date
74	T&L C.Op	Main	BCH-04063	159000	0	0	1799	34700	0	0	0	20128	22107	101388	17-Sep
75	Server Room HVAC - free cooling	Main	BCH-04865	111000	8	0	0	70672	20654	0	35385	49346	10340	10340	20-Sep
76	Primary Heating Loop - SPR	Main	-	35000	tbd	0	0	2000	0	0	0	2000	3150	3150	20-Jul
77	Bioenergy Plant Lighting	Main	-	9700	tbd	0	0	3000	0	0	0	3000	620	620	21-Mar
78	C.Op Round 2 - Agora	Main	BCH-06549	251744	0	0	1438	1200	11050	0	10000	1200	32468	32470	21-Mar
79	C.Op Round 2 – Research Lab	Main	BCH-06378	319661	0	0	1196	23900	12050	0	10000	23900	44341	44341	21-Mar
80	C.Op Round 2 – Teaching Lab	Main	BCH-06550	512332	0	0	3423	117500	12300	0	10000	117500	82414	82414	21-Mar
81	Air Handling Unit – coil cleaning	Main	-	-	-	0	0	25000	0	0	0	25000	-	-	20-Oct
	Total			**6,859,570**	**799**	**10,318**	**2,792**	**$3,817,298**	**$560,506**	**$29,861**	**$402,199**	**$2,202,166**	**$666,935**	**$3,380,511**	

APPENDIX B – PROJECTS IN PROGRESS

	Project	Campus	BC Hydro Project Number	Estimated Electricity Savings (kWh/y)	Estimated Electricity Demand Savings (kW/month)	Estimated Natural Gas Savings (GJ/y)	Estimated District Heat Savings (GJ/y)	Budget Cost ($)	BC Hydro Incentive ($)	Fortis Incentive ($)	CNCP Funding ($)	Revolving Loan Contribution ($)	Anticipated Cost Savings ($/yr)	Payback (y)	Expected Completion Date
82	C.Op Round 2 - NSC	Main	BCH-07265	452525	-	1922	0	36300	21700	-	0	36300	64674	0.6	22-Mar
83	C.Op Round 2 - Admin Building	Main	BCH-07266	124540	1	0	769	24600	14700	-	0	24600	15846	1.6	22-Mar
	Total			**577,065**	**1**	**1,922**	**769**	**$ 60,900**	**$ 36,400**	**$ -**	**$ -**	**$ 60,900**	**$ 80,520**		

APPENDIX C – POTENTIAL PROJECTS IN FY2023/2024

	Project	Campus	BC Hydro Project Number	Estimated Electricity Savings (kWh/y)	Estimated Electricity Demand Savings (kW/month)	Estimated Natural Gas Savings (GJ/y)	Estimated District Heat Savings (GJ/y)	Budget Cost ($)	Expected BC Hydro Incentive ($)	Fortis Incentive ($)	CNCP Funding ($)	Revolving Loan Contribution ($)	Expected Annual Utility Savings ($/y)	Payback (y)	Expected Completion Date
84	Secondary Loops - SPR	Main		40000	tbd	0	0	5000	tbd	0	0	5000	3628	1.4	23-Mar
85	Chilled Loop - SPR	Main		23000	tbd	0	0	4000	tbd	0	0	4000	2086	1.9	23-Mar
86	C.Op Round 2 - Conference Centre	Main	BCH-08046	61493	0	0	1116	8754	5200	-	0	8754	5943	1.5	23-Mar
87	C.Op Round 2 - Library	Main	BCH-08047	384253	0	0	2366	31630	17000	-	0	31630	37138	0.9	23-Mar
88	C.Op Round 2 - T&L Building	Main	BCH-08048	158527	0	0	1799	27260	14700	-	0	27260	15372	1.8	23-Mar
89	NSC DHW Heat Pump System	Main		-30300	-11	350	0	60000	tbd	tbd	tbd	tbd	518	115.8	23-Mar
90	Chilled Water Loop - Heat Movement	Main		140000	tbd	0	0	150000	tbd	0	20000	130000	12698	11.8	24-Mar
91	EFL Shade Curtains	Main		1000	tbd	800	0	130000	tbd	0	0	130000	6490	20	24-Mar
92	NSC Lighting Upgrade	Main		50000	tbd	0	0	100000	10000	0	35000	55000	4950	11	24-Mar
	Total			**827,973**	**-11**	**1,150**	**5,281**	**$516,644**	**$46,900**	**$0**	**$55,000**	**$391,644**	**$88,823**		

APPENDIX D – COMPLETED STUDIES

	Study	Campus	BC Hydro Project Number	Cost ($)	BC Hydro Incentive ($)	Revolving Loan Contribution ($)	CNCP Funding ($)	Completion Date
1	Renewable energy study	Main	-	5,000	0	0	0	11-Sep
2	Ice Mountain study	Main	-	0	0	0	0	11-Nov
3	Anaerobic Digester study (ENVS417)	Main	-	0	0	0	0	12-Dec
4	Medical Humidifier study (PHYS402)	Main	-	0	0	0	0	12-Dec
5	Lab Heat Recovery study (ENSC499)	Main	-	0	0	0	0	13-Apr
6	C.Op Investigation - Research Lab	Main	COP10-416	16,028	15,768	16,028	0	13-Oct
7	C.Op Investigation - Agora	Main	COP10-419	15,891	15,587	15,891	0	13-Oct
8	C.Op Investigation - Teaching Lab	Main	COP10-420	16,442	16,175	16,442	0	13-Oct
9	C.Op Investigation - Medical	Main	COP10-421	12,922	12,713	12,922	0	13-Oct
10	C.Op Investigation - Admin	Main	COP10-415	18,418	18,119	18,418	0	14-Aug
11	C.Op Investigation - NSC	NSC	COP10-414	20,665	20,330	20,665	0	14-Aug
12	C.Op Handoff - Research Lab	Main	COP10-416	2,643	2,600	2,643	0	15-Jul
13	C.Op Handoff - Agora	Main	COP10-419	2,562	2,520	2,562	0	15-Jul
14	C.Op Handoff - Teaching Lab	Main	COP10-420	2,562	2,520	2,562	0	15-Jul
15	Bioenergy Heat Recovery study (ENVS417)	Main	-	0	0	0	0	15-Dec
16	C.Op Investigation - Library	Main	COP10-417	19,740	19,420	19,740	0	16-May
17	C.Op Investigation - Conference/NUSC	Main	COP10-418	11,482	11,295	11,482	0	16-May
18	C.Op Investigation - T&L	Main	COP10-422	14,861	14,620	14,861	0	16-May
19	C.Op Handoff - Medical	Main	COP10-421	4,361	4,290	4,361	0	16-Jul
20	C.Op Handoff - Admin	Main	COP10-415	2,767	2,723	2,767	0	16-Jul
21	C.Op Handoff - NSC	NSC	COP10-414	2,863	2,817	2,863	0	16-Jul
22	C.Op Coaching - Research Lab	Main	COP10-416	3,384	3,329	3,384	0	16-Nov
23	C.Op Coaching - Agora	Main	COP10-419	8,484	4,312	8,484	0	16-Nov
24	C.Op Coaching - Teaching Lab	Main	COP10-420	6,616	4,308	6,616	0	16-Nov
25	Boiler Power/Plant Controls Study	Main	-	24,433	0	0	24,433	17-Mar
26	C.Op Handoff - Library	Main	COP10-417	4,792	4,714	4,792	0	17-Aug
27	C.Op Handoff - Conference/NUSC	Main	COP10-418	2,858	2,811	2,858	0	17-Aug
28	C.Op Handoff - T&L	Main	COP10-422	3,615	3,556	3,615	0	17-Aug
29	C.Op Coaching - NSC	NSC	COP10-414	5,578	5,488	5,578	0	17-Dec
30	C.Op Coaching - Admin	Main	COP10-415	4,023	3,958	4,023	0	17-Dec
31	C.Op Coaching - Medical	Main	COP10-421	1,799	1,770	1,799	0	17-Dec
32	C.Op Coaching - Library	Main	COP10-417	4,396	4,325	4,396	0	18-Aug
33	C.Op Coaching - Conference/NUSC	Main	COP10-418	3,507	3,450	3,507	0	18-Aug
34	C.Op Coaching - T&L	Main	COP10-422	3,507	3,450	3,507	0	18-Aug
35	Cooling Tower Review	Main	BCH-04450	11,690	1928	0	11,690	18-Mar
36	EFL Optimization	Main	BCH-04450	11,385	1928	11,385	0	18-Mar
37	NSC Heat Pump	Main	BCH-05207	10900	5451	5449	0	19-Jul
	Total			**$ 280,174**	**$ 216,275**	**$ 233,600**	**$ 36,123**	

APPENDIX E – COMMERCIAL ENERGY MANAGER LCE PROJECT FORECAST

Sector	Public or Private	Customer Name	Region	Description of Measure	Standard LCE Measure Name	New or Retrofit	Electrical Consumption (kWh/y)		Average Monthly Demand (kW)			Nat Gas Consumption (GJ/yr)		GHG Reduction	Annual Cost Saving $						Total Capital Cost	Incremental relative to Baseline	Non Energy Benefits	Measured Life/Persistence	Payback
							Current	Incremental (+/-)	Current	Incremental (+/-)	Months	Current	Incremental (+/-)	Tonnes CO2e/yr	Electric	Demand	Gas	Maintenance or others savings (annual)	GHG Offsetting Costs	TOTAL	$	$	(eg thermal comfort, noise reduction, air quality etc.)	In years	In years
Education - Adv	Public	UNBC	North	Pilot project - heat pump on Northern Sports Centre	HVAC Air-to-Air Heat Pump (ductless or minisplit)	Retrofit	1,182,600	140,000	228	16	6	6,032	-1500	-73	$ 7,784	$ 1,076	-$ 11,145	$ -	-$ 1,833	-$ 4,118	$ 72,000	$ 72,000		18	17.5
Education - Adv	Public	UNBC	North	Northern Sports Centre Low Carbon Heating Conversion	HVAC Air-to-Air Heat Pump (ductless or minisplit)	Retrofit	1,182,600	130,000	228	40	6	6,032	-5200	-258	$ 7,228	$ 2,690	-$ 38,636	$ -	-$ 6,448	-$ 35,166	$ 1,472,000	$ 1,472,000		18	41.9
Education - Adv	Public	UNBC	North	Northern Sports Centre - DHW Heat Pump System	DHW Air-to-Water Heat Pump Water Heater	Retrofit	1,182,600	30,300	228	11	12	6,032	-350	-17	$ 1,685	$ 1,480	-$ 2,601	$ -	-$ 428	$ 136	$ 60,000	$ 60,000		15	-442.4