99 Lone Pine Rd.

Georgian Bay, ON L0K 1S0

Climate Action Roadmap | Administration Building

EFFICIENCY ENGINEERING .COM
A Kontrol Technologies Company

Township of GEORGIAN BAY

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1 The Executive Summary

Efficiency Engineering has performed a comprehensive Net Zero Retrofit Study at the Administration Building, 99 Lone Pine Rd., for the Township of Georgian Bay. The Township has set aggressive greenhouse gas reduction targets. The purpose of this study is to catalogue the existing energy consuming systems at the building, analyze energy usage within the facility and provide recommendations on how to significantly reduce GHG emissions while improving the energy and water efficiency of the facility.

This study has been developed in accordance with the Federation of Canadian Municipalities (CFM) Community Building Retrofit (CBR) initiative guidelines which require the following scenarios to be studied:

- 50% GHG reductions in 10 years
- 80% GHG reductions in 20 years
- 80% GHG reductions in 5 years

A "business-as-usual" scenario will also be developed to create a 20-year cost baseline for the purposes of comparison.

1.1 Building Overview

The following table summarizes the facility details:

Table 1.1.1: Facility Details

Building Name:	Administration Building
Client Name:	Township of Georgian Bay
Site Contact:	Jennifer
Address:	99 Lone Pine Rd.
	Georgian Bay, ON
	L0K 1SO
Facility Area:	8,373 Sq.Ft.
Building Type:	Offices with Event Spaces
Year Constructed:	2006
Number of Stories:	1

1.1.1 Existing Building Profile

The Administration Building is an 8,373 ft^2 facility primarily comprised of office spaces.

Space heating, space cooling & ventilation for the facility is primarily supplied by four propane fired rooftop units equipped with onboard DX cooling. Heating is supplemented by electric heaters in vestibules and near exterior doors.

Domestic hot water for the facility is supplied by a single electric water heater with 80 gallons of storage and 3kW heating capacity. Water fixtures at the facility consist of washroom & kitchen sinks with standard 2 gpm aerators and 1.6 gpf flushvalve toilets.

Lighting at the facility is provided primarily by T8 linear florescent lamps with metal halide pot lights. Lighting is primarily controlled via wall switches.

The building is not equipped with an automation system. Equipment operates via stand alone controls. Rooftop units are controlled by individual programmable thermostats. Exhaust fans are controlled by wall switches or thermostats.

1.1.2 Previous Energy Conservation Measures

The administration building is a relatively new construction and has not undergone significant renovations or equipment replacements.

1.1.3 Existing Energy & GHG Emissions

The facility's existing energy consumption and GHG emissions are summarized as follows:

TABLE 1.1.2: EXISTING ENERGY KPI DETAILS

Utility	Consumption	EUI* (ekWh/ft²)	Total Energy (ekWh)	Emissions (tCO_2e)	% of Total Emissions
Electricity	60,530 kWh	7.2	60,530	1.8	9%
Propane	11,275 l	9.6	79,938	17.5	91%
Total	**N/A**	**16.8**	**140,468**	**19.3**	**100%**

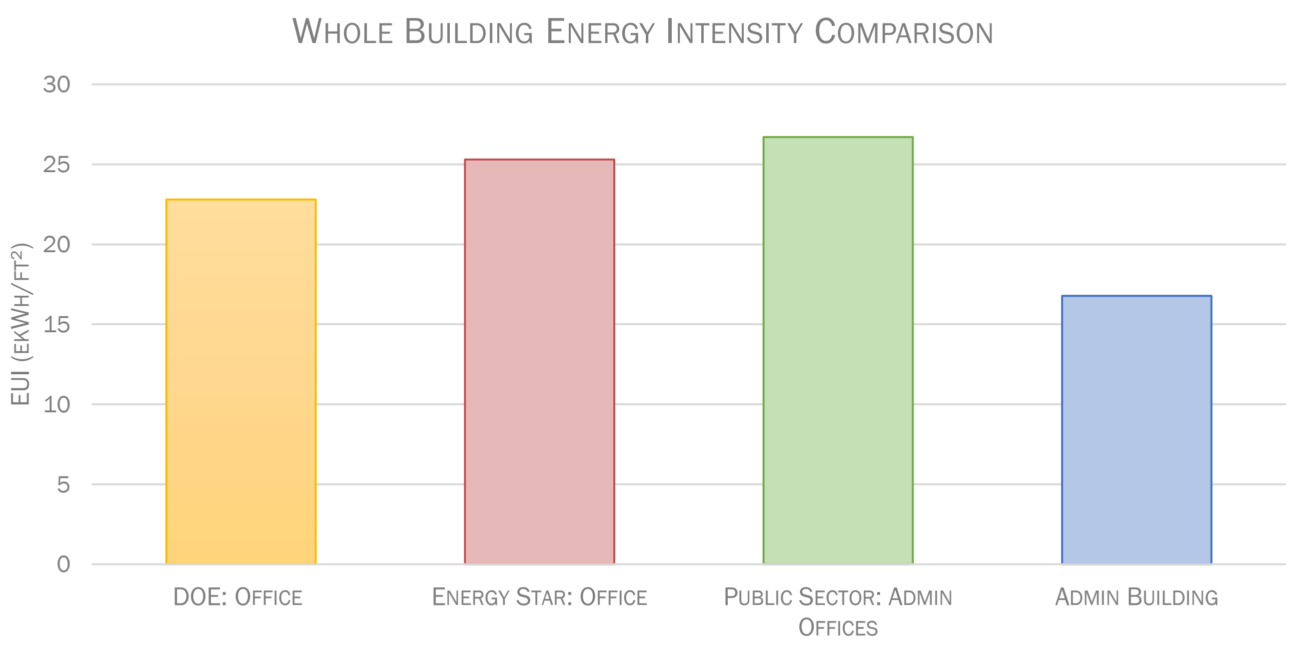
*EUI values presented throughout this report are calculated based on purchased energy and includes electricity provided by the grid, purchased propane etc.

Propane consumption at the facility is responsible for over 90% of GHG emissions at the facility. Propane fired equipment at this facility includes:

- Four (4) propane fired rooftop units totaling 595 MBH used for space heating/cooling & ventilation

Addressing this equipment with a low carbon alternative will be required to achieve either the 50% or 80% GHG reduction target.

The following benchmarking graph displays the comparative energy performance of the buildings studied as a part of this project.



1.2 Master List of Measures

Opp. #	Opportunity	Demand (kW)	Electricity (kWh)	Propane (l)	Water (m³)	GHG Emissions (tCO_2e)	Annual Savings	Project Costs	Simple Payback	Capital Payback	NPV	IRR	LC Cost per tCO2e
1	Install Ultra-low Flow Washroom Faucets	0	1,410	0	14	0.0	$336	$600	1.8	1.7	$4,700	63.5%	$0
2	Replace RTUs with ASHP RTUs & Propane Backup	0	-34,630	9,630	0	13.9	$2,339	$379,216	162.1	0.5	($195,605)	-6.6%	$705
3	Re-Caulk Window Frames	0	50	236	0	0.4	$230	$13,130	57.0	26.9	($9,433)	-3.8%	$1,283
4	Upgrade Lighting to LED Fixtures	27	8,200	-587	0	-0.7	$1,026	$31,910	31.1	18.2	($14,971)	1.2%	$0
5	Install a Building Automation System	0	2,460	3,647	0	5.7	$3,876	$99,645	25.7	16.4	($37,326)	2.6%	$326
6	Replace RTUs with ASHP RTUs & Electric Backup	-107	-43,520	11,279	0	16.2	$2,171	$392,664	180.9	0.8	($212,270)	-7.6%	$657
7	Install a 23-kW Solar PV System	85	26,900	0	0	0.8	$5,166	$121,395	23.5	15.2	($36,974)	3.6%	$2,291
8	Replace DHW Heater with Hybrid ASHP Tank Heater	0	1,028	0	0	0.03	$197	$13,537	68.6	20.4	($6,737)	-0.2%	$10,927
9	Install Triple Pane Windows	0	880	843	0	1.3	$956	$98,385	102.9	36.2	($82,996)	-7.8%	$3,116
10	Replace RTUs with Electric	-142	-57,630	11,279	0	15.7	-$539	$346,400	No Payback	No Payback	($210,287)	No IRR	$668
11	Install EIFS	0	460	1,147	0	1.8	$1,159	$535,514	462.0	64.1	($516,895)	-16.4%	$14,441

1.3 GHG Reduction Pathways

The GHG Reduction Pathways tie together all aspects of the audit, providing an implementation plan which considers energy savings and the results of the financial analysis as well as the need for capital renewal and budgeting.

This study analyzes four potential roadmaps for decarbonization. Generally speaking, the Roadmaps progress from less complex measures with lower installation costs to more complex and more efficient solutions with the understanding that more expensive equipment may provide lower operating costs.

Roadmap 1 – Minimum Performance: 50% GHG Reductions over 10 Years

This includes a group of energy reduction measures that will achieve a 50% reduction in GHGs over the following 10 years. This will generally include the lowest cost measures available to achieve this target.

Roadmap 2 – Minimum Performance: 80% Reductions over 20 Years

This includes a group of energy reduction measures that will achieve a 80% reduction in GHGs over the following 20 years. This will generally require the inclusion of the most aggressive GHG reduction measures, regardless of cost.

Roadmap 3 – Aggressive Performance: 80% Reductions over 5 Years

This roadmap will include the same suite of measures that Roadmap 2 includes, but with a more accelerated timeline of 5 years.

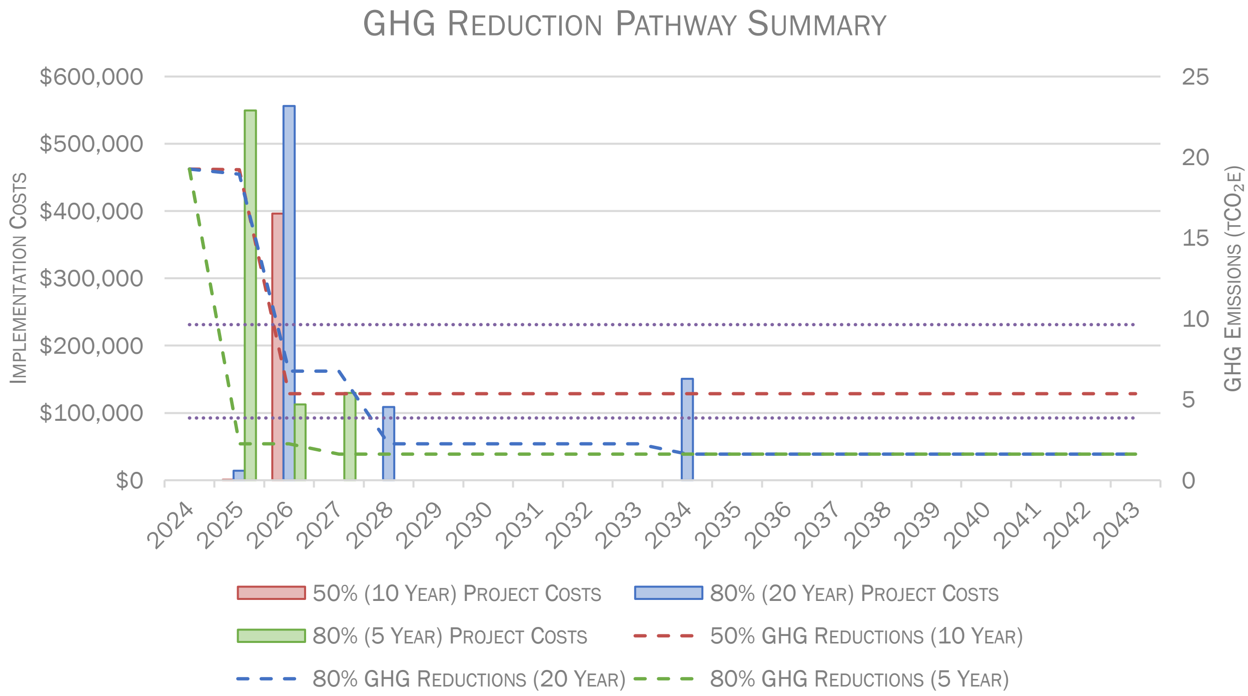
Roadmap 4 – Business-As-Usual

The Business-As-Usual Roadmap will include the project costs associated with replacing the equipment with like-for-like equivalents. This will provide a cost baseline for the other roadmaps to understand how much additional capital is required to implement the more energy efficient options.

Bundling measures into these pathways often results in interactive effects between systems. As a result, the total GHG reduction for a particular Roadmap will typically differ from the sum of the GHG reductions from individual measures. The Scenario Level Analysis accounts for these interactive effects between systems which are not represented in the Measure Level Analysis.

TABLE 1.3.1: SUMMARY OF SCENARIO LEVEL ANALYSIS

Opp. #	Opportunity	Emissions (tCO_2e)	50% Reduction Pathway (10 Year)	80% Reduction Pathway (20 Year)	80% Reduction Pathway (5 Year)
1	Install Ultra-low Flow Washroom Faucets	0.0	•	•	•
2	Replace RTUs with ASHP RTUs & Propane Backup	13.9	•		
3	Re-Caulk Window Frames	0.4		•	•
4	Upgrade Lighting to LED Fixtures	-0.7		•	•
5	Install a Building Automation System	5.7		•	•
6	Replace RTUs with ASHP RTUs & Electric Backup	16.2		•	•
7	Install a 23-kW Solar PV System	0.8		•	•
8	Replace DHW Heater with Hybrid ASHP Tank Heater	0.03			
9	Install Triple Pane Windows	1.3			
10	Replace RTUs with Electric	15.7			
11	Install EIFS	1.8			



Bundling measures into pathways, or scenarios, often results in interactive effects between systems. As a result, the total GHG reduction for a particular Roadmap will typically differ from the sum of the GHG reductions from the individual measures. The Scenario Level Analysis accounts for these interactive effects between systems which are not represented in the Measure Level Analysis.

Table 1.3.2: Reduction Pathway Summary of Energy & Costs

	Reductions				Financials		
GHG Reduction Pathways	Energy (ekWh)	Energy (%)	Emissions (tCO_2e)	Emissions (%)	Annual Savings	Project Costs	20-Year LC Cost
50% Reductions (10 Year)	35,059	25%	13.9	72%	$2,675	$379,815	$563,736
80% Reductions (20 Year)	86,428	62%	17.7	92%	$12,805	$767,330	$697,129
80% Reductions (5 Year)	86,428	62%	17.7	92%	$12,805	$767,330	$700,515
Business-As-Usual	$0	0%	$0	0%	$0	$163,285	$479,356

The study compares the costs of implementing multiple options or Pathways against the costs of operating the facility in a "business-as-usual" manner. The Pathways provide options to upgrade HVAC equipment and other energy consuming systems to more efficient options. However, all of the equipment addressed in this study will have to be replaced at some point - if not by more efficient equipment, then by "like-for-like" equipment replacements. By implementing these energy efficiency measures, the "like-for-like" costs are avoided.

Table 1.3.3 presents the financial details of each pathway taking into consideration the incremental costs of implementing energy efficient measures through the GMF program.

Table 1.3.3: Reduction Pathway Summary of Life Cycle Costs

	Financials						
Pathway	Project Costs	Potential Grant	Avoided Cost	Incremental Costs	LC Cost	Incremental 20-Year LC Cost	Incremental LC Cost per Tonne CO^2e
50% Reductions in 10 Years	$379,815	$75,963	$163,285	$140,567	$563,736	$84,379	$303
80% Reductions in 20 Years	$767,330	$153,466	$163,285	$450,579	$697,129	$217,773	$617
80% Reductions in 5 Years	$767,330	$153,466	$163,285	$450,579	$700,515	$221,159	$626
Business-As-Usual	$163,285	$0	$0	$0	$479,356	N/A	N/A

Limited Liability

This report was prepared by Efficiency Engineering Inc. for the account of the Township of Georgian Bay. The material in it reflects our best judgment in light of the information available to us at the time of preparation. Without express written permission, any use which a third-party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Efficiency Engineering Inc. accepts no responsibility for damages, if any, suffered by any third-party as a result of decisions made or actions based on this report.

Acknowledgements

Assistance from the Township of Georgian Bay was provided by:

- Jennifer Schnier, Director of Sustainability, Township of Georgian Bay

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2 Methodology

Efficiency Engineering utilizes a rigorous and standardized approach for all of our energy audits. We utilized a comprehensive "form based" data collection process to ensure all relevant data is collected during our site visits. Utility bills are collected and analyzed to ASHRAE14-2002 standards. Savings for each Opportunity are calculated based on sound engineering principles and always related back to actual consumptions. Costing utilizes a combination of MEANS standard costing tools, vendor quotes and our experience in design and project management.

Utility Bill Analysis

The purpose of performing a detailed utility bill analysis on the building is to:

- Normalize the consumption or demand for billing period, heating degree days (HDD), Cooling Degree Days (CDD) and any other independent variables.
- Calculate the energy use for benchmarking (comparison to typical buildings).
- Break out the consumption into weather dependent and weather independent portions.
- Calculate the heating and cooling balance point temperatures.
- Look for anomalies that may indicate heating plant efficiency, accuracy of the building automation system, building use, etc.
- Look for changes in the consumption over a period of time.
- Look for billing errors (over-billing) that may be recouped from the utility.

The utility meters have been modeled using standard modeling calculations. The utility data received has been correlated with actual weather data from the nearest weather station to produce a "best fit" equation using linear regression. The data has been normalized for billing periods, HDD, CDD as well as up to three user-defined variables. The heating and cooling balance point temperatures are adjusted to your specific building to properly model each utility.

The Modeling process creates an equation that allows us to calculate the consumption for any given period. A typical equation is as follows:

Consumption (kWh) = Days x 5,000 + HDD (13°C) x 50 + CDD (14°C) x 100
Regression (R^2 Value) = 0.92

Heating Degree Days (HDD) and Cooling Degree Days (CDD) are relative measurements of outdoor air temperature used as an index for heating and cooling energy requirements. Heating/cooling degree days are the number of degrees that the daily average temperature falls below or rises above a given balance point temperature. Coefficients are the constants in the baseline models. They are the values that are multiplied by the independent variables to get the model results, and are determined during the baseline model process. The Regression value indicates how well the actual bills match the equation, with 1.0 being a perfect fit. Typical year data (Environment Canada) is used to calculate the consumption for an average year. This consumption is used in all of the savings calculations.

Savings Methodology

Savings for opportunities are calculated using rigorous scientific modeling tools to ensure accuracy. The first step in the savings calculations is to find the existing consumption(s) of the equipment, based on equipment nameplate data, operating parameters, logged data (when available) and modeling from the utility bill analysis. The next step is to calculate the retrofit consumption once the opportunity is implemented. The savings are simply the difference between the two.

The calculation method varies depending on the Opportunity. For weather dependent savings, we would typically use a modified bin method from our own proprietary software. The underlying data used for creating the modified bins is ASHRAE WYEC (Weather Year for Energy Calculations). This ensures that the savings are based on a typical year, not an abnormally warm or abnormally cold year. When appropriate, we use other well-accepted methods such as eQUEST whole-building simulation.

Savings calculations for a particular Opportunity assume that other Opportunities listed ahead of it have been implemented. For example, if Opportunity 1 recommends upgrading to a better technology and Opportunity 2 recommends reducing lighting hours, the savings for Opportunity 2 will be based on the lighting upgrade recommended in Opportunity 1. This ensures that savings are not “double counted”.

Certain Opportunities have additional annual savings or costs, such as an increase or decrease in annual maintenance. The Annual Savings noted in the financial analysis tables throughout the report includes the energy savings as well as these additional annual savings or costs.

Cost Estimates

Cost estimates are calculated based on our experience, industry standards and market conditions. Market conditions can vary significantly between the writing of this report and the actual implementation of the recommendations.

PWGSC (Public Works and Government Services Canada) has defined classes of cost estimation for building construction or renovation. We provide Class C Cost Estimates as standard, however in many instances (especially with lighting opportunities) our work is closer to Class B.

Table 1.3.1: Classes of Cost Estimates

Class D	Rule of thumb costing to get an order of magnitude – for study approval.
Class C	Measured quantities based on preliminary design – for project approval.
Class B	Measured quantities based on detailed engineering sizing calculations
Class A	Measured quantities based on design drawings

The Project Cost shown in the Financial Analysis tables throughout the report includes materials and labour and contingency as well as engineering and or third-party project management where appropriate. Costing does not include any applicable taxes.

Financial Analysis

The following Financial Factors are taken into account in the life cycle costing analysis presented throughout this report. The table lists the actual values used in the calculations.

Financial Factors

- Real Dollars: Monetary units of constant purchasing power.
- Real MARR: $MARR_R$, the minimum acceptable rate of return when cash flows are expressed in real dollars.
- Actual Dollars: Monetary units at the time of payment.
- Actual MARR: $MARR_A$, The minimum acceptable rate of return for actual dollar cash flows. It is the real MARR adjusted upwards for inflation. (Also called discount rate)
- Net Present Value (NPV): Total value of all cash streams discounted to present day dollars, or Net Present Value.
- Internal Rate of Return (IRR): The IRR represents the annualized (year over year) Return on Investment (ROI) an Opportunity is expected to generate. For example, if an investment provides 10% each year over 5 years, a $1 investment turns into $1 \times (1+10\%)^5 = \$1.61$. The IRR is 10%, the average annual ROI is 10% and the ROI over the five-year period is 61%.
- Inflation: The rate of increase in average prices of goods and services over a one-year period; Also, the rate year period of decrease in purchasing power of money over a one-year period
- Escalation Rate: The rate of increase in utility costs due to a combination of factors including inflation, supply, demand, environmental and political effects.
- Simple Payback: Determines the financial payback or the time taken for the cash flows from a capital investment project to equal the cash outflows. The payback is represented in years and provides a timeframe for when initial costs will be recovered
- Capital Payback: provides the time required to recover capital investment in years, while taking into consideration factors such as the time value of money and life cycle costing

Table 1.3.2: Financial Factors

$MARR_R$:	5.0%
Inflation:	2.20%
$MARR_A$:	7.31%
Interest Rate (APR):	1.9%

4 The Existing Building Profile

The following section highlights the main building details and examines each energy-consuming system, including all HVAC system, lighting, building envelope, etc. The facility details are as follows:

TABLE 3.1: FACILITY DETAILS

Building Name:	Administration Building
Client Name:	Township of Georgian Bay
Site Contact:	Jennifer
Address:	99 Lone Pine Rd.
	Georgian Bay, ON
	L0K 1SO
Facility Area:	8,373 Sq.Ft.
Building Type:	Offices with Event Spaces
Year Constructed:	2006
Number of Stories:	1

4.1 Heating Cooling & Ventilation

Heating, cooling & ventilation to the facility is primarily provided by four packaged rooftop units (RTUs) each equipped with propane heat & DX cooling. The units are original to the building (2006) and are in fair operating condition.

Each rooftop unit is controlled by an individual wall mounted, programmable thermostat located in the space supplied.

Space heating is supplemented by electric resistance heaters in vestibules. Ventilation is supplemented by individual washroom exhaust fans which operate via light switches.

Packaged Rooftop Unit – Typical of (4)

TABLE 4.1.1: HEATING EQUIPMENT DETAILS

Tag ID	Heating	Heating Capacity	Cooling Capacity	Condition
RTU1	Propane	115 MBH	4 tons	Fair
RTU2	Propane	115 MBH	4 tons	Fair
RTU3	Propane	115 MBH	4 tons	Fair
RTU4	Propane	250 MBH	10 tons	Fair

4.2 Domestic Hot Water

DHW Heater - Electric

Domestic hot water (DHW) for the facility is provided by a single electric tank heater rated at 3-kW with 178 litres of storage. The tank heater was installed in 2022 and is in good operating condition.

Table 4.2.1: DHW Equipment Details

Tag ID	Boiler Type	Capacity	Efficiency	Condition
HT1	Electric	3 kW	100%	Good

All piping was observed to be properly insulated.

4.3 Building Envelope

Window Frame: Caulking in Poor condition

The facility was constructed in 2006 with a red brick façade and includes a pitched roof with asphalt shingles. The roof consists of wood and asphalt shingles. Windows are double glazed with an argon fill. Front entrance doors are mostly glass with aluminum frames. Services doors around the building are generally metal with hollow cores.

The facility is approaching 20-years old. The building envelope is in overall good condition with the exception of significant cracking/degradation of the caulking around window and door frames.

4.4 Water Fixtures

Water fixtures in the facility were generally observed to be standard flow. Water and domestic hot water consumption at this facility are relatively low.

Table 4.4.1: Water Fixture Details

Fixture	Flow
Bathroom Faucets:	2 GPM
Kitchen Faucets:	2 GPM
Toilets:	1.6 GPF

4.5 Lighting

Lighting in the facility generally consists of T8 fluorescent and compact fluorescent (CFL) lamps. Lighting is primarily controlled by wall switches or circuit breakers.

TABLE 4.5.1: LIGHTING DETAILS

Lamp Type	Wattage	Location
T8 Fluorescent	32 W	Corridors, offices, mechanical rooms
CFL	18 W	Pot lights

4.6 Controls

The building is not equipped with an automation system. Equipment operates via standalone controls. Rooftop units are controlled by individual programmable thermostats. Exhaust fans are controlled by wall switches or thermostats.

4.7 Electrical Service

The site is serviced by three pole mounted 50 kVA transformers. This supplies the main disconnect for the building which is rated at 100A.

No metered demand data was available at the time of this study. The calibrated energy model estimates the facility's peak electrical demand at 27-kW.

5 The Energy Usage Report

5.1 Utility Meters

The following utility meters were modeled as part of this report:

TABLE 5.1.1: UTILITY METER DETAILS

Utility	Units	Escalation Rate	Marginal Rate ($/Unit)	GHG Emissions (Tonnes/Unit)
Electricity	kW	5.2%	$0.1920	0.000036
Propane	l	5.0%	$0.9334	0.001548
Water	m^3	3.0%	$4.7748	0.000000

These utility meters and account numbers can be used to cross-reference reports in *the Appendices*.

The “Effective Marginal Rate” is an average of the base marginal rates plus additional charges that the Utility Providers charge per unit of consumption or demand. This number is used in calculations to determine the utility cost savings of individual measures.

5.2 Utility Rate Structures

The following charges apply to this facility through the utility bills:

Energy Consumption Charges: typically billed monthly per unit of energy used by the building. Such charges may include customer charges, energy charges and other miscellaneous charges. These charges may vary from month to month.

Electric Demand Charges: determined by the maximum power demand in kilowatts that a building requires each month. The demand charge is based on the “peak demand” that the building required during the billing cycle. The peak demand is typically set during a period varying from 15 minutes to one hour. This can mean that very short periods of high energy demand during the billing cycle can result higher demand charges.

Regulatory Charges: the costs of administering the wholesale electricity system and maintaining the reliability of the provincial grid and include costs associated with funding Ontario Power Authority conservation and renewable energy programs.

Distribution Charges: delivering electricity from electricity generating stations across the province to your LDC, then to your facility. This includes the costs to build and maintain the transmission and distribution lines, towers and poles and operate provincial and local electricity systems.

A portion of these charges are fixed and do not change from month to month. Others are variable and increase or decrease depending on the amount of electricity used.

Power Factor Charges: “Power Factor” is the ratio of real power (kilowatt) to apparent power (kilovolt-ampere, kVA) for any given load and time. It is a measure of how much of the power being delivered to the facility is actually performing work.

Power factors for resistive loads, such as lighting and electrical heating are (ideally) 1.0, meaning that all power being supplied is performing work. Electric motors (used for pumps, fans, elevators etc.) are inductive loads which have a power factor of less than 1.0. A motor with a power factor of 0.85 effectively uses only 85% of the power being delivered.

A low power factor affects the utilization of the installed capacity of the electrical system. Additional charges for having a low or less-than-optimum power factor are often structured as additional demand charges or can be per kilovolt-ampere reactive (KVAR) charges.

Time-of-use Rates: Time-of-use rate structures use varying rates for energy costs based on the time of day. The rates are typically associated with peak, off-peak and mid-peak periods. Prices can vary based on the time of day, day of the week, or season. They are higher during peak periods and lower during off-peak periods. Since time of use rates are designed to encourage energy conservation during peak periods, load shifting strategies used in the energy model can result in significant energy cost savings.

Global Adjustment Charges: Consumers who pay the Hourly Ontario Energy Price (HOEP), or have signed a retail contract, will see their electricity bills also include a line for the Global Adjustment. This charge accounts for the differences between the market price and the rates paid to regulated and contracted generators and for conservation and demand management programs. The charge shows on bills in different ways, depending on the type of customer:

1. Class B Consumers: those with a peak demand over 50kW and under 5MW
2. Class A Consumers: those with an average hourly peak demand of 3MW or higher

Other Charges: Utilities often charge additional taxes and surcharges based on local regulations and/or programs, such as energy conservation and low-income assistance programs. Additionally, there can also be fuel adjustment charges, which are related to the cost of resource energy to the utility. Often this charge is an additional multiplier that is applied to the energy charge and will vary monthly based on fuel cost fluctuations.

5.3 Meter Modeling

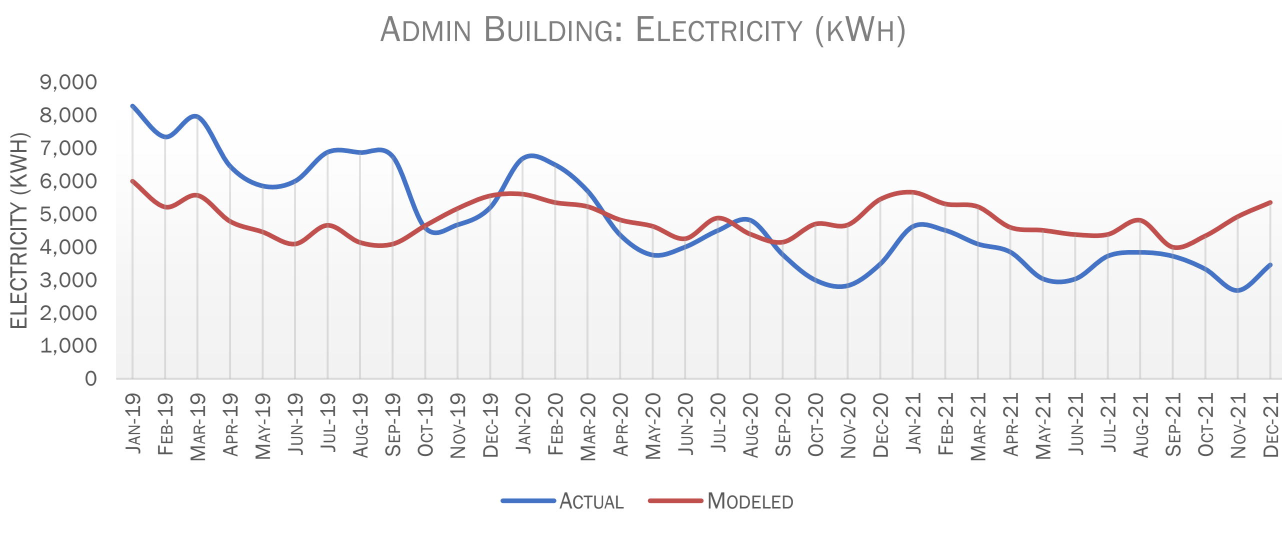
Daily mean temperatures from Barrie-Oro (WMO ID 71314) were used in creating the baseline models for this facility.

5.3.1 Electricity

Baseline Equation:

Electricity (kWh) = Days x 133.24 + HDD x 2.57 + CDD x 7.99.
The underlying regression of this baseline equation is $R^2 = 0.9087$.
HDD (Heating Degree Days) calculated using a balance point of 16°C.
CDD (Cooling Degree Days) calculated using a balance point of 18°C.
In a typical year, consumption will be 61,108 kWh.

Modeling Graphs:



Rate Structure:

Electricity for this building is provided by Hydro One. It is classified as a Small Commercial account with a monthly demand of under 50 kW. This is a “Standard Rate” structure which charges electricity based on the Hourly Ontario Energy Price (HOEP) and Global Adjustment (GA). Both of these rates change from month-to-month as they are based on real-time market conditions. Regulatory Charges are also added to this cost on a per kWh basis.

Comments:

Electrical consumption at the facility dropped measurably between 2019 and 2020. This is attributed to changing operating conditions as a result of the Covid pandemic.

5.3.2 Propane

Baseline Equation:

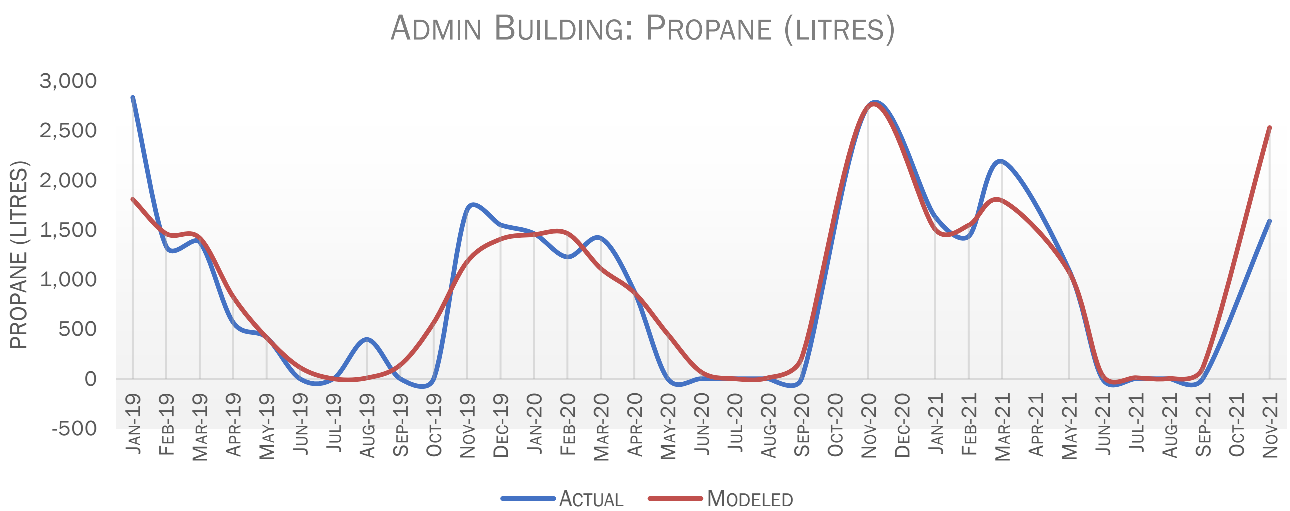
Propane (litres) = Days x 0 + HDD x 2.33.

The underlying regression of this baseline equation is R^2 = 0.9212.

HDD (Heating Degree Days) calculated using a balance point of 16°C.

In a typical year, consumption will be 9,558 litres.

Modeling Graphs:



Rate Structure:

Propane for the facility is purchased and delivered by the Township's fuel provider.

Comments:

No anomalies or irregularities were noted during the modeling period of this report.

5.4 Building Energy Performance

The following section provides benchmarking information for the facility.

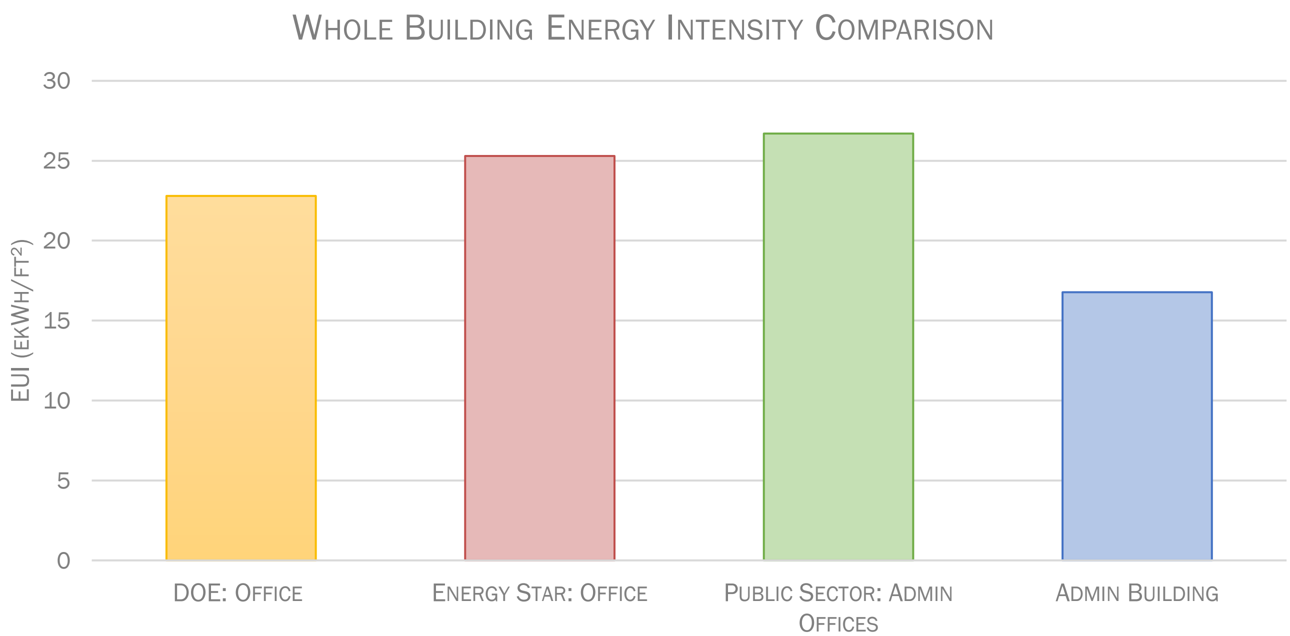
Electricity intensity for the building is 7.2 ekWh/ft² (0.28 GJ/m²). Propane intensity for the building is 9.6 ekWh/ft² (0.36 GJ/m²). Total energy intensity for the building is 16.8 ekWh/ft² (0.65 GJ/m²).

The energy performance of the Administration Building is compared to buildings of similar usage or size from multiple benchmarking databases including Energy Star, Department of Energy (DOE), Ontario Broader Public Sector buildings and a database of energy use intensities maintained by Efficiency Engineering:

Benchmark	EUI	% Variance
DOE: Office	22.8	-26%
Energy Star: Office	25.3	-34%
Public Sector: Admin Offices	26.7	-37%
Admin Building	**16.8**	

*A positive variance indicates that the facility EUI is xx% higher than the stated benchmark. A negative variance indicates that this facility's EUI is below the indicated benchmark, consuming less energy per unit of area.

A comparison of the total energy intensity of the facility with buildings of a similar type and characteristics are shown in the chart below.



Compared to other buildings of a similar type, the overall energy intensity at the Administration Building is low. This is attributed to the facility being of fairly new construction with modern equipment and insulation standards.

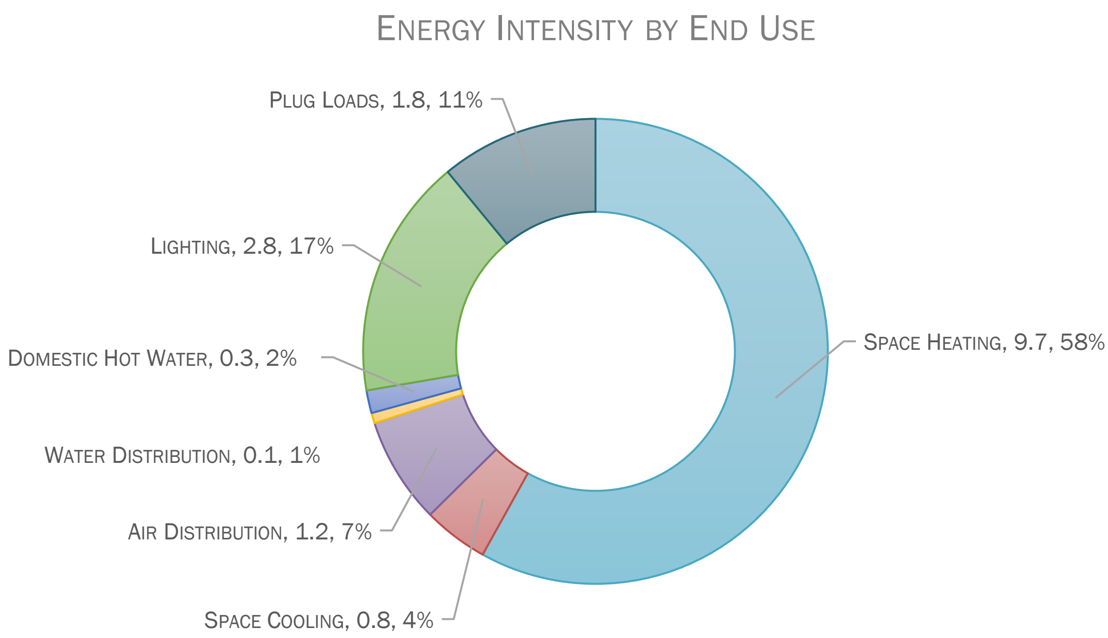
5.5 Energy Breakout by End Use

Energy consumption by end use for the facility has been calculated based on the building's overall energy consumption, calibrated energy models, nameplate information, schedules and estimated cycle times for equipment.

The end use energy breakdown for this facility is:

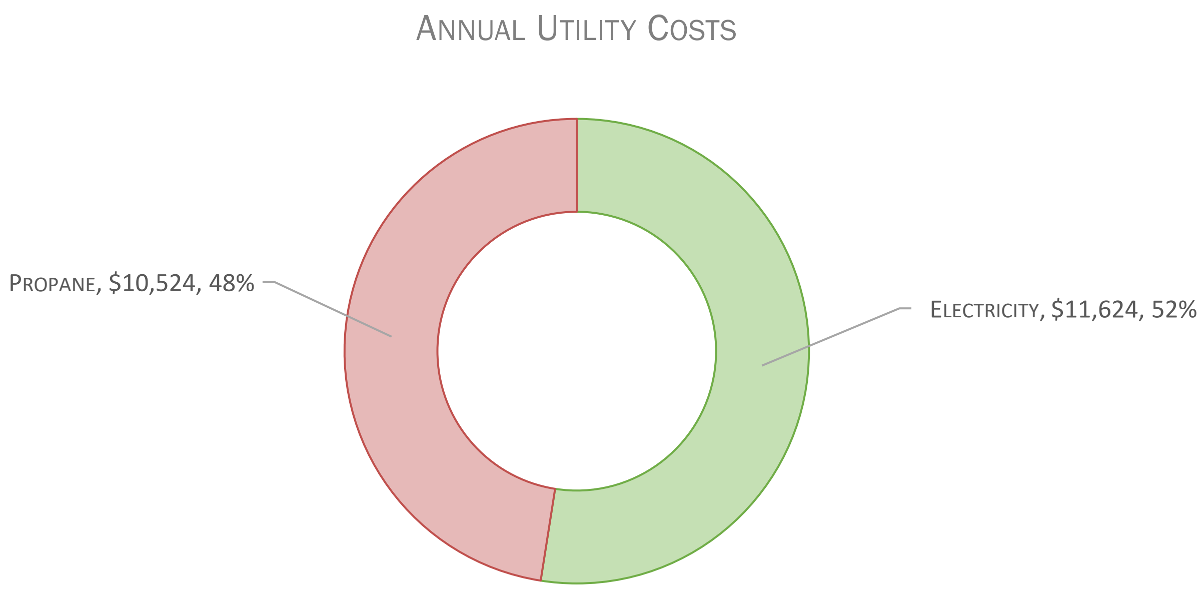
End Use	Electricity (kWh)	Propane (l)	EUI (ekWh/ft²)	GHG Emissions (tCO_2e)
Space Heating	1,050	11,275	9.7	17.5
Space Cooling	6,320	0	0.8	0.2
Air Distribution	10,310	0	1.2	0.3
Water Distribution	1,010	0	0.1	0.0
Domestic Hot Water	2,210	0	0.3	0.1
Lighting	23,320	0	2.8	0.7
Plug Loads	15,300	0	1.8	0.5
Other	1,010	0	0.1	0.0
Total	**60,530**	**11,275**	**16.8**	**19.3**

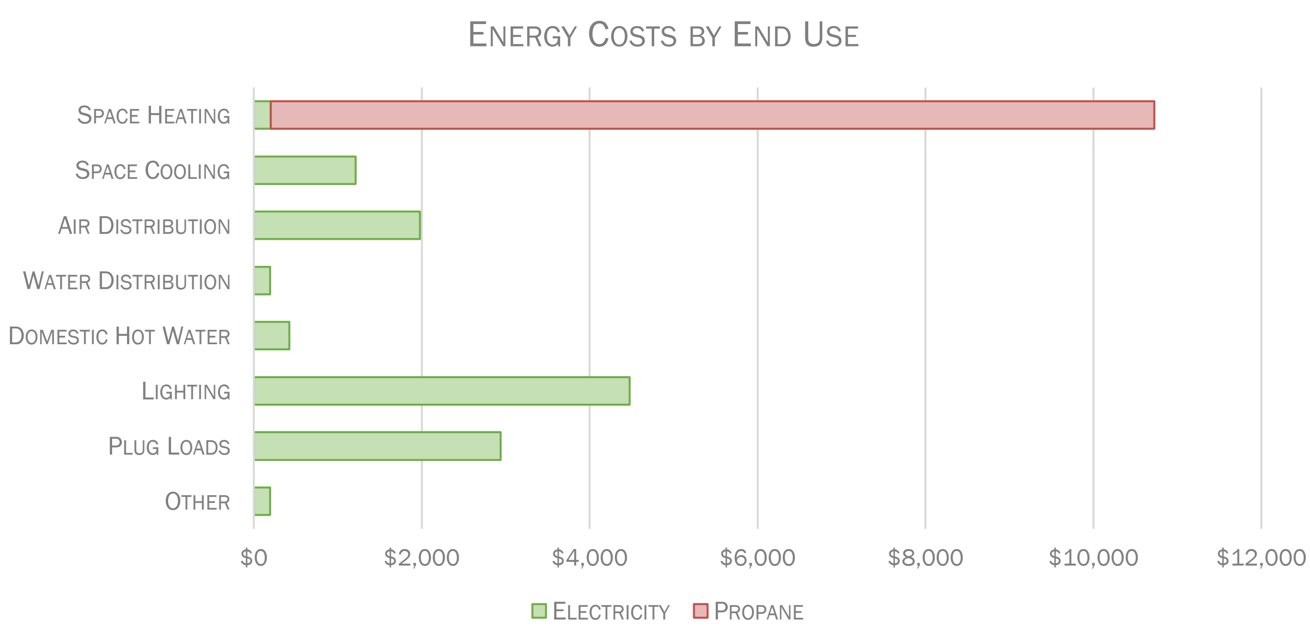
The following chart shows the energy intensity of the Administration Building broken out by end use.



5.6 Utility Costs

In a Typical Model Year, the building would expect to spend the following at the current utility rates. Energy costs by end use are:





6 Measure Level Analysis

The Measure Level Analysis quantifies the energy savings and implementation costs for each Opportunity (or "Measure"). As Opportunities are organized into Roadmaps, interactive effects will occur. As such, the total GHG emissions reductions may differ between the sum of the individual measures and the total for the Roadmap. Individual Opportunities may be included in multiple roadmaps.

The financial analyses for the Opportunities listed in the following section includes a Life Cycle Cost Analysis or LCCA. The LCCA provides a more detailed analysis over the lifespan of the measure and includes the following items:

- **Inflation Rate:** An annual inflation rate is included for future avoided costs and additional annual maintenance costs/savings.
- **Discount Rate:** The rate used to approximate the present-day value of future costs/savings.
- **Utility Escalation Rate:** Utility costs escalate year after year. This value increases the energy savings/costs accordingly over the 20-year period. These escalation rates can be found in Table 5.1.1.
- **Operational Costs:** Implementing some measures will require additional annual maintenance (for example, chemical treatment for a new boiler plant), while others require less annual maintenance (such as longer lasting LED lighting).
- **Avoided Costs:** If some pieces of equipment are due for replacement in the coming years, then by implementing related energy efficiency measures as a part of this project, you are avoiding the future costs associated with the replacement of this equipment.

The results of the LCCA are summarized in a single value: the Capital Payback. Where a simple payback will give you a general idea of how an Opportunity will perform economically (using first year utility savings and the upfront implementation costs), the Capital Payback identifies at what point along the 20-year LCCA the Opportunity recoups its initial investment, taking all of the above into consideration.

Further details are located in the Appendices of this report.

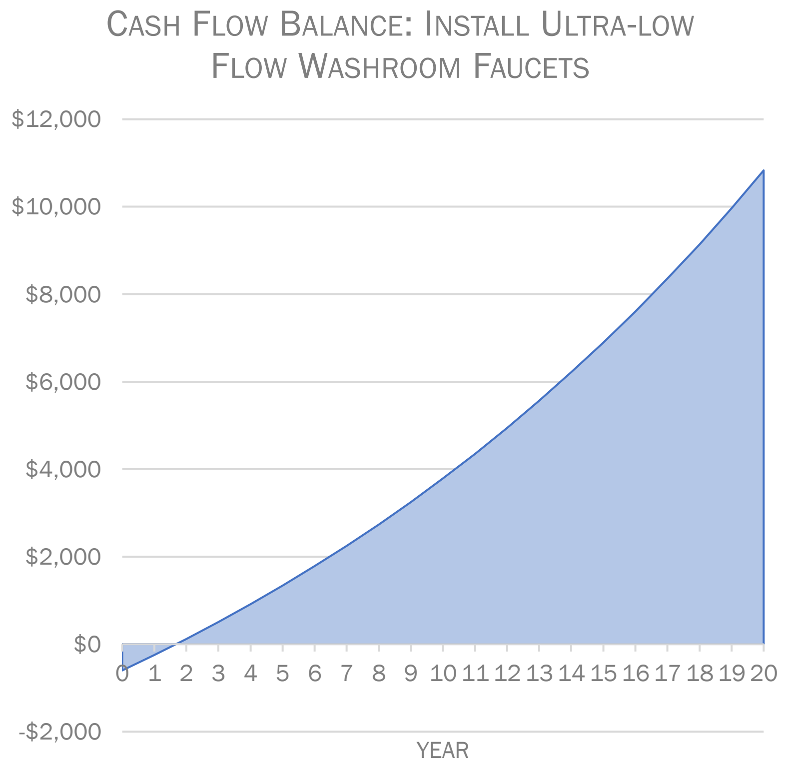
6.1 Opportunity 01: Install Ultra-low Flow Washroom Faucets

The Detailed Financial Analysis

Using the Financial Factors listed in this report, this project results in the following Annual Utility Savings, Simple Payback and Net Present Value:

TABLE 6.1.1: DETAILED FINANCIAL ANALYSIS

Utility Savings	
Demand (kW):	0
Electricity (kWh):	1,410
Propane (l):	0
Water (m³):	14
Emissions (tCO_2e):	0.0
Financials	
Utility Savings:	$336
Materials & Labour:	$480
Engineering & PM:	$72
Contingency:	$48
Project Costs:	$600
Simple Payback:	1.8
Capital Payback:	1.67
NPV:	$4,700
IRR:	63.5%



Existing Conditions

Water fixtures at the facility were generally observed to be a mix of standard flow and low flow units.

TABLE 6.1.2: WATER FIXTURE DETAILS

Fixture	Flow
Bathroom Faucets:	2 GPM
Kitchen Faucets:	2 GPM
Toilets:	1.6 GPF

Retrofit Conditions

We recommend installing new ultra low-flow (0.5 gpm) faucets at the facility. These fixtures perform similarly to standard flow units but consume considerably less water and hot water resulting in significant utility savings and GHG reductions.

While it is possible (and less expensive) to replace just the aerators on the existing fixtures, aerators are easily removed or damaged, resulting in reduced savings.

It is recommended that only well reviewed products from quality manufacturers be installed. Quality fixtures will result in greater user satisfaction and reduce the risk of complaints and fixture replacement by occupants.

This measure will have no measurable impact on operations and maintenance at the facility.

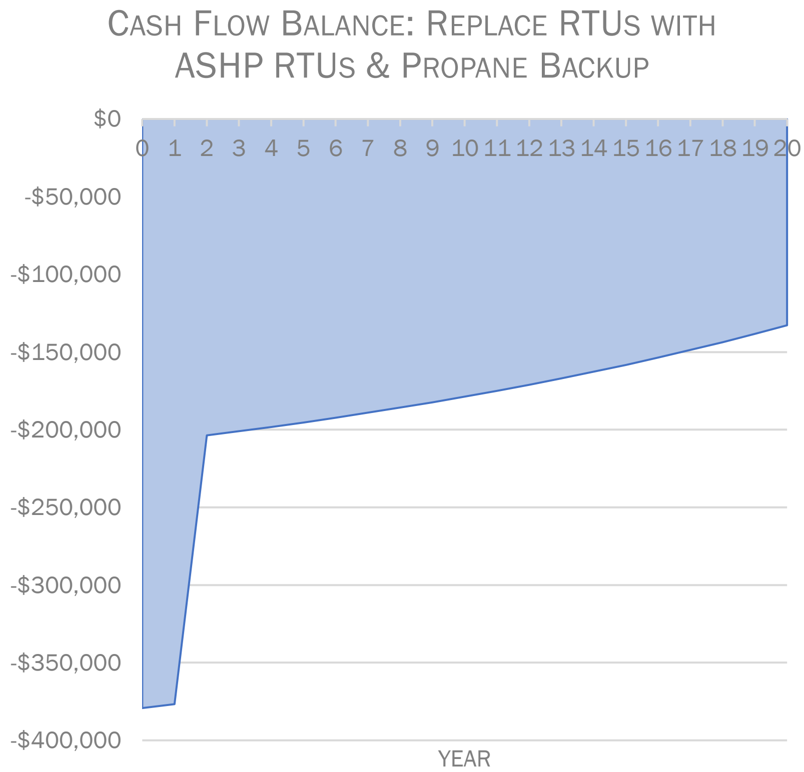
6.2 Opportunity 02: Replace Rooftop Units with ASHP Rooftop Units & Propane Backup

The Detailed Financial Analysis

Using the Financial Factors listed in this report, this project results in the following Annual Utility Savings, Simple Payback and Net Present Value:

Table 6.2.1: Detailed Financial Analysis

Utility Savings	
Demand (kW):	0
Electricity (kWh):	-34,630
Propane (l):	9,630
Water (m³):	0
Emissions (tCO_2e):	13.9
Financials	
Utility Savings:	$2,339
Materials & Labour:	$303,372
Engineering & PM:	$45,506
Contingency:	$30,337
Project Costs:	$379,216
Simple Payback:	162.1
Capital Payback:	0.5
NPV:	-$195,605
IRR:	-6.6%



Existing Conditions

Heating, cooling & ventilation to the facility is primarily provided by four packaged rooftop units (RTUs) each equipped with propane heat & DX cooling. The units are original to the building (2006) and are in fair operating condition.

Packaged Rooftop Unit – Typical of (4)

Each rooftop unit is controlled by an individual wall mounted, programmable thermostat located in the space supplied.

TABLE 6.2.2: HEATING EQUIPMENT DETAILS

Tag ID	Heating	Heating Capacity	Cooling Capapacity	Condition
RTU1	Propane	115 MBH	4 tons	Fair
RTU2	Propane	115 MBH	4 tons	Fair
RTU3	Propane	115 MBH	4 tons	Fair
RTU4	Propane	250 MBH	10 tons	Fair

Retrofit Conditions

This measure includes replacing the four existing propane fired rooftop units with air source heat pump rooftop units equipped with propane fired backup heat.

The rooftop units will be replaced by ASHP rooftop units sized to the cooling capacity of the existing units. This minimizes the demand impact of the new equipment and allows for implementation without the need to upgrade the building's electrical service. The 4-ton rooftop units will be replaced with 4-ton ASHP rooftop units and the 10-ton unit will be replaced with a 10-ton ASHP rooftop unit. Backup heating will be sized to match the existing heating capacity.

Typical Dual Fuel Heat Pump Rooftop Unit

Rather than generating heat, heat pumps primarily operate by transferring heat from one medium (the source) to another (the load). In heating mode, air source heat pumps extract heat from the atmosphere (the source) and transfer it to the occupied space within the building (the load). Since the heat pump is not actually generating the heat, just transferring it, they're able to supply heating energy much more efficiently than propane fired equipment.

As outdoor temperatures drop below the operating envelope of the air source heat pumps, an alternate or backup source of heat must be used. When outdoor temperatures fall below the operating temperature of the units, propane fired backup heating will carry the heating load.

Analysis shows that sizing the units based on the above strategy would offset approximately 85% of the propane consumption of the existing rooftop units.

Weight is always a consideration when replacing rooftop equipment. ASHP rooftop units are available from multiple manufacturers. Weights will vary by capacity, manufacturer, size and model. The exact weight of the replacement rooftop units will not be known until the project is designed, tendered and products selected.

The average weight of ASHP rooftop units is typically slightly higher than that for standard rooftop units when comparing similar compressor capacities.

To account for potential structural issues, costing for this measure includes increased allowances for structural evaluations of the roof structure and increased costs for structural reinforcement which may be required.

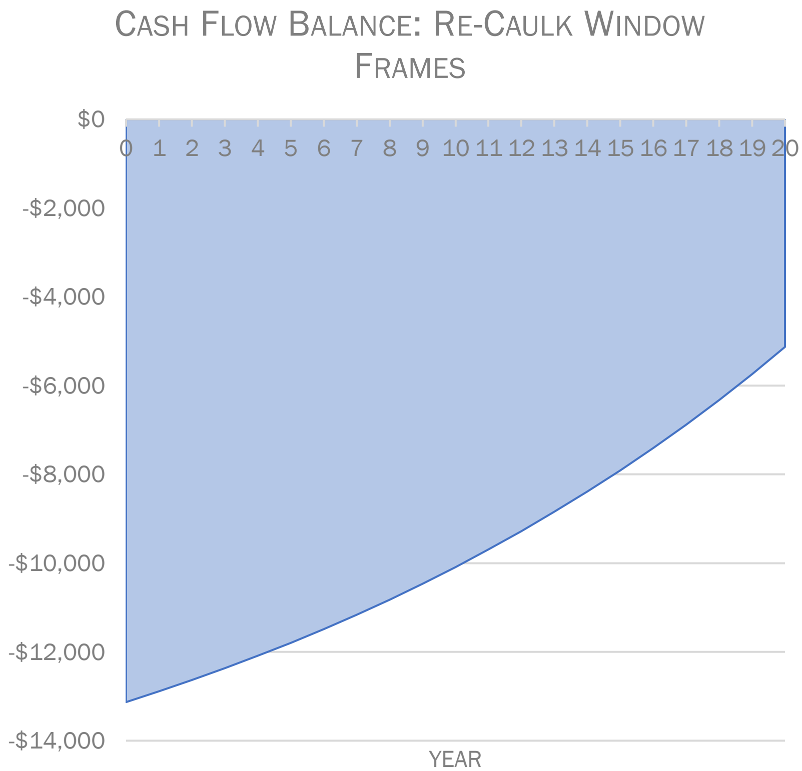
6.3 Opportunity 03: Re-Caulk Window Frames

The Detailed Financial Analysis

Using the Financial Factors listed in this report, this project results in the following Annual Utility Savings, Simple Payback and Net Present Value:

TABLE 6.3.1: DETAILED FINANCIAL ANALYSIS

Utility Savings	
Demand (kW):	0
Electricity (kWh):	50
Propane (l):	236
Water (m^3):	0
Emissions (tCO_2e):	0.2
Financials	
Utility Savings:	$230
Materials & Labour:	$11,937
Engineering & PM:	$0
Contingency:	$1,194
Project Costs:	$13,130
Simple Payback:	57.0
Capital Payback:	26.9
NPV:	-$9,433
IRR:	-3.8%



Existing Conditions

The facility was constructed in 2006 with a red brick façade and includes a pitched roof with asphalt shingles.

Windows are double glazed with an argon fill. The overall building envelope is in good condition with the exception of significant cracking/degradation of the caulking around window and door frames.

Poor seals and cracking around window frames leads to uncontrolled air infiltration resulting in drafts, occupancy comfort issues and increased energy consumption.

Window Frame: Caulking in Poor condition

Retrofit Conditions

Weather stripping and caulking can be some of the most cost-effective ways of minimizing energy consumption. When replacing weather stripping or caulking, care should be taken to ensure that commercial grade products are used to ensure proper adhesion and long life.

Once implemented, this measure will have no impact on operations or maintenance at the facility.

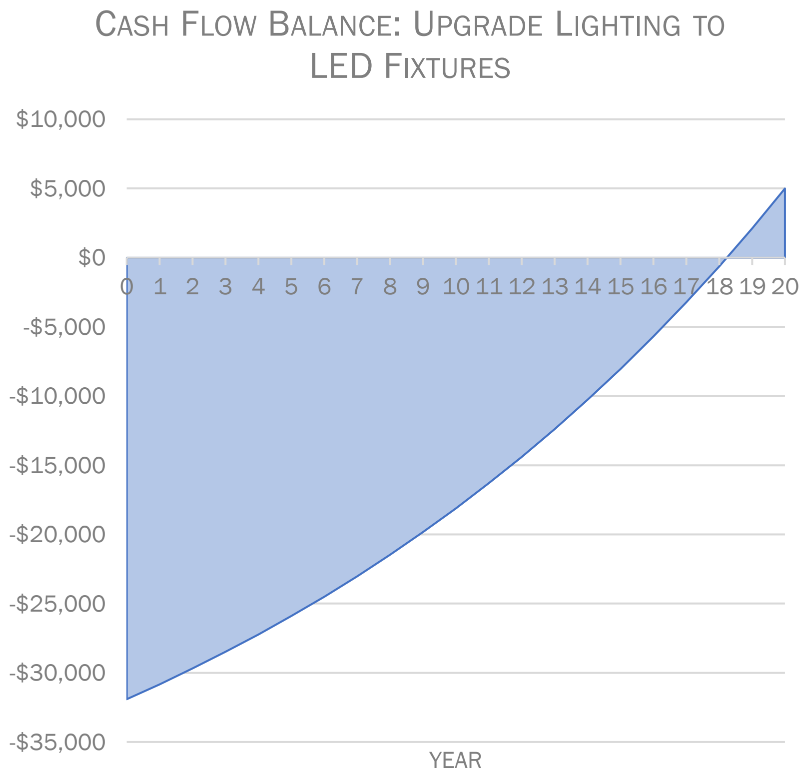
6.4 Opportunity 04: Upgrade Lighting to LED Fixtures

The Detailed Financial Analysis

Using the Financial Factors listed in this report, this project results in the following Annual Utility Savings, Simple Payback and Net Present Value:

TABLE 6.4.1: DETAILED FINANCIAL ANALYSIS

Utility Savings	
Demand (kW):	27
Electricity (kWh):	8,200
Propane (l):	-587
Water (m^3):	0
Emissions (tCO_2e):	-0.7
Financials	
Utility Savings:	$1,026
Materials & Labour:	$25,528
Engineering & PM:	$3,829
Contingency:	$2,553
Project Costs:	$31,910
Simple Payback:	31.1
Capital Payback:	18.2
NPV:	-$14,971
IRR:	1.2%



Existing Conditions

Lighting in the facility generally consists of T8 fluorescent and compact fluorescent (CFL) lamps. Lighting is primarily controlled by wall switches or circuit breakers.

TABLE 6.4.2: LIGHTING DETAILS

Lamp Type	Wattage	Location
T8 Fluorescent	32 W	Corridors, offices, mechanical rooms
CFL	18 W	Pot lights

Retrofit Conditions

We recommend replacing all interior fluorescent fixtures with equivalent LED fixtures.

Many LED fixtures now have occupancy sensors integral to the fixture. Installing fixtures with individual integral sensors or networked sensors maximizes the savings that can be achieved in large areas with inconsistent/infrequent activity such as multipurpose rooms, meeting rooms and fitness rooms.

Advantages of LED

- Instant "ON/OFF"
- Work well with occupancy sensors/photocells/lighting control systems
- Dimmable
- Long Life (50,000-100,000+ hours)
- Reduced Maintenance Costs
- Good Colour Rendering (>80 CRI)
- Typical Colour Temperatures Availability from 2700K up to 5000K
- Many fixtures have option for Integrated Occupancy Sensors
- Better Uniformity of light across playing surface
- Ability to cycle lights "ON/OFF" "flash lights" with no effect to system life

In addition to the upfront energy savings, LEDs true savings lie in the reduced maintenance costs associated with lamp and ballast life. Typical LED fixtures are rated for 50,000 - 100,000+ hours as opposed to the 15,000 - 24,000 hour average lamp life for High Intensity Discharge (HID) or the 20,000 – 36,000 hour average lamp life for linear fluorescent lamps. Care should be taken in selecting a quality LED fixture which meets the needs of the application while being supported by a reputable company guaranteeing a lengthy warranty. LED fixtures should be either Design Lighting Consortium (DLC) listed or Energy Star Certified.

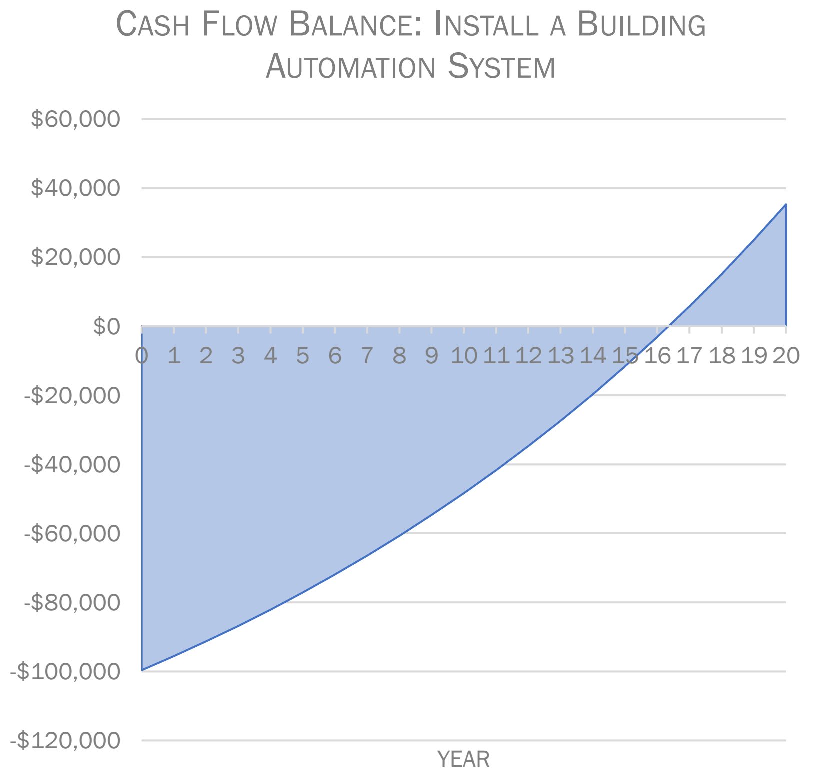
6.5 Opportunity 05: Install a Building Automation System

The Detailed Financial Analysis

Using the Financial Factors listed in this report, this project results in the following Annual Utility Savings, Simple Payback and Net Present Value:

Table 6.5.1: Detailed Financial Analysis

Utility Savings	
Demand (kW):	0
Electricity (kWh):	2,460
Propane (l):	3,647
Water (m³):	0
Emissions (tCO_2e):	0
Financials	
Utility Savings:	$3,876
Materials & Labour:	$79,716
Engineering & PM:	$11,957
Contingency:	$7,972
Project Costs:	$99,645
Simple Payback:	25.7
Capital Payback:	16.4
NPV:	-$37,326
IRR:	2.6%



Existing Conditions

The building is not currently equipped with an automation system. HVAC & lighting equipment operates via standalone controls. Rooftop units are controlled by individual programmable thermostats. Exhaust fans are controlled by wall switches or thermostats.

Retrofit Conditions

Building automation systems (BAS) can be thought of as computer networks, with miniature computers controlling the important pieces of mechanical equipment within a given facility. These computers talk to each other through the network to enable interaction with one another according to central control logic and to allow central oversight and centrally-managed features.

A building automation system (BAS) could be installed at the facility and programmed to operate the major HVAC and lighting systems at the facility. The system would be programmed at the time of installation according to energy-conserving strategies specified by the design engineer.

BAS systems can include many safety and convenience features such as full graphic terminal operation, remote access via internet, dial out/e-mail of alarms, security monitoring, and trending of energy and equipment data. To get all the features of a full BAS system can be quite expensive, however it is possible to start small and expand the control network over time. For the purpose of this study, we are recommending the most cost-effective approach, which is the installation of a BAS system intended to save energy. Further components can be added at a later date.

The cost of a system is closely tied to the number of control "points": physical input and output devices such as temperature sensors and relays. Costing for this measure includes points to enable the BAS to control the following:

- Four heating/cooling rooftop units
- Exhaust fans
- Interior and exterior lighting (zones)
- The DHW systems (monitoring only)

The BAS will allow for the following improvements to equipment control:

- Schedule heating and cooling setback temperatures during unoccupied hours
- Schedule ventilation rates to ensure building is not over-ventilated during unoccupied hours
- Turn fans (RTUs & exhaust) off during unoccupied hours (unless called for heating or cooling)
- Enable/disable lighting on a zone-by-zone basis
- Lock out cooling during unoccupied hours
- Lock out simultaneous heating and cooling

BAS systems can include many safety and convenience features such as full graphic terminal operation, remote access via phone line, ethernet LANs, WANs, internet, intranet for alarms, security monitoring, and trending of energy and equipment data.

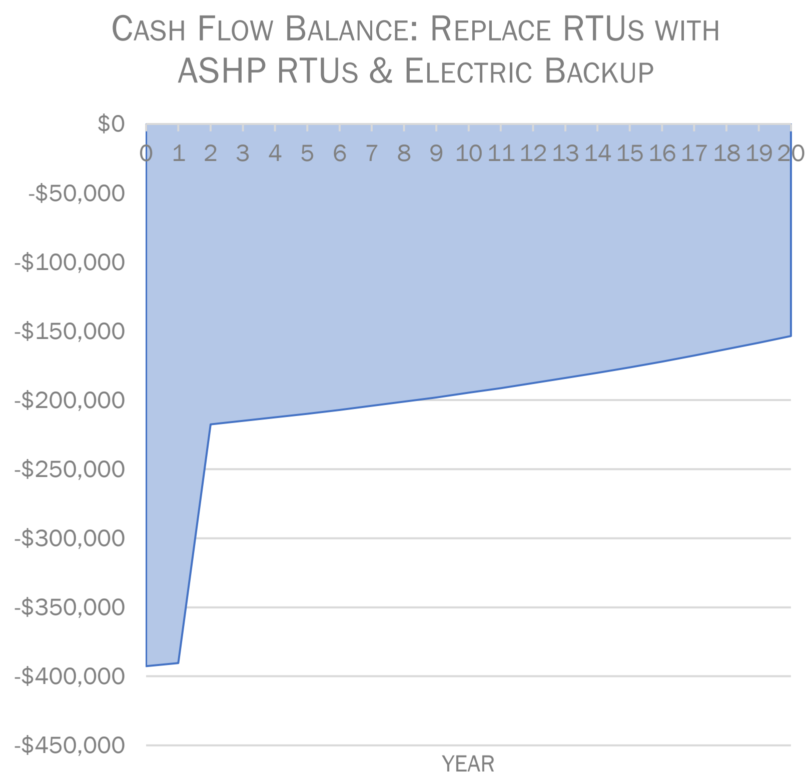
6.6 Opportunity 06: Replace Rooftop Units with ASHP Rooftop Units & Electric Backup

The Detailed Financial Analysis

Using the Financial Factors listed in this report, this project results in the following Annual Utility Savings, Simple Payback and Net Present Value:

TABLE 6.6.1: DETAILED FINANCIAL ANALYSIS

Utility Savings	
Demand (kW):	0
Electricity (kWh):	-43,520
Propane (l):	11,279
Water (m³):	0
Emissions (tCO_2e):	16.2
Financials	
Utility Savings:	$2,171
Materials & Labour:	$314,131
Engineering & PM:	$47,120
Contingency:	$31,413
Project Costs:	$392,664
Simple Payback:	180.9
Capital Payback:	0.8
NPV:	-$212,270
IRR:	-7.6%



Existing Conditions

Heating, cooling & ventilation to the facility is primarily provided by four packaged rooftop units (RTUs) each equipped with propane heat & DX cooling. The units are original to the building (2006) and are in fair operating condition.

Packaged Rooftop Unit – Typical of (4)

Each rooftop unit is controlled by an individual wall mounted, programmable thermostat located in the space supplied.

TABLE 6.6.2: HEATING EQUIPMENT DETAILS

Tag ID	Heating	Heating Capacity	Cooling Capapacity	Condition
RTU1	Propane	115 MBH	4 tons	Fair
RTU2	Propane	115 MBH	4 tons	Fair
RTU3	Propane	115 MBH	4 tons	Fair
RTU4	Propane	250 MBH	10 tons	Fair

Retrofit Conditions

This measure includes replacing the four existing propane fired rooftop units with air source heat pump rooftop units equipped with electric backup heat.

The rooftop units will be replaced by ASHP rooftop units sized to the cooling capacity of the existing units. The 4-ton rooftop units will be replaced with 4-ton ASHP rooftop units and the 10-ton unit will be replaced with a 10-ton ASHP rooftop unit. Backup electric heating will be sized to match the existing heating capacity.

Typical Dual Fuel Heat Pump Rooftop Unit

Rather than generating heat, heat pumps primarily operate by transferring heat from one medium (the source) to another (the load). In heating mode, air source heat pumps extract heat from the atmosphere (the source) and transfer it to the occupied space within the building (the load). Since the heat pump is not actually generating the heat, just transferring it, they're able to supply heating energy much more efficiently than propane fired equipment.

As outdoor temperatures drop below the operating envelope of the air source heat pumps, an alternate or backup source of heat must be used. When outdoor temperatures fall below the operating temperature of the units, electric resistance heating will carry the heating load thereby offsetting 100% of the propane consumed by the existing rooftop units.

Weight is always a consideration when replacing rooftop equipment. ASHP rooftop units are available from multiple manufacturers. Weights will vary by capacity, manufacturer, size and model. The exact weight of the replacement rooftop units will not be known until the project is designed, tendered and products selected.

The average weight of ASHP rooftop units is typically slightly higher than that for standard rooftop units when comparing similar compressor capacities.

To account for potential structural issues, costing for this measure includes increased allowances for structural evaluations of the roof structure and increased costs for structural reinforcement which may be required.

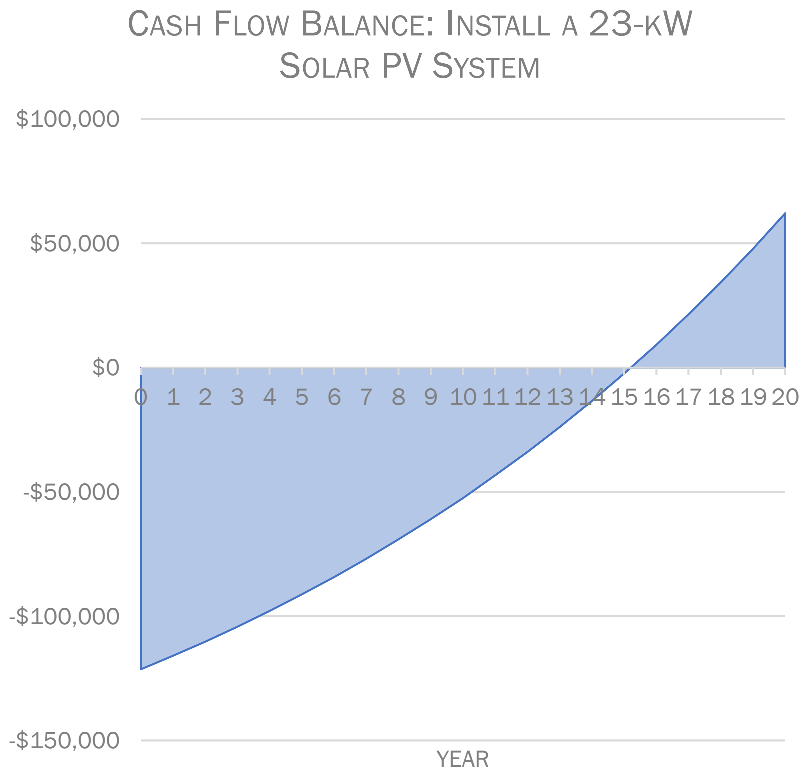
6.7 Opportunity 07: Install a 23-kW Solar PV System

The Detailed Financial Analysis

Using the Financial Factors listed in this report, this project results in the following Annual Utility Savings, Simple Payback and Net Present Value:

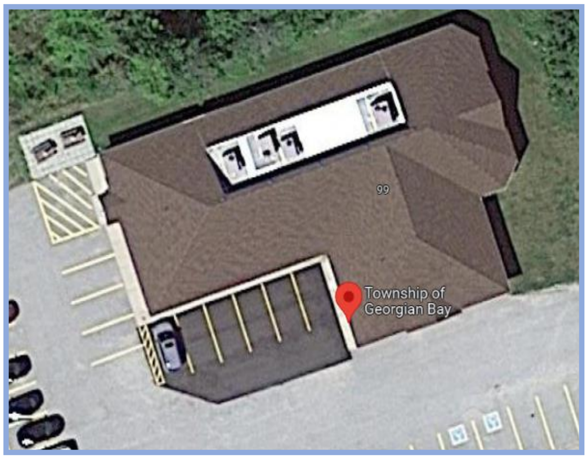
Table 6.7.1: Detailed Financial Analysis

Utility Savings	
Demand (kW):	85
Electricity (kWh):	26,900
Propane (l):	0
Water (m³):	0
Emissions (tCO_2e):	0
Financials	
Utility Savings:	$5,166
Materials & Labour:	$110,359
Engineering & PM:	$0
Contingency:	$11,036
Project Costs:	$121,395
Simple Payback:	23.5
Capital Payback:	15.2
NPV:	-$36,974
IRR:	3.6%



Existing Conditions

The facility is constructed with a sloped roof. The roof orientation and layout is not ideal for a solar PV installation, however it does provide adequate space for a small PV installation on the south and southwest facing slopes.



Aerial View: Administration Building

Retrofit Conditions

Photovoltaic (PV) solar panels convert solar energy directly into electricity. The electricity can then be coupled to the building's electrical distribution, where it can be used within the building or sold back to the utility (with a net-metering agreement). Clear exposures to eastern, southern, and western skies will help maximize the electricity production of the PV system.

Analysis shows that available roof space could accommodate a system of approximately 23-kW which will generate approximately 27,000 kWh of usable electricity for the building. This equates to approximately 45% of the building's total (existing) electrical consumption.

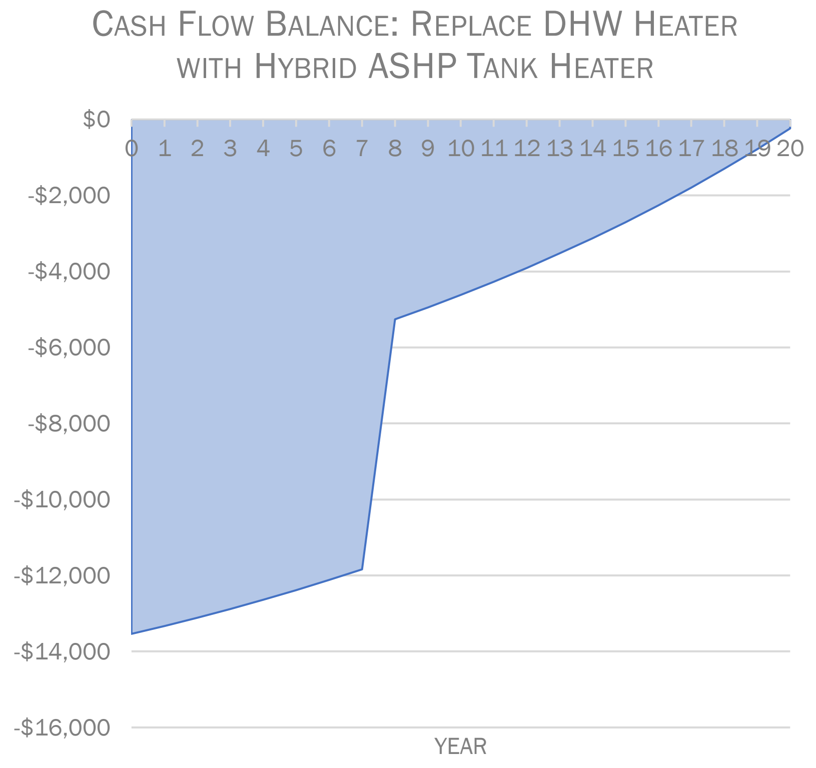
6.8 Opportunity 08: Replace DHW Heater with Hybrid ASHP Tank Heater

The Detailed Financial Analysis

Using the Financial Factors listed in this report, this project results in the following Annual Utility Savings, Simple Payback and Net Present Value:

Table 6.8.1: Detailed Financial Analysis

Utility Savings	
Demand (kW):	0
Electricity (kWh):	1,028
Propane (l):	0
Water (m³):	0
Emissions (tCO_2e):	0.03
Financials	
Utility Savings:	$197
Materials & Labour:	$10,830
Engineering & PM:	$1,624
Contingency:	$1,083
Project Costs:	$13,537
Simple Payback:	68.6
Capital Payback:	20.4
NPV:	-$6,737
IRR:	-0.2%



Existing Conditions

Domestic hot water (DHW) for the facility is provided by a single electric tank heater rated at 3-kW with 178 litres of storage. The tank heater was installed in 2018 and is in good operating condition.

DHW Heater - Electric

Table 6.8.2: DHW Equipment Details

Tag ID	Boiler Type	Capacity	Efficiency	Condition
HT1	Electric	3 kW	100%	Good

All piping was observed to be properly insulated.

Retrofit Conditions

The existing electric DHW heater can be replaced with residential style “hybrid” ASHP tank heater.

Multiple manufacturers currently offer residential and light commercial hybrid domestic hot water tanks which utilize a combination of an air source heat pump and electric resistance heating. The air source heat pump operates at a low capacity over longer durations of time to slowly increase or maintain tank temperatures. During times of high loads, the electric resistance heater cycles on to carry the peak loads.

Typical Hybrid ASHP/Electric Tank Heater

This measure includes demolition and removal of the existing electric tank heater. A new hybrid tank heater would be installed in the location of the existing equipment.

This measure will have no measurable impact on operations and maintenance at the facility.

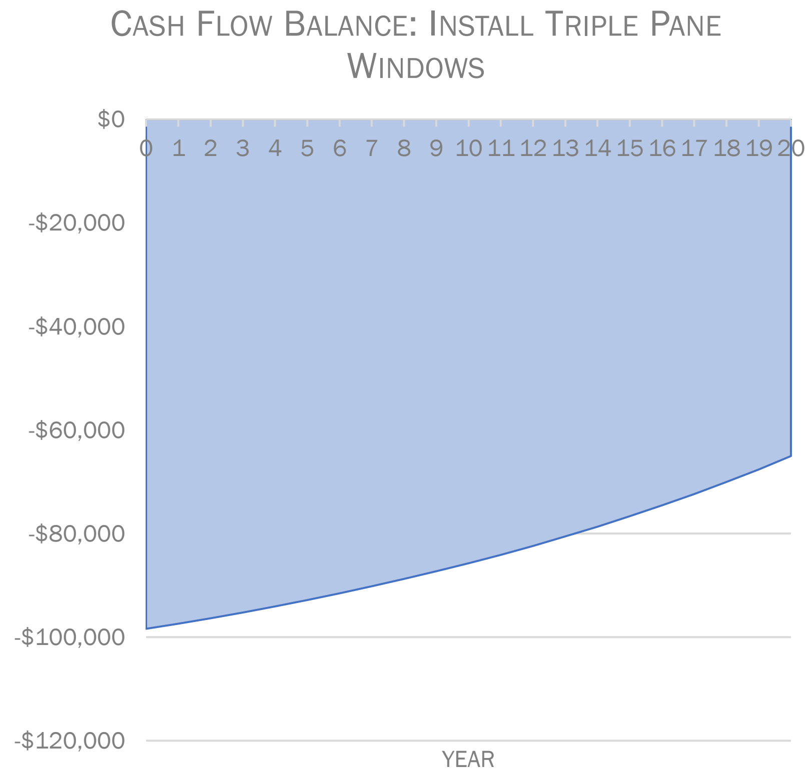
6.9 Opportunity 09: Install Triple Pane Windows

The Detailed Financial Analysis

Using the Financial Factors listed in this report, this project results in the following Annual Utility Savings, Simple Payback and Net Present Value:

Table 6.9.1: Detailed Financial Analysis

Utility Savings	
Demand (kW):	0
Electricity (kWh):	880
Propane (l):	843
Water (m^3):	0
Emissions (tCO_2e):	1.3
Financials	
Utility Savings:	$956
Materials & Labour:	$78,708
Engineering & PM:	$11,806
Contingency:	$7,871
Project Costs:	$98,385
Simple Payback:	102.9
Capital Payback:	36.2
NPV:	-$82,996
IRR:	-7.8%



The Existing Conditions

The facility was constructed in 2006. Windows are double glazed with an argon fill. The windows themselves are in relatively good condition with the exception of the caulking around window frames which has begun to crack/degrade.

The Retrofit Conditions

The windows can be replaced with more efficient triple glazed, argon filled windows to reduce energy consumption and GHG emissions. Window frames should be made of thermally broken aluminum or fiberglass. Existing operable windows should be replaced with operable windows. Newer windows will have a higher R-value (better insulating characteristics) and will also have tighter frames resulting in less infiltration. Specify argon-filled windows with a low-emissivity interior coating to block some of the summer radiant heat gain. Savings calculations were determined using a new window with an R-value of 4.

Window Frame: Caulking is Cracked and Degraded

The existing windows are currently 18-years old with an average life expectancy of 50-years. This measure is relatively expensive when compared to other GHG reduction measures and is not required to achieve either the 50% or 80% GHG reduction targets. It is recommended that this measure be reconsidered when the existing windows approach the end of their life expectancy.

This measure will have no measurable impact on operations and maintenance at the facility.

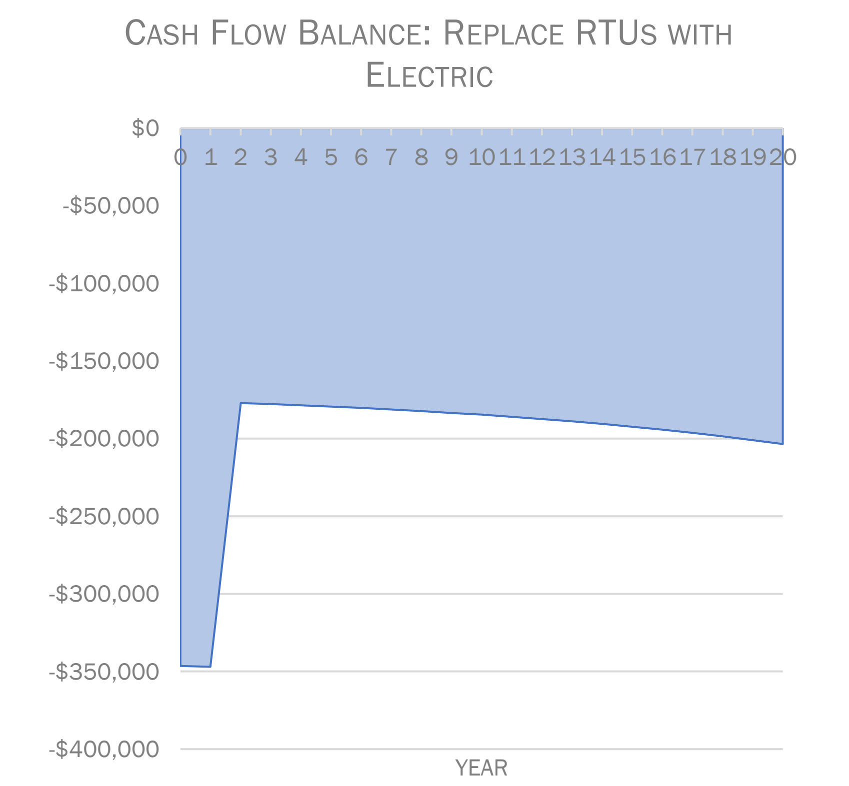
6.10 Opportunity 10: Replace Rooftop Units with Electric

The Detailed Financial Analysis

Using the Financial Factors listed in this report, this project results in the following Annual Utility Savings, Simple Payback and Net Present Value:

Table 6.10.1: Detailed Financial Analysis

Utility Savings	
Demand (kW):	-142
Electricity (kWh):	-57,630
Propane (l):	11,279
Water (m³):	0
Emissions (tCO_2e):	15.7
Financials	
Utility Savings:	-$539
Materials & Labour:	$277,120
Engineering & PM:	$41,568
Contingency:	$27,712
Project Costs:	$346,400
Simple Payback:	No Payback
Capital Payback:	No Payback
NPV:	-$210,287
IRR:	No IRR



Existing Conditions

Heating, cooling & ventilation to the facility is primarily provided by four packaged rooftop units (RTUs) each equipped with propane heat & DX cooling. The units are original to the building (2006) and are in fair operating condition.

Packaged Rooftop Unit – Typical of (4)

Each rooftop unit is controlled by an individual wall mounted, programmable thermostat located in the space supplied.

Table 6.10.2: Heating Equipment Details

Tag ID	Heating	Heating Capacity	Cooling Capapacity	Condition
RTU1	Propane	115 MBH	4 tons	Fair
RTU2	Propane	115 MBH	4 tons	Fair
RTU3	Propane	115 MBH	4 tons	Fair
RTU4	Propane	250 MBH	10 tons	Fair

Retrofit Conditions

This measure includes replacing the existing propane fired rooftop units with rooftop units equipped with electric resistance heating & DX cooling. Units would be sized to the nominal heating & cooling capacities of the existing rooftop units.

The average weight of newer/more efficient rooftop units is typically slightly higher than that for standard rooftop units when comparing similar capacities. To account for potential structural issues, costing for this measure includes increased allowances for structural evaluations of the roof structure and increased costs for structural reinforcement which may be required.

Costs also include the installation of new electrical feeds from the rooftop units to their respective electrical panels.

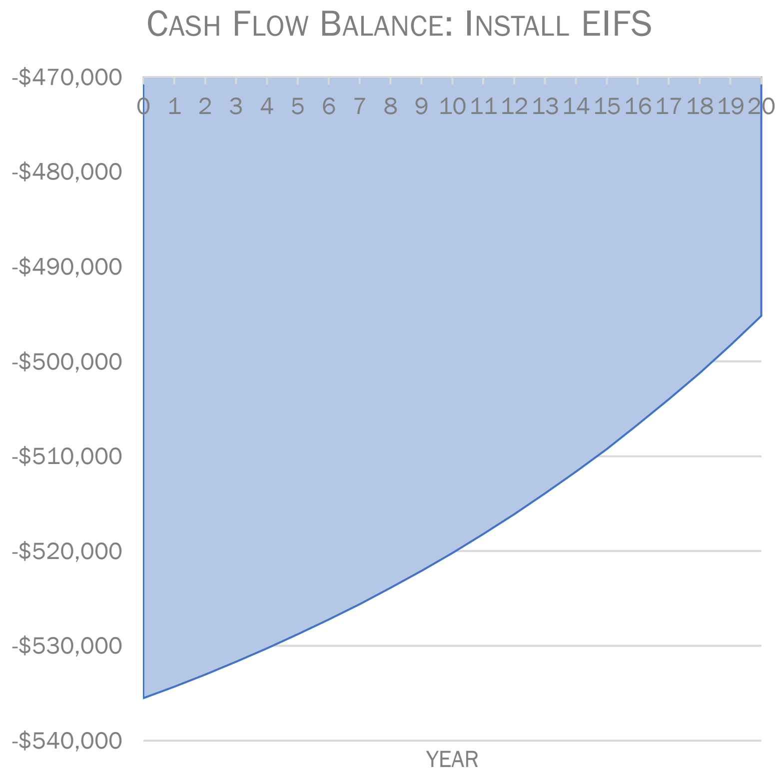
6.11 Opportunity 11: Install External Insulation & Finishing System (EIFS)

The Detailed Financial Analysis

Using the Financial Factors listed in this report, this project results in the following Annual Utility Savings, Simple Payback and Net Present Value:

Table 6.11.1: Detailed Financial Analysis

Utility Savings	
Demand (kW):	0
Electricity (kWh):	460
Propane (l):	1,147
Water (m³):	0
Emissions (tCO_2e):	1.8
Financials	
Utility Savings:	$1,159
Materials & Labour:	$428,411
Engineering & PM:	$64,262
Contingency:	$42,841
Project Costs:	$535,514
Simple Payback:	462.0
Capital Payback:	64.1
NPV:	-$516,895
IRR:	-16.4%



Existing Conditions

The facility was constructed in 2006 with a red brick façade and includes a pitched roof with asphalt shingles. The facility is approaching 20-years old. What was considered "adequate" or "best practice" for insulation values 20-years ago has evolved significantly.

Building Envelope: Administration Building

Retrofit Conditions

The facilty is aproaching 20-years in age. What was considered as acceptable or even “best practice” years ago has evolved. Additionally, insulation values of wall assemblies typically deteriorates over time due to cracks, penetrations and moisture infiltration into materials.

External Insulation and Finishing Systems (EIFS) consist of an added layer of rigid insulation applied over the building’s existing façade and then finished with an overlay of cladding or exterior veneer. EIFS systems typically contain an additional 4 inches of rigid insulation. One inch of rigid insulation provides an average R-value of 5. Four inches of rigid insulation would add a total of R20 to the building’s existing insulation.

This EIFS system will be installed and maintained by a qualified contractor. No additional staff training is required. This measure will have no measurable impact on operations and maintenance costs at the facility and will have no impact on occupancy comfort or safety.

7 Scenario Level Analysis

As per the funding guidelines set out by the Green Municipal Fund, the measures presented in this study will be grouped in the following GHG reduction target pathways:

- 50% GHG reductions in 10 years
- 80% GHG reductions in 20 years
- 80% GHG reductions in 5 years

7.1 GHG Reduction Pathway Summary

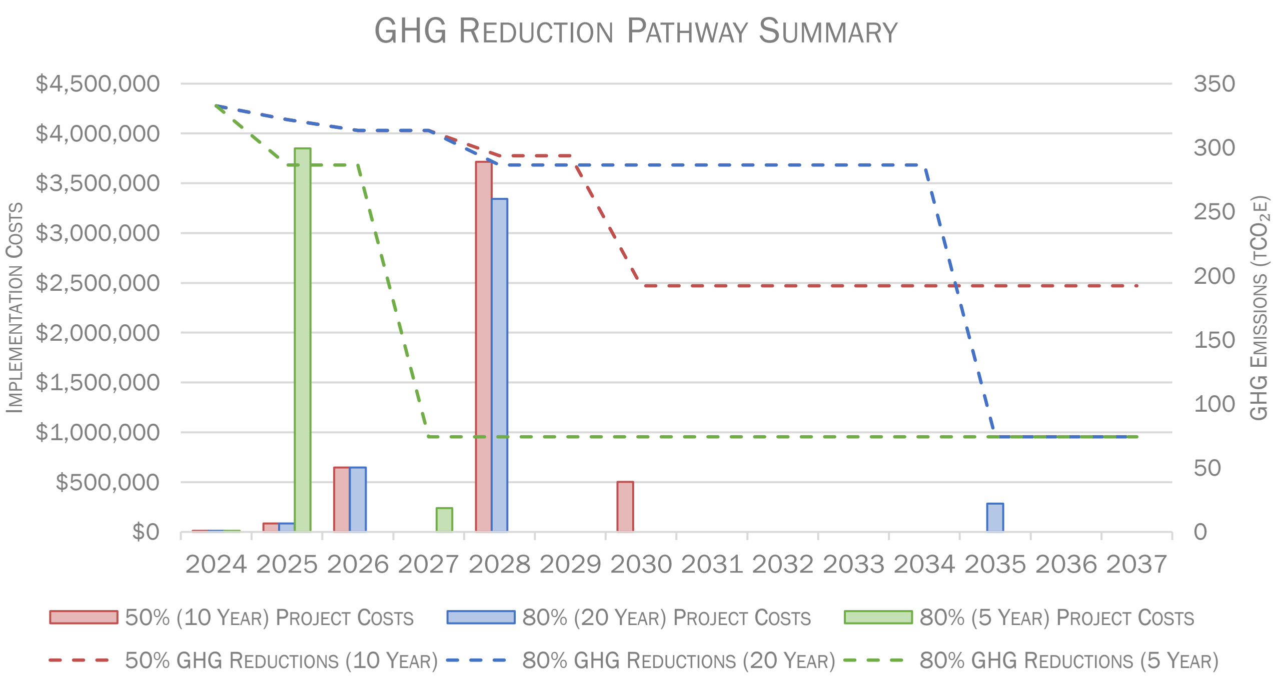
The following table summarizes which measures are included in each pathway.

Opp. #	Opportunity	50% Reduction Pathway (10 Year)	80% Reduction Pathway (20 Year)	80% Reduction Pathway (5 Year)
1	Install Ultra-low Flow Washroom Faucets	•	•	•
2	Replace RTUs with ASHP RTUs & Propane Backup	•		
3	Re-Caulk Window Frames		•	•
4	Upgrade Lighting to LED Fixtures		•	•
5	Install a Building Automation System		•	•
6	Replace RTUs with ASHP RTUs & Electric Backup		•	•
7	Install a 23-kW Solar PV System		•	•
8	Electrical Service Upgrade		•	•
9	Replace DHW Heater with Hybrid ASHP Tank Heater			
10	Install Triple Pane Windows			
11	Replace RTUs with Electric			
12	Install EIFS			

Measures not assigned to a reduction pathway were analyzed however are not required to achieve the stated targets of 50% and 80% GHG reductions.

Bundling measures into pathways, or scenarios, often results in interactive effects between systems. As a result, the total GHG reduction for a particular Roadmap will typically differ from the sum of the GHG reductions from individual measures. The Scenario Level Analysis accounts for these interactive effects between systems which are not represented in the Measure Level Analysis.

	Reductions				Financials		
GHG Reduction Pathways	Energy (ekWh)	Energy (%)	Emissions (tCO_2e)	Emissions (%)	Annual Savings	Project Costs	20-Year LC Cost
50% Reductions (10 Year)	35,059	25%	13.9	72%	$2,675	$379,815	$563,736
80% Reductions (20 Year)	86,428	62%	17.7	92%	$12,805	$767,330	$697,129
80% Reductions (5 Year)	86,428	62%	17.7	92%	$12,805	$767,330	$700,515
Business-As-Usual	$0	0%	$0	0%	$0	$163,285	$479,356



Another aspect of this analysis is considering the costs associated with a "business-as-usual" approach. This study is offering upgrade options to HVAC equipment and other energy consuming systems to reduce overall GHG emissions. However, all of the equipment addressed in this study will have to be replaced at some point, if not by more efficiency equipment, then by "like-for-like" equipment replacements. By implementing these energy efficiency measures, the "like-for-like" costs are avoided.

The table below shows the financial details of each pathway taking into consideration the incremental costs of implementing energy efficient measures through the GMF program.

	Financials						
Pathway	Project Costs	Potential Grant	Avoided Cost	Incremental Costs	LC Cost	Incremental 20-Year LC Cost	Incremental LC Cost per Tonne CO^2e
50% Reductions in 10 Years	$379,815	$75,963	$163,285	$140,567	$563,736	$84,379	$303
80% Reductions in 20 Years	$767,330	$153,466	$163,285	$450,579	$697,129	$217,773	$617
80% Reductions in 5 Years	$767,330	$153,466	$163,285	$450,579	$700,515	$221,159	$626
Business-As-Usual	$163,285	$0	$0	$0	$479,356	N/A	N/A

7.2 Demand Impact Summary

A major component of achieving net-zero carbon is fuel switching from fossil fuels such as natural gas or propane to a fuel source that emits comparatively less emissions, such as electricity. However, converting most or all of a building's HVAC systems from propane fired equipment to electrical can have a significant impact on the building's electrical demand. If the building is unable to support the sudden increase in electrical demand as a result of implementing fuel-switching measures, then further investment into bolstering the building's existing electrical capacity may be necessary.

The site is serviced by three pole mounted 50 kVA transformers. This supplies the main disconnect for the building which is rated at 100A.

No metered demand data was available at the time of this study. The calibrated energy model estimates the facility's peak electrical demand at 27-kW.

Pathway	Demand Increase (kW)	Demand Upgrade Costs
50% Reduction Pathway	0	$0
80% Reduction Pathway	140	$107,986

The costs of upgrading electrical distribution to support the implementation of a measure (wiring, conduit, circuit breakers, etc.) are already included in each measure's project costs. However, if the demand impact of implementing several measures exceeds the building's installed capacity, then further electrical costs will be required. These upgrades are typically done by the utility by local distribution company (LDC) and costs are passed onto the building owner. These costs are already included in the total project costs listed in the financial tables above.

APPENDIX A

UTILITY BILL ANALYSIS

Appendix B

Appendix B. Floorplans