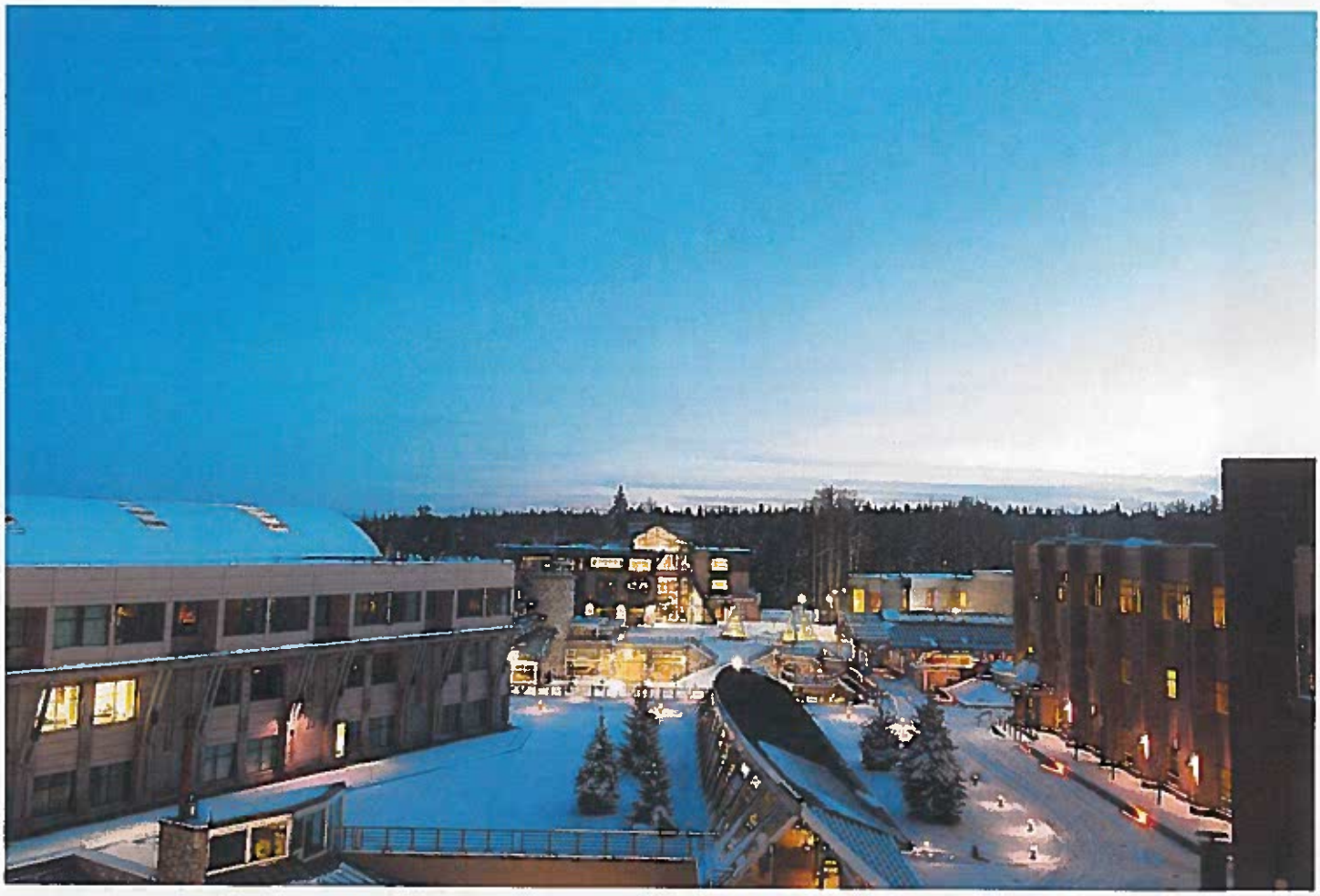
UNBC UNIVERSITY OF NORTHERN BRITISH COLUMBIA

BC Hydro Power smart

FY2019 Strategic Energy Management Plan

October 1, 2018



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Senior Management Support:

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October 15, 2018

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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 engagement, and awareness campaigns; and showcasing renewable and efficient energy systems that are of particular interest to northern and remote communities. This commitment continues to be demonstrated with the recent expansion of the award winning Bioenergy system, and the ongoing efforts of the energy management team in reducing energy consumption. To-date, UNBC has achieved a 34% reduction in electricity use, a 76% reduction in natural gas consumption (and greenhouse gas emissions), and an 21% reduction in utility costs compared to 2010.

The energy management (EM) program at UNBC has been strongly supported by BC Hydro for the past 8 years. BC Hydro provides 50% of the funding for a dedicated Energy Manager, as well as incentives to implement energy efficiency and conservation projects. To-date, BC Hydro has contributed over $1 million to UNBC's EM program, which has facilitated 50 projects that have saved UNBC roughly $2.2 million in electricity costs. This year, UNBC intends to claim 552,000 kWh towards their BC Hydro Energy Manager target.

In addition to the BC Hydro targets, UNBC has 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). To work towards the 2020 reduction targets, UNBC has developed a project plan for the next couple years which is outlined in this report. Funding for the identified projects is committed through the UNBC Energy Conservation Revolving Loan Fund, and funding partnerships will be pursued with BC Hydro and the provincial Carbon Neutral Capital Program. In addition to the planned projects, UNBC will continue to engage the UNBC community to maximize conservation and awareness.

Through the EM program, and the switch from fossil fuels to bioenergy, UNBC has avoided the purchase of roughly $4.3 million worth of energy over the past 8 years. Including the $1.4 million brought in through incentives and salary reimbursements, UNBC's commitment to sustainable operations can be valued at $5.7 million.

2. ENERGY MANAGEMENT AT UNBC

The energy management portfolio includes all facilities where UNBC has direct operational control. This permits 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 in downtown Prince George, and the Quesnel River Research Centre (QRRC). Of the 22 buildings, 16 are located at the Prince George Campus, account for 98% of the total energy consumption, and house 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 - FY2018 Utility Breakdown

	Annual Consumption		Annual Cost
Electricity	13,184,712	kWh	$1,162,950
Bioenergy (Hog Fuel)	3800	bdt	$262,420
Natural Gas	25,239	GJ	$193,954
Bioenergy (Pellets)	271	bdt	$6,690
Propane	6,665	L	$6,970
Total			$1,633,000

Figure 1 shows the breakdown of energy consumption in FY2018. Electricity accounted for 31% of total energy consumption, and heat generated from hog fuel (sawmill wood waste), natural gas, and wood pellets accounted for the remaining 69%. Of the heat, 74% was generated from bioenergy. The Prince George campus operates two bioenergy systems: a 4.4MW Bioenergy Plant that uses hog fuel to make hot water for the main campus district heating loop; and a 400kW Wood Pellet Plant that uses wood pellets to produce low-temperature water for on campus student residences and the I.K. Barber Enhanced Forestry Lab. 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.

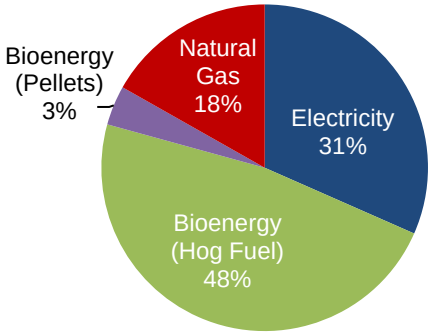

Figure 1 - Energy Use Breakdown

Although electricity accounted for only 31% of the energy consumption, it represented 71% of total energy costs, due to the relatively high marginal rate of electricity, see

Table 2. Electricity costs 2 to 5 times the cost of natural gas per unit of energy, and 7 times the cost of hog fuel. 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 – FY2018 Marginal Energy Rates

Energy Source	Account(s)	Marginal Rate (¢/kWh)
Electricity	BMO	12.73
	NSC/Bioenergy Plant	6.07
	Prince George Campus	5.98
	QRRC	9.60
	Terrace	9.72
Natural Gas	Terrace	6.56
	Daycare/Bio Plant	3.08
	Agora/EFL	2.80
	Prince George Campus	2.36
	NSC	2.27
Bioenergy (Hog Fuel)	Prince George Campus	1.73
Bioenergy (Pellets)	Prince George Campus	0.53

2.1.1. BIOENERGY AND DISTRICT HEATING

The Prince George Campus has two district heating systems: the main district heating (DH) system serves nine buildings and is anchored by the Bioenergy Plant and backed up by the natural gas boilers in the Power Plant; and the Low-temperature district heating system serves 4 buildings and is anchored by the Wood Pellet Plant and backed up by the main district heating system. The Low-temperature DH system was commissioned in September 2016, and the Wood Pellet Plant was re-commissioned in November 2016. The Low-temperature DH system delivers heat to both student residence buildings, the Childcare Centre, and the Enhanced Forestry Lab.

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

The breakdown of fuel used for the Main DH and Low-temperature DH systems for FY2018 is displayed in Figure 2. In total, 3,800 bone dry tonnes (bdt) of hog fuel were used by the Bioenergy Plant, 320 bdt of wood pellets were used by the Wood Pellet Plant, and 14,410 GJ of natural gas was used by the natural gas boilers.

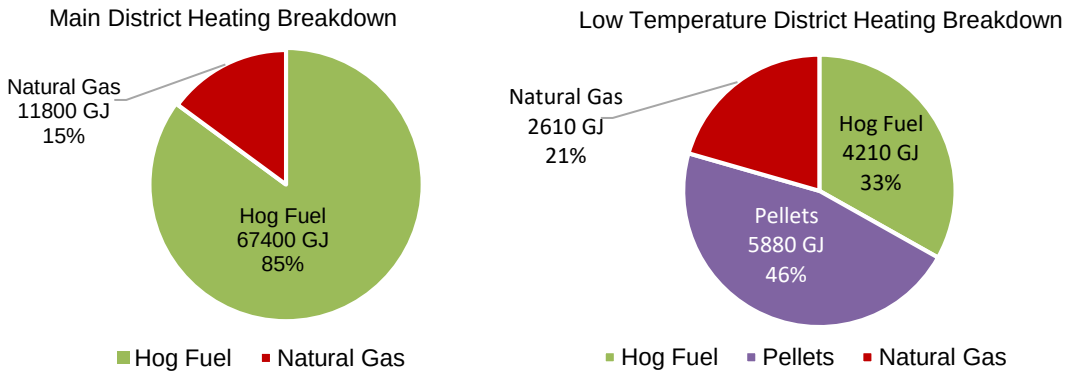

Figure 2 - District Heating Fuel Breakdown

2.1.2. ENERGY CONSUMPTION BY BUILDING

In 2012, UNBC installed submeters throughout the Prince George Campus to measure electricity, hot water, chilled water, natural gas, and domestic water at the building level. The submetered 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 is broken down into electricity; main district heating (Main DH) served by the Bioenergy Plant and back up by the natural gas boilers; cooling from the central chillers; natural gas; and low temperature district heating (Low Temp DH) served by the Wood Pellet Plant and backed up by the Main DH.

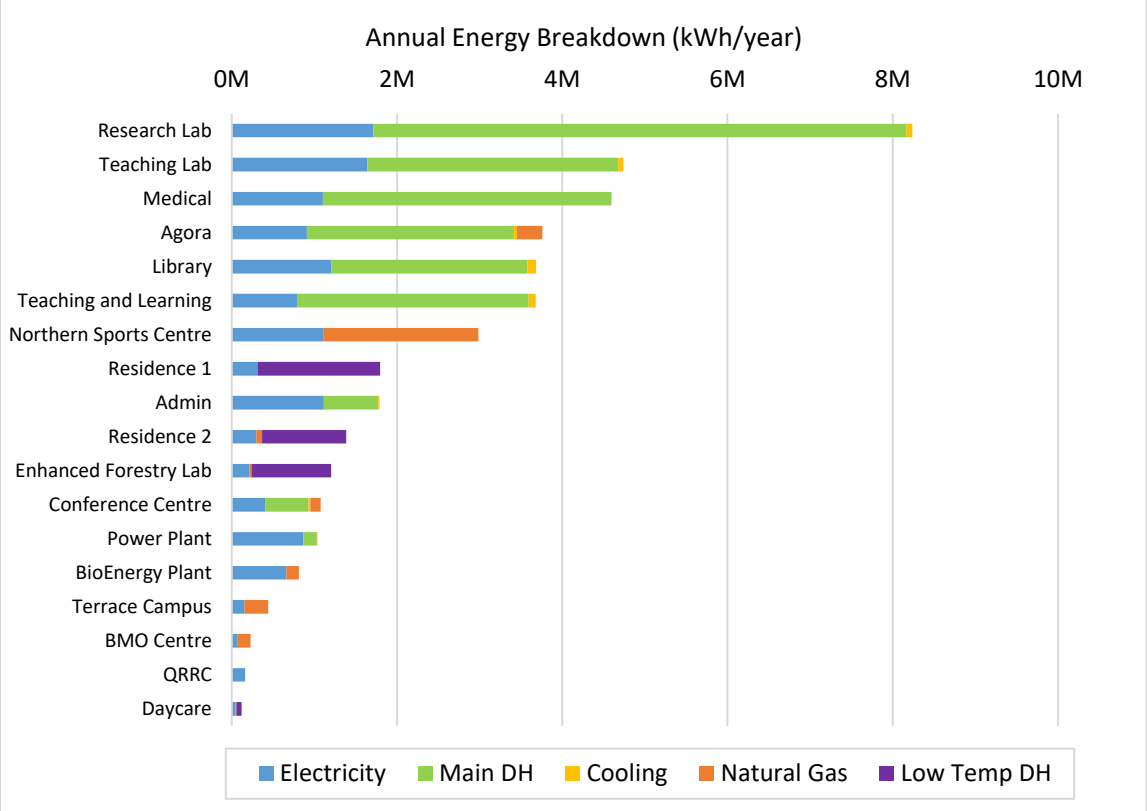

Figure 3 – FY2018 Breakdown by Building

Figure 3 shows the magnitude of the energy used by each building, however, does not show how the buildings are performing compared to each other. In order to determine performance of our buildings, we correct for building floor area and compare the buildings with similar purposes as seen in Table 3.

As displayed in Figure 3 and Table 3 the laboratory buildings are the highest consumers of energy both in terms of total energy and energy intensity. Laboratories account for 45% or our energy consumption, but only 21% of the total floor space. Lab buildings operate 24 hours a day and condition 100% outdoor air since recirculation of air is prohibited, resulting in high energy demands. The Enhanced Forestry Lab (EFL) greenhouse is the highest in terms of energy used per square meter due to the large heating requirements of the space and the poor insulation due to the amount of glass.

Table 3 – FY2018 Energy Intensity and Cost Intensity by Building

	Building Area	Annual Consumption	Annual Cost	Energy Intensity	Cost Intensity
	m2	kWh/year	$/year	kWh/m2/year	$/m2/year
Laboratories					
Enhanced Forestry Lab	931	1,204,700	$31,889.62	1,294	34
Medical	4,468	4,594,856	$147,814.46	1,028	33
Research Lab	7,581	8,238,304	$250,583.77	1,087	33
Teaching Lab	7,921	4,739,356	$192,865.49	598	24
Subtotal	20,901	18,777,216	$623,153.35	898	30
Industrial					
Bioenergy Plant	1,046	811,668	$62,190.54	776	59
Power Plant	1,253	1,037,389	$78,324.36	828	63
Subtotal	2,299	1,849,057	$140,514.90	804	61
Administrative					
Conference Centre	3,253	1,077,485	$49,159	331	15
Agora	8,556	3,758,121	$128,534	439	15
Teaching and Learning	10,130	3,679,712	$117,845	363	12
Library	11,754	3,683,193	$149,457	313	13
Terrace Campus	1,314	441,661	$36,142	336	28
BMO Centre	1,320	226,542	$14,406	172	11
Childcare Centre	639	117,687	$4,730	184	7
QRRC	812	160,896	$18,761	198	23
Admin	9,161	1,789,517	$108,114	195	12
Subtotal	46,939	14,934,815	$627,148.30	318	13
Recreational/Accommodations/Other					
Northern Sports Centre	13,485	2,984,584	$147,960	221	11
Residence 1	7,425	1,797,163	$43,448	242	6
Residence 2	7,425	1,384,923	$39,368	187	5
Maintenance Building	352	47,208	7,148	134	20
Subtotal	28,687	6,213,878	237,924	217	8
Total	98,826	41,774,967	1,628,741	423	16

The average Building Energy Performance Index (BEPI) for UNBC in FY2018 was 423 kWh/year/m^2: a 5% decrease from last year. This decrease in BEPI, however is mainly a return to normal, as FY2017 was significantly colder than previous years and saw an increase of 7%.

Compared to other institutions, the UNBC BEPI of 423 kWh/year/m^2 was significantly below the outdated 719 kWh/year/m^2 reported by Natural Resources Canada for Canadian universities and colleges in 2003. Though there are more recent Canadian BEPIs being reported, there has been little updated data for universities and colleges. Additionally, the different breakdowns in building functions (laboratories, administrative, etc), and differences in climates can make comparing any average BEPI difficult. For example, Prism Engineering compared the Energy Intensity for 6 different colleges and found an average intensity of 266 kWh/m^2/year. However, all 6 institutions

are located in the Lower Mainland and Vancouver Island where the climate is milder than Northern BC. Furthermore, none of the 6 institutions are research intensive, whereas UNBC has several Lab buildings which significantly increase the average BEPI. That said, UNBC's average electricity BEPI was 129 kWh/m^2/year, which is slightly lower than the Prism benchmark average of 134 kWh/m^2/year.

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 applies, each year, for incentive funding from BC Hydro to help implement electricity efficiency projects. UNBC also receives funding from the Ministry of Advanced Education Carbon Neutral Capital Program (AVED 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 a 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 FY2018, the Loan Fund facilitated over $1,317,000 of spending towards energy efficiency projects. A summary of the Revolving Loan cash flow can be seen in Figure 4. The implemented projects have saved roughly $1,278,000 in utility costs, with net utility savings of $549,000 after loan repayments.

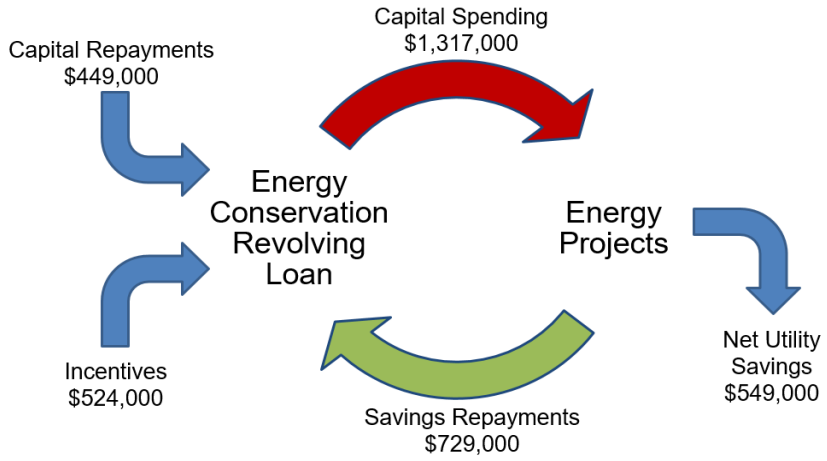

Figure 4 - Revolving Loan Summary

2.3. ENERGY COMMITMENTS AND TARGETS

UNBC has developed a new Energy Policy to replace the previous 2011 policy. New energy targets have been established, which set the following goals:

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

Reductions are based on a comparison with the 2009/2010 baselines which are corrected for building floor space and variations in weather.

Target achievement not only involves implementing energy efficiency projects, but requires the participation, engagement, and support of students, faculty, staff, and senior administration. To help reach the above target, UNBC will claim 552,000 kWh worth of energy efficiency projects in FY2019 as part of the Energy Manager Program, and has committed to completing employee engagement programs supported by BC Hydro.

3. ENERGY INITIATIVES

The EM program keeps a detailed list of energy projects to meet its energy reduction targets. The list is updated and prioritized regularly to address the operational issues and requirements of the campuses as they arise. In addition, projects are planned and scheduled based on internal capacity, and the availability of funding.

A full list of completed and in-progress projects and studies is included in the Appendix.

3.1. FY2019

In FY2019, UNBC will complete projects estimated to save 552,000 kWh of electricity annually resulting in a 4.3 % reduction of electricity use. All 552,000 kWh of savings will count towards the BC Hydro Energy Manager target as summarized in Table 4.

Table 4 - FY2019 BC Hydro Incentive Project Summary

Project	BC Hydro Number	Annual Electricity Savings (kWh/y)	Project Cost ($)	Incentives		Payback (y)
				BC Hydro	CNCP	
Library: Medical Lighting	BCH-04867	64,000	$84,660	$11,517		17.0
Library: Wavelinks Lighting	BCH-04866	122,000	$214,200	$21,713	$65,385	15.5
Residence 2 Heating System Conversion	BCH-04873	366,000	$100,000			4.1
Subtotal		552,000	$398,860	$33,230	$65,385	8.1

3.1.1. LED LIGHTING RETROFITS

The Prince George campus is undergoing extensive lighting upgrades to replace magnetic-ballasted linear fluorescent fixtures from the original campus built over 20 years ago. The magnetic ballasts are starting to fail resulting in inoperable lights, however, even working ballasts are responsible for flickering lights, humming, and high energy consumption.

In FY2019 the Library will have the remainder of its lighting upgraded to LED. Once that is done, partial or complete retrofits will have been completed in all of the original buildings.

3.1.2. 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 created to deliver upgrades and retrofits to key systems, equipment, and controls in each of the 9 buildings over three phases, starting with the buildings that had the highest savings potential. In FY2019 the C.Op Program will be fully wrapped up with the completion of the Q4 Coaching Report

for the Conference/NUSC, Library, and Teaching & Learning buildings. The results of each phase are summarized in Table 5.

Table 5 – Continuous Optimization Program Results

			Before C.Op Program						After C.Op Program			
			Annual Energy Consum.			Annual Utility Cost			Implem. Cost	Simple Payback	Energy Savings	
Phase	C.Op #	Building	Elec kWh/ft2/yr	Fuel GJ/ft2/yr	Total ekWh/ft2/yr	Elec $/ft2/yr	Fuel $/ft2/yr	Total $/ft2/yr	$/ft2	Years	Elec % kWh	Total $/yr
3	10-417	Library	15.75	0.05	28.47	1.05	0.23	1.29	0.39	1.0	16.1	21,670.68
3	10-418	Conference	15.51	0.11	46.15	1.04	0.56	1.60	0.52	1.6	22.4	8,246.56
3	10-422	T&L	8.47	0.06	24.41	0.57	0.29	0.86	0.29	1.3	24.0	15,000.90
2	10-414	NSC	10.99	0.05	24.96	0.66	0.54	1.20	0.24	0.6	13.9	13,433.64
2	10-415	Admin	16.16	0.02	20.37	1.08	0.08	1.16	0.18	1.0	24.4	26,305.94
2	10-421	Medical	24.61	0.21	82.60	1.48	1.06	2.54	0.19	1.4	0.9	593.04
1	10-416	Research Lab	24.43	0.29	104.19	1.47	1.46	2.93	0.37	1.2	14.1	17,595.60
1	10-419	Agora	14.49	0.10	42.20	0.87	0.51	1.38	0.28	1.0	17.4	13,470.18
1	10-420	Teaching Lab	29.68	0.22	89.52	1.78	1.10	2.88	0.56	1.2	16.7	25,672.92
		Total										$ 141,989.46

Table 5 shows that the largest consumers of energy per unit floor area, as mentioned throughout this report, are the lab buildings including Medical, Research Lab, and Teaching Lab. Accordingly, two of the labs were addressed in Phase 1 of C.Op.

Phase 1 resulted in the greatest savings of the three phases with $56,738/yr; Phase 3 resulted in savings of $44,918/yr; and Phase 2 resulted in savings of $40,332/yr. Therefore, a total of approximately $142,000 in electrical operating costs is anticipated to be saved annually by the university as a result of C.Op.

When it comes to individual performance in terms of gross dollars saved, C.Op was most effective for the Admin building with the Teaching Lab coming in a close second. When the metric is adjusted to account for floor area of both buildings, their order reverses. It is also worth noting that the Medical building saw a limited return on investment (80% lower than targeted) in its first measured year (though this may change in future years), meaning the payback period will likely be longer than anticipated. Regardless of order, every building saw tangible benefits from participating in the C.Op program and the return on investment will extend well into the future for UNBC.

3.1.3. ENERGY WISE

UNBC is an active participant in the BC Hydro Energy Wise Network. As part of the network, we will complete three employee engagement campaigns in FY2019, with the help of the UNBC Green Team, to promote energy conservation on campus.

3.1.4. ENERGY MANAGEMENT ASSESSMENT (EMA)

UNBC completed an EMA in December 2017 to identify new priorities and opportunities to improve the Energy Management program. Recommended actions included:

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.

3.2. FY2020

In FY2020 we will continue the replacement of magnetic-ballasted lighting from the original campus. The focus will be to complete the Administration building (Charles J McCaffray Hall), and Agora. In addition, we will upgrade the HVAC system in our server room (postponed from 2019), investigate opportunities for free cooling around the central chilled water system, and design a heat recovery system for the Bioenergy Plant. The projects outlined in Table will reduce electricity consumption by 2.4% compared to FY2010.

Table 6 - FY2020 Project List

Project	Annual Electricity Savings (kWh/y)	Project Cost ($)	Incentives ($)	Payback (y)
Admin 1st Floor Lighting	36,000	$40,000	$7,200	16.6
Agora Lighting	111,000	$120,000	$22,200	16.1
EFL Grow Lights	56,000	$50,000	$10,000	13.3
Research Lab Lighting	200,000	$330,000	$20,000	17.5
Server Room HVAC	70,000	$100,000	$63,000	7.9
Subtotal	473,000	$640,000	$122,400	16.3

CNCP funding and BC Hydro Custom Incentive funding is expected for the FY2020 projects. The remaining costs will be covered by the Loan Fund.

3.3. FY2021

In FY2021, we will replace the remaining magnetic-ballasted fixtures in the Research Lab which will complete the original campus lighting upgrades.

The FY2021 year will see 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 seven years. A refined list of projects will be formed over the upcoming year, and will be included in next year's report.

3.4. LOW CARBON ELECTRIFICATION

The purpose of low carbon electrification 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, diesel for backup electricity generation, and the vehicle fleet.

This fiscal year 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, while adding 2200 kWh to the annual electrical consumption.

A pilot project is proposed to gather data on the effectiveness of heat pumps in a cold climate. This would see the install of a heat pump at the NSC to provide partial offset of the heating requirements for one of the large air handlers at the indoor soccer field. 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 this facility.

After the successful conclusion of the 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.

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 17% reduction in energy use compared to FY2010.

Figure 5 also shows how UNBC has successfully reduced its natural gas consumption by 72%. 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. In the fall of FY2017, the Low-temperature 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 the Childcare Centre were converted to hot water systems and connected to the Low-temperature DH system. Now only 3 of UNBC's 22 buildings use natural gas as their primary means of heating.

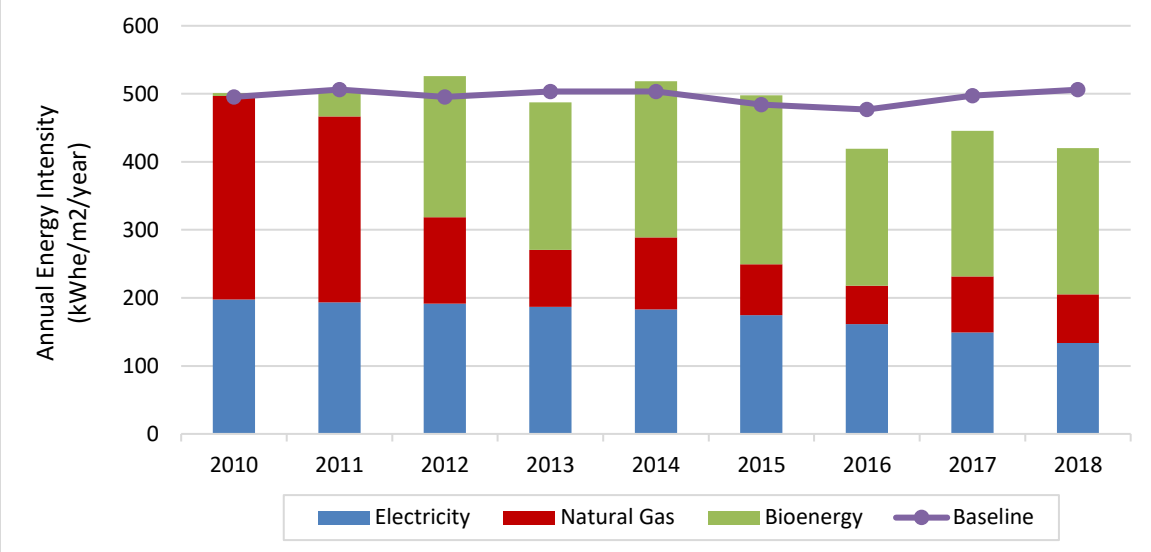

Figure 5 - Historical Energy Intensity

UNBC has seen an overall reduction of 21% in utility costs since FY2010, as shown in Figure 6. Compared to the baseline energy cost, UNBC has seen a utility cost reduction of 34%.

The significant overall cost reduction is due to the commissioning of the Bioenergy Plant in FY2011. The hog fuel used by the Bioenergy Plant is roughly half of the cost of the equivalent amount of natural gas. In addition, UNBC started purchasing natural gas for its two largest accounts from Shell Canada in FY2015, which has lowered natural gas costs by $98,000 to date.

Though UNBC has achieved a 34% reduction in electricity use, the increasing rates of electricity have lead to a 13% cost increase. However, compared to the baseline electricity cost (if we had not reduced our electricity consumption), our electricity costs have decreased by 33%.

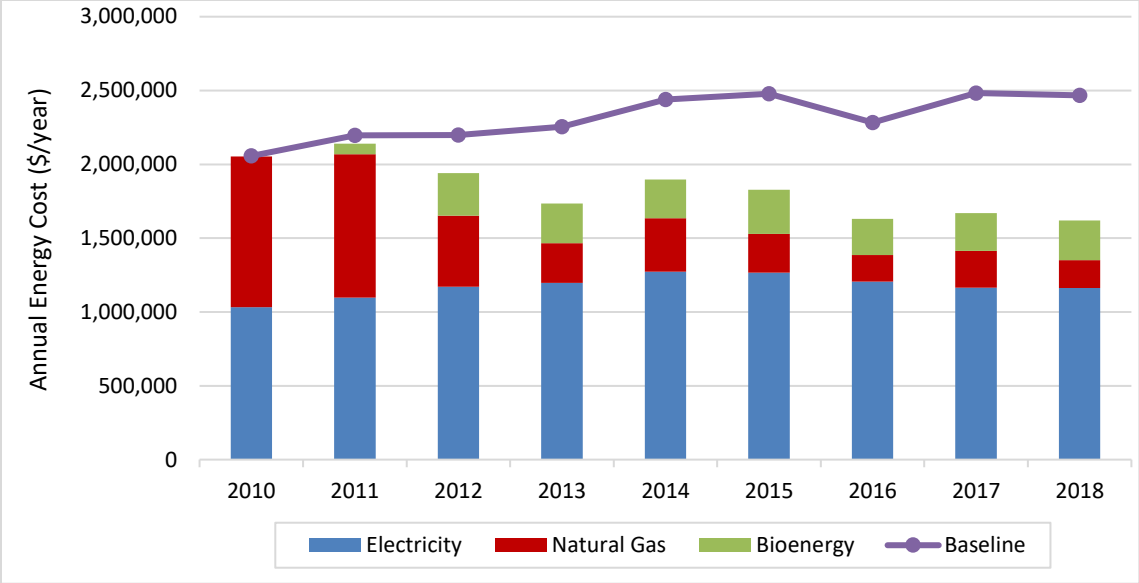

Figure 6 - Historical Energy Cost

4.1. ELECTRICITY SAVINGS

Since FY2010, UNBC has reduced electricity consumption by 34% as shown in Figure 7. Compared to last year, UNBC decreased electricity consumption by 1,575,914 kWh or 10%. This significant decrease in consumption is due primarily to the strong focus on electricity reduction projects.

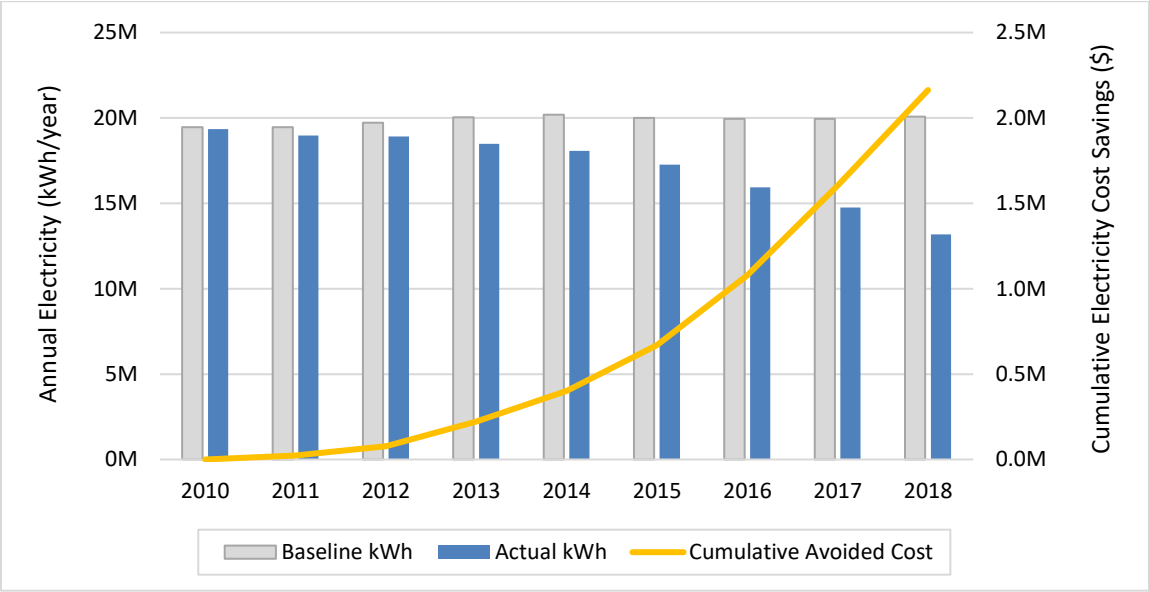

Figure 7 - Historical Electricity Consumption

UNBC saved $1,000 in electricity costs compared to last year. However, compared to the baseline cost, UNBC avoided $559,000 in electricity costs. Since FY2010, UNBC has avoided the purchase of $2.1 million worth of electricity due to its efficiency and conservation efforts.

4.2. HEAT SAVINGS

Since FY2010, UNBC has successfully reduced natural gas consumption by 76%, by converting to bioenergy on the Prince George Campus. However, with the start-up of the Bioenergy Plant, our total purchased heat increased slightly, and has just returned to FY2010 levels, 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. An energy density of 18.848 GJ/bdt was used to calculate the energy content of the purchased bioenergy.

The reason for the increase in purchased heat is due to the difference in efficiencies between the Bioenergy Plant and the natural gas boilers that originally provided the heat to the Main district heating loop. 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, likely resulting in a lower efficiency. In addition, the efficiency of the Bioenergy Plant is slightly lower than the NG boilers at full capacity, and can vary widely depending on the moisture content of the fuel, the time between boiler cleanings, and operator interventions.

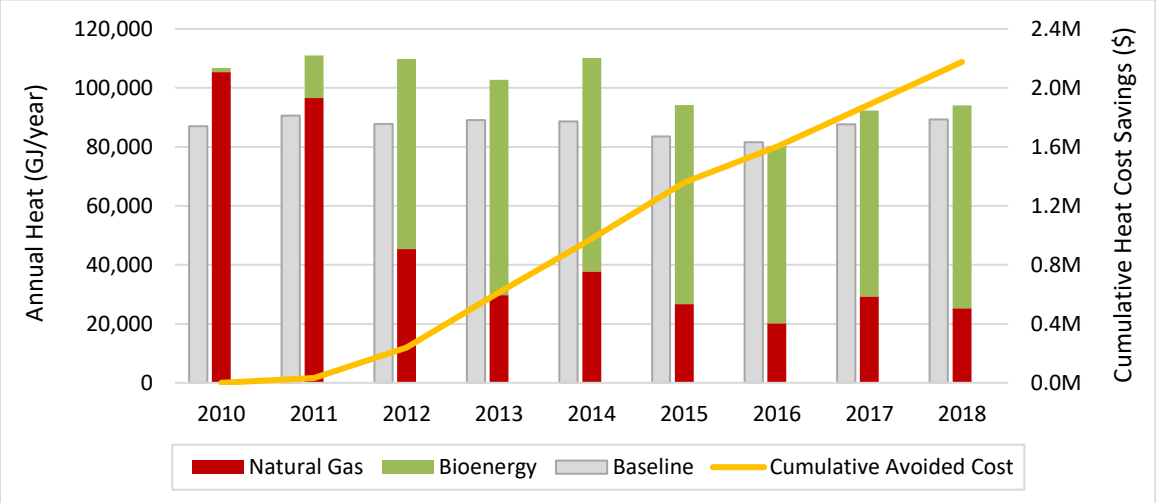

Figure 8 - Historical Heat Consumption

Comparing to FY2012 when the Bioenergy Plant came online, we have seen an 14% decrease in purchased heat, roughly 17,000 GJ. This is nearly twice the expected savings of 9,000 GJ from completed heat reduction projects such as Continuous Optimization, low-flow showerheads in the Residences, and the Power Plant air handler controls upgrade. Similarly, the submeter heat data from the buildings on the Prince George Campus show a 23% reduction in heating since they were installed in 2012.

Since the commissioning of the Bioenergy Plant, UNBC has cut heating costs by $2.1 million. The hog fuel used by the Bioenergy Plant is roughly half the cost of the equivalent amount of natural gas. In addition, UNBC started purchasing natural gas at the market price for its two largest accounts in FY2015, which has lowered natural gas costs by $98,000 to date.

5. SUMMARY

Over the past 8 years, the UNBC EM program has brought in $818,000 in incentives and $624,000 in salary reimbursements, and has implemented projects which have saved roughly $1,641,000 in utility costs. Including the savings attributed to the Bioenergy Plant and Wood Pellet Plant, UNBC has saved a total of $4,339,000 on utilities. Figure 9 shows the breakdown of the close to $6 million value of UNBC's sustainable operations.

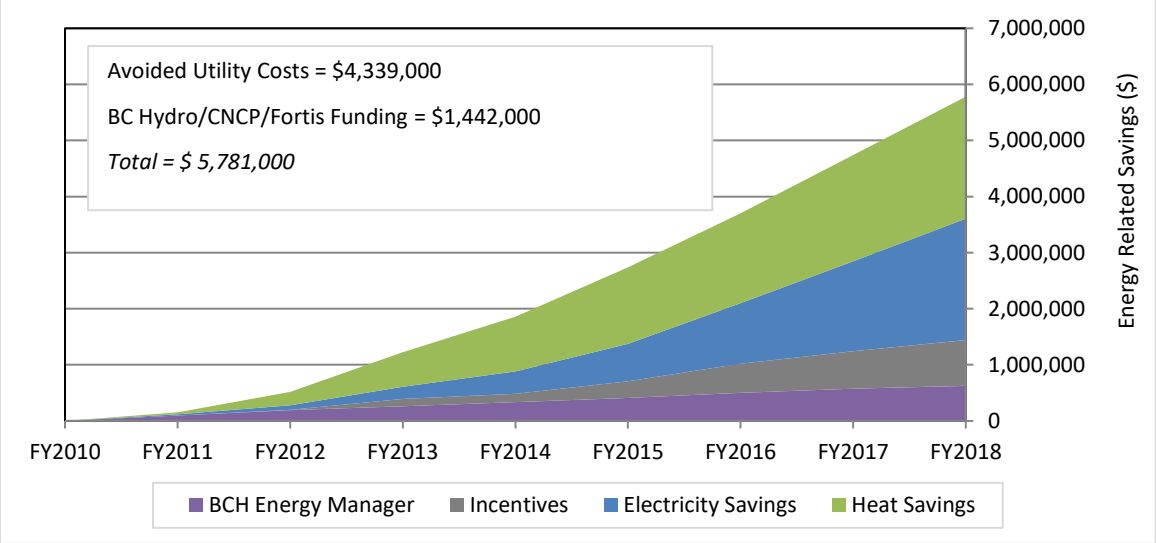

Figure 9 - Energy Management and Utility Savings

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	-	3,700	1	0	0	6,000	0	0	0	0	401	2,464	Aug-10
2	Terrace Boiler Replacement	Terrace	-	0	0	300	0	45,000	0	0	0	0	5,219	34,228	Oct-10
3	Green Centre Lighting	Main	-	1,240	0	0	0	640	0	0	0	0	135	807	Jan-11
4	Wintergarden Lights	Main	-	2,630	1	0	0	640	0	0	0	0	245	1,499	Jan-11
5	Agora North Entrance Lighting	Main	PSPX110586	999	0	0	0	476	218	0	0	0	60	388	Apr-11
6	Rotunda Gallery Lighting	Main	PSPX110587	5,931	1	0	0	1,987	1,165	0	0	0	553	3,295	May-11
7	Rotunda Gallery Ramp Lighting	Main	PSPX111364	2,475	1	0	0	774	390	0	0	0	231	1,375	May-11
8	NUSC Event Space (Round 1)	Main	PSPX111455	960	1	0	0	402	160	0	0	0	145	814	May-11
9	Thirsty Moose Lighting	Main	PSPX101130	6,034	2	0	0	2,311	1,412	0	0	0	655	3,718	Sep-11
10	Bookstore/Cafeteria Lighting	Main	PSPX100434	20,796	7	0	0	6,684	3,258	0	0	6,684	2,256	12,551	Dec-11
11	Admin Chiller for electrical vault	Main	-	98,600	11	0	0	70,000	0	0	0	0	7,569	44,210	Mar-12
12	T&L Daylight Harvesting	Main	-	9,519	2	0	0	0	0	0	0	0	862	4,856	Mar-12
13	Medical AV free cooling	Main	-	22,950	3	0	0	11,000	0	0	0	0	1,762	10,178	Apr-12
14	Residence Lighting	Main	SUCH11-965	284,000	0	0	0	61,547	24,090	0	0	61,547	17,106	104,118	May-12
15	NUSC Event Space	Main	PSPX110510	11,344	7	0	0	6,090	2,474	0	0	6,090	1,710	8,520	Jun-12
16	Lecture Theatre Lighting	Main	PSPX113112	78,705	26	0	0	22,811	11,988	0	0	22,811	8,540	44,849	Jun-12
17	Terrace Campus lighting upgrade	Terrace	PSPX153073	16,599	0	0	0	14,805	3,994	0	0	14,396	1,950	8,608	Jun-12
18	Residence Lighting	Main	PSPX112054	14,414	0	0	0	17,216	3,208	0	0	17,216	868	5,174	Jul-12
19	Coil Cleaning	Main	SUCH12-1077	195,000	39	0	0	23,523	9,684	0	0	23,523	17,328	92,471	Aug-12
20	NSC Soccer Field and Gym	NSC	SUCH12-1103	182,000	56	0	0	135,188	41,160	0	0	0	19,533	99,287	Sep-12
21	Canfor/Warehouse	Main	SUCH12-1112	99,000	22	0	0	53,046	21,214	0	0	0	9,158	46,096	Dec-12
22	EFL Cold Storage Lighting	Main	PSPX130081	1,181	0	0	0	578	139	0	0	0	119	579	Jan-13
23	QRRC Lighting Upgrade	QRRC	PSPX112392	7,752	3	0	0	5,129	1,258	0	0	5,129	826	3,609	Mar-13
24	Agora Daylight Harvesting	Main	-	24,600	6	0	0	0		0	0	0	2,295	10,588	Jun-13
25	Residence Low-flow showerheads	Main	-	0	0	1,400	0	696	0	0	0	696	12,607	48,226	Jul-13
26	Admin Daylight Harvesting	Main	-	33,000	8	0	0	0		0	0	0	3,079	13,981	Jul-13
27	Exterior Lighting - globes	Main	BCH-00377	66,000	0	0	0	106,629	18,152	0	0	42,936	4,365	19,300	Nov-13
28	Teaching Lab Pot lights/Agora exterior	Main	-	15,868	0	0	0	6,950	0	0	0	6,950	1,237	4,209	May-14
29	Teaching Lab Pot lights/Agora exterior	Main	BCH-01166	59,000	13	0	0	26,433	2,935	0	0	26,433	7,440	16,414	Feb-15
30	Medical Humidifier	Main	BCH-01716	476,000	66	0	-280	151,240	74,941	0	0	151,240	52,083	115,943	Feb-15
31	Teaching Lab Penthouse Lighting	Main	PSPX142369	1,022	0	0	0	781	105	0	0	781	166	360	Feb-15
32	Reef Tank Lighting	Main	-	2,300	0	0	0	1,664	0	0	0	700	255	568	Feb-15
33	Power Plant AHU controls	Main	-	40,000	6	450	0	68,430	0	25,811	48,661	19,769	7,818	15,847	Mar-15
34	Research Lab C.Op	Main	BCH-02086	214,000	0	0	1,146	58,598	0	0	0	58,598	30,505	58,224	May-15
35	Agora C.Op	Main	BCH-02087	218,000	0	0	1,031	59,694	0	0	0	59,694	29,956	57,256	May-15
36	Teaching Lab C.Op	Main	BCH-02088	264,000	0	0	3,228	72,290	0	0	0	72,290	52,514	99,186	May-15
37	Conference/NUSC Solar PV	Main	-	5,000	5	0	0	30,287	0	0	0	5,986	1,247	1,874	Sep-15
38	Workplace Conservation Awareness	Main	BCH-02090	304,636	0	0	0	5,311	4,935	0	0	0	33,641	39,289	Jan-16
39	Workplace Conservation Awareness	NSC	BCH-02090	32,222	0	0	0	0	0	0	0	0	3,612	4,219	Jan-16
40	Workplace Conservation Awareness	QRRC	BCH-02090	4,303	0	0	0	0	0	0	0	0	480	560	Jan-16
41	Workplace Conservation Awareness	Terrace	BCH-02090	2,821	0	0	0	0	0	0	0	0	325	378	Jan-16
42	Workplace Conservation Awareness	Bio	BCH-02090	13,240	0	0	0	0	0	0	0	0	1,484	1,734	Jan-16
43	Main campus streetlights/wallpacks	Main	BCH-02693	167,000	0	0	0	164,188	45,160	0	44,700	118,107	18,442	21,538	Jan-16
44	NSC Exterior lighting	NSC	BCH-02694	86,000	0	0	0	60,027	20,717	0	0	60,027	9,642	11,260	Jan-16
45	Conf/NUSC Air Handler HW conversion	Main	-	0	0	846	-816	6,368	0	0	6,368	0	925	1,322	Jan-16
46	Medical C.Op	Main	BCH-02089	48,000	0	0	207	1,284	0	0	0	0	7,140	7,140	Mar-16
47	NSC C.Op	NSC	BCH-03368	453,000	0	1,922	0	27,028	0	0	0	22,702	65,578	65,578	Mar-16
48	Admin C.Op	Main	BCH-03370	144,000	0	0	741	-13,627	0	0	0	5,119	22,405	22,405	Mar-16
49	Energy Wise FY2017	Main	BCH-03654	0	0	0	0	270	267	0	0	0	0	0	Apr-16
50	Terrace exterior lighting (PSPX)	Terrace	PSPX111693	504	0	0	0	162	77	0	0	162	53	53	Apr-16
51	Terrace Exterior Lighting	Terrace	-	4,896	0	0	0	9,073	0	0	0	1,811	517	517	Apr-16

	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
52	Main campus wallpacks	Main	BCH-03047	53,000	0	0	0	20,411	8,073	0	0	10,515	3,505	3,505	Aug-16
53	Residence 1 Heating System Conversion	Main	Program Enabled	386,700	69	3,000	-4,500	500,000	0	0	0	100,000	26,057	26,057	Aug-16
54	Residence 1 Heating System Conversion	Bio	Program Enabled	-37,200	-4	0	0	0	0	0	0	0	-2,870	-2,870	Aug-16
55	Corner Store Reno	Main	PSPX153444	1,230	0	0	0	2,047	333	0	0	0	116	116	Aug-16
56	BMO Boiler Replacement	BMO	-	0	0	0	0	0	0	4,050	0	0	0	0	Oct-16
57	Admin Lighting Upgrade	Main	Program Enabled	118,000	17	0	0	103,498	0	0	40,952	0	0	0	Mar-17
58	Residence 2 Heating System conversion	Res	BCH-04873	366,000	67	2,000	-3,500	100,000	0	0	0	0	6,959	6,959	Jun-18
59	Daycare Heating System conversion	DC	-	0	0	400	-400	-	0	0	0	0	243	243	Aug-17
60	Power Plant Boiler Bypass/DHW Tank	Main	-	0	0	0		98,184	0	0	0	0	0	0	Sep-17
61	Library Lighting -1st Floor	Main	BCH-04148	139,000	46	0	0	70,409	20,013	0	35385	33,242	5,151	5,151	Aug-17
62	Conf/NUSC Lighting	Main	BCH-04149	69,000	12	0	0	52,659	10,768	0	29978	20,354	2,038	2,038	Aug-17
63	Library C.Op	Main	BCH-04061	384,000	0	0	2,366	31,479	0	0	0	12,303	11,284	11,284	Sep-17
64	Conf/NUSC C.Op	Main	BCH-04062	61,000	0	0	1,118	12,542	0	0	0	4,838	3,450	3,450	Sep-17
65	T&L C.Op	Main	BCH-04063	159,000	0	0	1,799	34,700	0	0	0	20,128	6,503	6,503	Sep-17
66	Soccer Field lighting controls	NSC	BCH-04240	55,000	3	0	0	28,288	8,119	0	0	28,288	658	658	Oct-17
67	Power Plant/Utilidor Lighting	Main	BCH-04146	94,000	11	0	0	34,718	9612	0	0	15,699	1,209	1,209	Jan-18
68	Daycare/Research Lab/PP Highbays	Main	BCH-04147	81,000	14.0	0	0	36,040	11,394	0	0	12,826	1,154	1,154	Jan-18
69	Recycling Room Lighting	Main	PSPX170052	1,030	0.3	0	0	878	0	0	0	504	9	9	Feb-18
	Total			**5,676,001**	**521**	**10,318**	**2,140**	**2,488,611**	**361,413**	**29,861**	**206,044**	**1,070,092**	**434,896**	**1,633,368**	

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 ($)	Expected Completion Date	Payback (y)	Expected Completion Date
70	Library-Medical Lighting	Main	BCH-04867	64,000	31	0	0	77,000	11,517	0	0	65,483	4,480	14.6	Oct-18
71	Library - Wavelinks Lighting	Main	BCH-04866	122,000	47	0	0	195,000	21,713	0	63,000	173,287	8,540	12.9	Oct-18
72	Server Room HVAC - free cooling	Main	BCH-04865	70,000	18	0	0	100,000	0	0	0	100,000	4,900	20.4	Jul-19
	Total			**256,000**	**96**	**0**	**0**	**372,000**	**32,230**	**0**	**63,000**	**338,770**	**17,920**	**15.4**	

APPENDIX C – POTENTIAL PROJECTS IN FY2020

	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
73	Admin 1st Floor Lighting	Main		36,000	9	0	0	40,000	7,200	0	0	40,000	2,520	13.0	Aug-19
74	Agora Lighting	Main		111,000	28	0	0	120,000	22,200	0	0	120,000	7,770	12.6	Aug-20
75	EFL Grow Lights	Main		50,000	13	0	0	50,000	10,000	0	0	50,000	3,500	11.4	Mar-20
76	Research Lab Lighting	Main		200,000	79	0	0	330,000	20,000	0	65,000	245,000	14,000	17.5	Oct-19
77	EFL Optimization	Main	-	tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd
	Total			**397,000**	**128**	**0**	**0**	**540,000**	**59,400**	**0**	**65,000**	**455,000**	**27,790**	**15.0**	

APPENDIX D – COMPLETED STUDIES

Study	Campus	BC Hydro Project Number	Cost ($)	BC Hydro Incentive ($)	Revolving Loan Contribution ($)	CNCP Funding ($)	Completion Date
Renewable energy study	Main	-	5,000	0	0	0	Sep-11
Ice Mountain study	Main	-	0	0	0	0	Nov-11
Anaerobic Digester study (ENVS417)	Main	-	0	0	0	0	Dec-12
Medical Humidifier study (PHYS402)	Main	-	0	0	0	0	Dec-12
Lab Heat Recovery study (ENSC499)	Main	-	0	0	0	0	Apr-13
C.Op Investigation - Research Lab	Main	COP10-416	16,028	15,768	16,028	0	Oct-13
C.Op Investigation - Agora	Main	COP10-419	15,891	15,587	15,891	0	Oct-13
C.Op Investigation - Teaching Lab	Main	COP10-420	16,442	16,175	16,442	0	Oct-13
C.Op Investigation - Medical	Main	COP10-421	12,922	12,713	12,922	0	Oct-13
C.Op Investigation - Admin	Main	COP10-415	18,418	18,119	18,418	0	Aug-14
C.Op Investigation - NSC	NSC	COP10-414	20,665	20,330	20,665	0	Aug-14
C.Op Handoff - Research Lab	Main	COP10-416	2,643	2,600	2,643	0	Jul-15
C.Op Handoff - Agora	Main	COP10-419	2,562	2,520	2,562	0	Jul-15
C.Op Handoff - Teaching Lab	Main	COP10-420	2,562	2,520	2,562	0	Jul-15
Bioenergy Heat Recovery study (ENVS417)	Main	-	0	0	0	0	Dec-15
C.Op Investigation - Library	Main	COP10-417	19,740	19,420	19,740	0	May-16
C.Op Investigation - Conference/NUSC	Main	COP10-418	11,482	11,295	11,482	0	May-16
C.Op Investigation - T&L	Main	COP10-422	14,861	14,620	14,861	0	May-16
C.Op Handoff - Medical	Main	COP10-421	4,361	4,290	4,361	0	Jul-16
C.Op Handoff - Admin	Main	COP10-415	2,767	2,723	2,767	0	Jul-16
C.Op Handoff - NSC	NSC	COP10-414	2,863	2,817	2,863	0	Jul-16
C.Op Coaching - Research Lab	Main	COP10-416	3,384	3,329	3,384	0	Nov-16
C.Op Coaching - Agora	Main	COP10-419	8,484	4,312	8,484	0	Nov-16
C.Op Coaching - Teaching Lab	Main	COP10-420	6,616	4,308	6,616	0	Nov-16
Boiler Power/Plant Controls Study	Main	-	24,433	0	0	24,433	Mar-17
C.Op Handoff - Library	Main	COP10-417	4,792	4,714	4,792	0	Aug-17
C.Op Handoff - Conference/NUSC	Main	COP10-418	2,858	2,811	2,858	0	Aug-17
C.Op Handoff - T&L	Main	COP10-422	3,615	3,556	3,615	0	Aug-17
C.Op Coaching - NSC	NSC	COP10-414	5,578	5,488	5,578	0	Dec-17
C.Op Coaching - Admin	Main	COP10-415	4,023	3,958	4,023	0	Dec-17
C.Op Coaching - Medical	Main	COP10-421	1,799	1,770	1,799	0	Dec-17
C.Op Coaching - Library	Main	COP10-417	4,396	4,325	4,396	0	Aug-18
C.Op Coaching - Conference/NUSC	Main	COP10-418	3,507	3,450	3,507	0	Aug-18
C.Op Coaching - T&L	Main	COP10-422	3,507	3,450	3,507	0	Aug-18
Cooling Tower Review	Main	BCH-04450	11,690	1928	0	11,690	Mar-18
EFL Optimization	Main	BCH-04450	11,385	1928	11,385	0	Mar-18
Total			**269,273**	**210,822**	**228,151**	**36,123**	

APPENDIX E – STUDIES IN PROGRESS

Project	Campus	BC Hydro Project Number	Cost ($)	BC Hydro Incentive ($)	Revolving Loan Contribution ($)	CNCP Funding ($)	Completion Date
District Cold Water free cooling	Main	-	20,000	0	0	0	Mar-18
Server Room free cooling	Main	-	10,000	0	0	0	Mar-18
Total			**62,096**	**31,575**	**32,096**	**0**	

APPENDIX F – COMMERCIAL ENERGY MANAGER LCE PROJECT FORECAST

Sector	Public or Private	Customer Name	Region	Description of Measure	Standard LCE Measure name (Use drop down)	New or Retrofit	Electrical Consumption (kWh/y)		Average Monthly Demand (kW)		
							Current	Incremental (+/-)	Current	Incremental (+/-)	Months
Education - Adv	Public	UNBC	North	Pilot project - heat pump on Northern Sports Center	HVAC Air-to-Air Heat Pump (ductless or minisplit)	Retrofit	1,182,600	140,000	228	16	6
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

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 (+/-)	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
6,032	-1500	-73	$ 7,784	$ 1,076	-$ 11,145	$ -	-$ 1,833	-$ 4,118	$ 72,000	$ 72,000		18	17.5
6,032	-5200	-258	$ 7,228	$ 2,690	-$ 38,636		-$ 6,448	-$ 35,166	$ 1,472,000	$ 1,472,000		18	41.9