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Energy Audit

17 Queen Street, Ripley, ON

Prepared for:
Township of Huron-Kinloss
17 Queen Street
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Reference List of Frequently Used Acronyms:

Abbreviation	Full Name
CDD	Cooling Degree Days
DHW	Domestic Hot Water
EA	Energy Audit
ECM	Energy Conservation Measures
EUI	Energy Utilization Index
GHG	Green House Gas
HDD	Heating Degree Days
HVAC	Heating, Ventilation, and Air Conditioning
IESO	Independent Electricity System Operator
IRR	Internal Rate of Return
LED	Light-Emitting Diode
NPV	Net Present Value
OEE	Office of Energy Efficiency
PV	Photovoltaics
RTUs	Packaged Rooftop Unit
TGBS	Toronto Green Building Standard
ASHRAE	The American Society of Heating, Refrigerating and Air-Conditioning Engineers
GaGBC	Canada Green Building Council

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1 Introduction

1.1 Terms of Reference

Pretium Engineering Inc. (Pretium) was retained by Mike Fair of the Township of Huron-Kinloss Community Services to perform an energy audit (EA) of the building at 17 Queen Street, Ripley, Ontario. The purpose of the audit it to determine the base building energy consumption and greenhouse gas (GHG) emissions and identify energy conservation measures (ECMs) that can be implemented to reduce that consumption and the corresponding emissions. The report will be used as part of Township of Huron-Kinloss Community's application for funding through the Green and Inclusive Community Buildings Program offered by Infrastructure Canada.

1.2 Background

The community centre is located at 17 Queen Street in Ripley, ON and was originally constructed in 1975. The gross floor area of the building is approximately 2,993 m^2 (32,217 sq.ft). The building consists of a social room, kitchen, change rooms, mechanical room, storage room, ticket booth, washrooms, office, and an arena. According to the director of community services, of the following is a history of renovations completed at the building:

- 1993: Addition of dressing rooms and lobby renovation.
- 1997: Installed a dehumidifier.
- 1999: Installed a condenser.
- 2003: Arena roof replacement.
- 2007: Renovation of the arena floor, arena boards, chiller, and electrical control panel with scheduling temperature controls for hockey and figure skating.
- 2018: Renovation of the offices and auditorium including access to bleachers with an accessible viewing platform.
- 2018: All baseboard heaters and two water heaters removed at the front of the arena replaced with an on-demand boiler.
- 2021: Snack bar renovation.
- 2022: Front entrance remodelling and the addition of two small accessible dressing rooms.

1.3 Documentation

The following documents were provided by the Client to Pretium for consideration.

.1 **Monthly Electricity Records:** January 2015 to November 2022.

.2 **Monthly Propane Records:** January 2015 to December 2022.

.3 **Architectural Drawings:**

.1 Existing Arena: architectural drawings prepared by Peirson Building Limited, dated July 3rd, 1974.

.2 Dressing Room Addition: architectural drawings prepared by Robert J Dyck Architect & Engineer Incorporated.

.3 Final Ripley Area: architectural drawings prepared by Domm Construction LTD, dated September 12th, 2022.

.4 **Mechanical Summary**: Facilities Inventory (including all mechanical systems) received from Client, dated January 9th, 2023.

1.4 Methodology

.1 Created the Baseline model which is based on available drawings, and documents. This includes a comprehensive review to document the equipment and floor plan.

.2 A utility analysis was performed to develop a baseline against which ECM performance can be quantified and to identify major areas of improvement to determine the most fruitful interventions.

.3 Energy Conservation Measure (ECM) Identification and Analysis: Each measure proposed for implementation on this project has been selected based on its viability, as measured against the following criteria:

.1 Costs and savings within overall criteria for evaluation guidelines.

.2 Appropriateness for tasks performed in the space.

.3 Consistency of application (all areas of similar function are consistent).

.4 Equipment approval by facilities personnel.

.5 Impact on occupant behaviour and general acceptance of changes.

.4 The energy savings calculations were based on estimated reductions in electrical and propane consumption and electrical demand, where appropriate. ECM assumptions and calculations are available upon request.

.5 Opinions of probable costs for implementing ECMs are estimated based on the approximate 'capital cost' for the materials, labour, (demolition and installation). Costs are based upon assumed quantities, average unit prices, general approaches, and Pretium's experiences with similar work; costs are not based on prepared specifications. The costs are accurate to within Class "C", i.e. +/- 25%.

.6 Recommendations: From the options considered, recommendations are put forward based on financial and practical feasibility using indicators such as simple payback, capital cost, and net present value (NPV). The client did not indicate they are looking to collect an Internal Rate of Return (IRR) from the energy savings; however, one was still provided for informational purposes, assuming an interest rate of 2%.

2 Findings and Comments

2.1 Building Envelope

The exterior walls consist of a combination of concrete block and steel siding. The block is located on the lower portion of the wall (varying from 8-12' from grade) and the siding at the upper section to the underside of the roof. Based on the information provided by the client, the windows are a combination of fixed and awning double pane insulated glazing units in an aluminium frame and appear to be in good condition.

There are 2 types of roof construction, one from the original building and one for the addition. Based on the provided architectural drawings, the original roof was a 26 GA standing seam roof. We understand around 2005 – 2007 the existing roof was retrofit with an additional layer of 2" of insulation and a new single ply membrane to match the roofing membrane at the addition.

2.2 Mechanical Systems

The following is a description of the mechanical systems and components that were identified during the assessment.

2.2.1 Domestic Hot Water (DHW) Systems

- **Hot Water Tanks:** The building consists of three (3) water tanks, one (1) Lobby Boiler Luna (LUNA DUO TEC 1.33 GA), one (1) of Bradford White – Defender (MITW50S6FCX) with 50 gallons (US) hot water tank, and one (1) A.O Smith hot water tank (BTRC-197 119). These systems are all run using propane.

2.2.2 Heating, Cooling and Ventilation Systems

Heating in the building is provided by the following:

- **Furnace:** This building has two (2) furnaces. one (1) RUDD – Achiever (TUHIB080A9H31CA) and one (1) RUDD – Achiever (UGRB-07EMAES) both with 92.8% seasonal efficiency
- **Electric Space Heaters:** There are two (2) electric space heaters in the building.

Cooling in the building is provided by the following:

- **Fridges/Freezers:** There are fourteen (14) fridges/freezers in the buildings.
- **Pumps and motors:** There are seven (7) pumps and motors in the buildings.

Fans, AHU's, & Air conditioning in the building is provided by the following:

- **Fans:** There are six (6) fans in the building.
- **Dehumidifier Ice surface:** There is one (1) 5,700 CFM Dehumidifier system with 2 compressors (6,957 wattage), made by Dectron – Dry-o-tron (DAZ-035-53).
- **RPB packaged unit:** There is one (1) 1,800 CFM Reznor package unit/air handler (RPB200-S2J) to supply social room and kitchen.
- **Packaged rooftop unit:** There is one (1) Carrier air conditioner (48TCEAD6A2A5A0B0A0), with a combustion and a compressor. This system is used for the social room.
- **Packaged rooftop unit:** There is one (1) Carrier air conditioning (48HCED08A2A5A0B0A0), with two (2) compressors. This system is used for the auditorium.

2.3 Electrical Systems

2.3.1 Elevator systems: There is one (1) elevator in the building, made by Concord elevator (8000 Series).

2.3.2 Lighting Systems

- **Lighting system:** The lights in the building are a combination of LEDs and T8s. The lighting system includes the exit signs, lobby, hallways, dressing rooms, offices, parking lot, goal lights, mechanical room, social room, auditorium, Zamboni, and ice surface.
- **Scoreboard:** There is one (1) scoreboard in the building.

2.3.3 Miscellaneous Loads

There are various plug loads in the building. They include office loads such as computers, monitors, security cameras, televisions, phones, and printers as well as some other equipment like kitchen appliances. These will contribute to the overall energy use.

3 Utility Analysis and Benchmarking

The following sections detail the energy analysis completed for the building, and includes a utility analysis, a benchmark comparison, and an estimated breakdown of energy consumed by fuel.

The utility analysis consists of the review of over 24 months of the facility's utility consumption history. This analysis identifies notable trends and irregularities in monthly energy use and relates consumption to climate using Heating Degree Days (HDD) and Cooling Degree Days (CDD). The result is the development of energy and cost indices, which are then compared with the Office of Energy Efficiency (OEE) benchmarks to assess the facility's performance against similar buildings.

3.1 Current Utility Consumption

Building electricity and propane consumption data invoices used in the analysis were provided by the Client. According to information provided, the Client building has a main electrical meter and propane used measurement.

The data in Table 1 summarizes electricity and propane consumption from January 2020 to December 2021.

Table 1 Summary of Utility Data

Year	Electricity		Propane		Total	
	Consumption (kWh)	Cost ($)	Consumption (L)	Cost ($)	EUI (ekWh/m²)	Cost Index ($/m²)
2021	230,000	30,504	42,161	21,112	195	128
2022	221,000	33,278	39,603	24,831	185	120
Average	**225,500**	**31,891**	**40,882**	**22,971**	**190**	**124**

The graph in Figure 1 is a visual summary of annual electricity, propane, and total energy consumption for the period from 2020 to 2021 for the building. The propane consumption has been converted to equivalent kilowatt hours to allow for comparison.

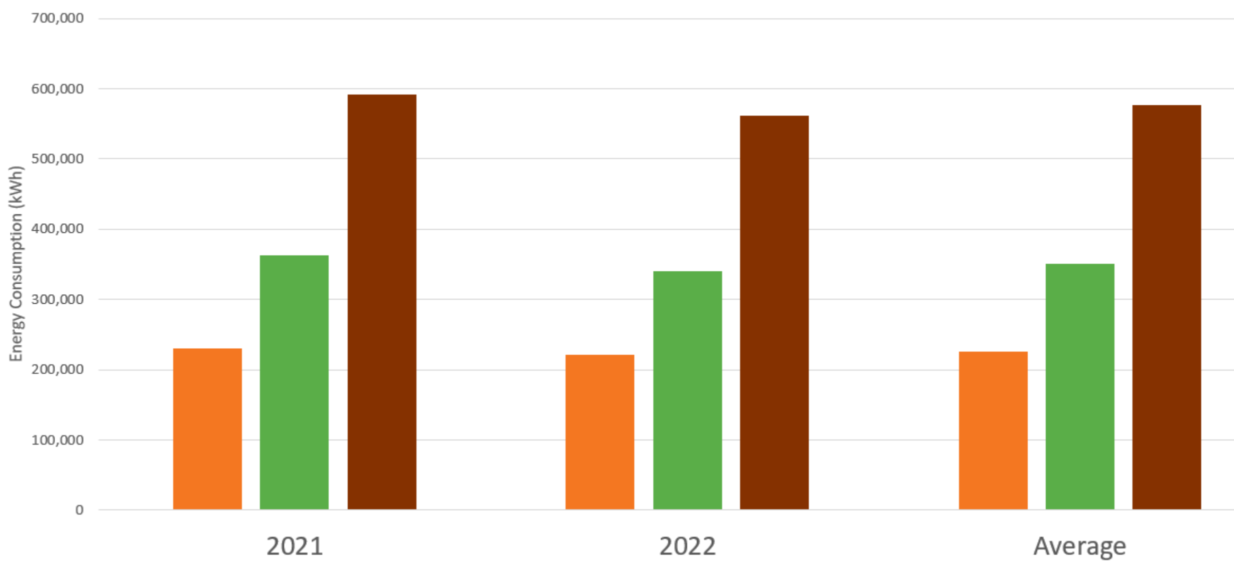

Figure 1 Annual Electricity and Propane Consumption (ekWh) of the building

3.2 Utility Price Structure

For the purposes of this report, blended rates for each primary utility were used, which include all fees, taxes, and bulk charges, which appear in each utility provider's billings. This effectively assumes that a reduction in consumption will reduce the cost by the rate that applies to the last unit of energy. These rates are listed in Table 2 below.

Table 2 Utility Rates (Electricity: Dec 2020 to November 2022; Propane: Jan 2021 to Dec 2022)

Item	Value	Units
Electricity Rate	0.14	$/ekWh
Propane Rate	0.57	$/L
	0.08	$/ekWh

3.3 Electricity

The 24 months of electricity utility data was collected, analysed, and then plotted to illustrate trends and identify any irregularities. In Figure 2, the monthly electricity is plotted from December 2020 to November 2022.

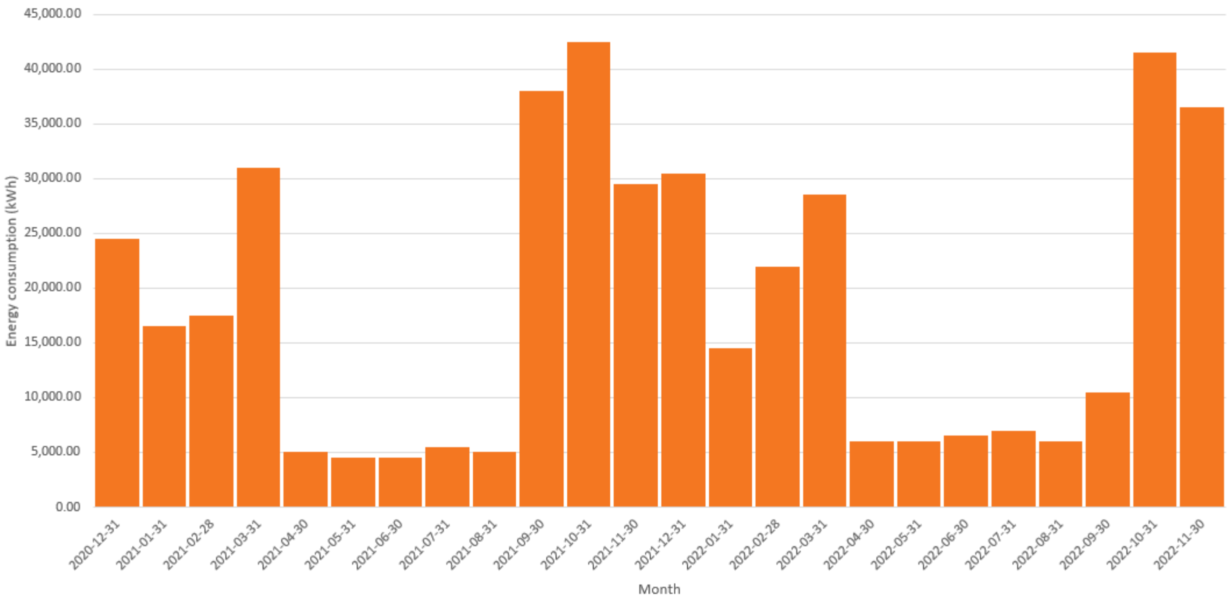

Figure 2 Monthly Electricity (ekWh) Consumption

Electricity is used on site for lighting, fridges/freezers, pumps, motors, fans, and plug loads. The average monthly consumption for the period of this analysis is 9,156 kWh. When comparing the seasonal averages, consumption was found to be highest in the fall (42,500 kWh) and lowest in the summer (4,500 kWh). The winter electricity consumption was 9.44 times higher than the summer consumption. The data indicates higher building loads in the fall to winter season, likely due to the higher occupancy rate in the building.

Linear regression analyses were performed to examine how electricity consumption responds to changes weather, measured by heating degree days (HDD) and cooling degree days (CDD). A heating degree day is the number of degrees that a day's average temperature is below 18°C, and a cooling degree day is the number of degrees above 18°C. They are location dependent climate data used to indicate heating and cooling loads for a building. The climate data information was collected from the government of Canada's web-based Historical Climate Data records. The resulting R-square value indicates the strength of the correlation between electricity consumption and HDDs or CDDs. The closer the value is to 1, the more energy is consumed as the HDDs/CDDs decrease.

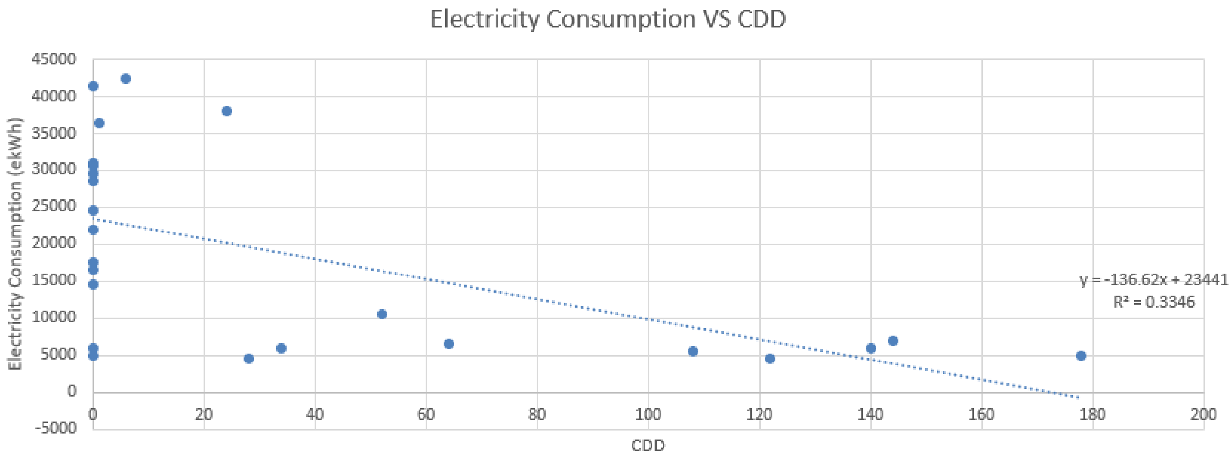

Figure 3 Electricity and Cooling Degree Day Regression Analysis

Based on the analysis as shown in Figure 3 there is a moderate correlation between electricity consumption and hot weather (i.e. CDDs). This was expected as building cooling is provided by rooftop units. This was expected as base electrical loads include building plug loads, fans, interior lighting, pump and motors, which are heavily occupant driven.

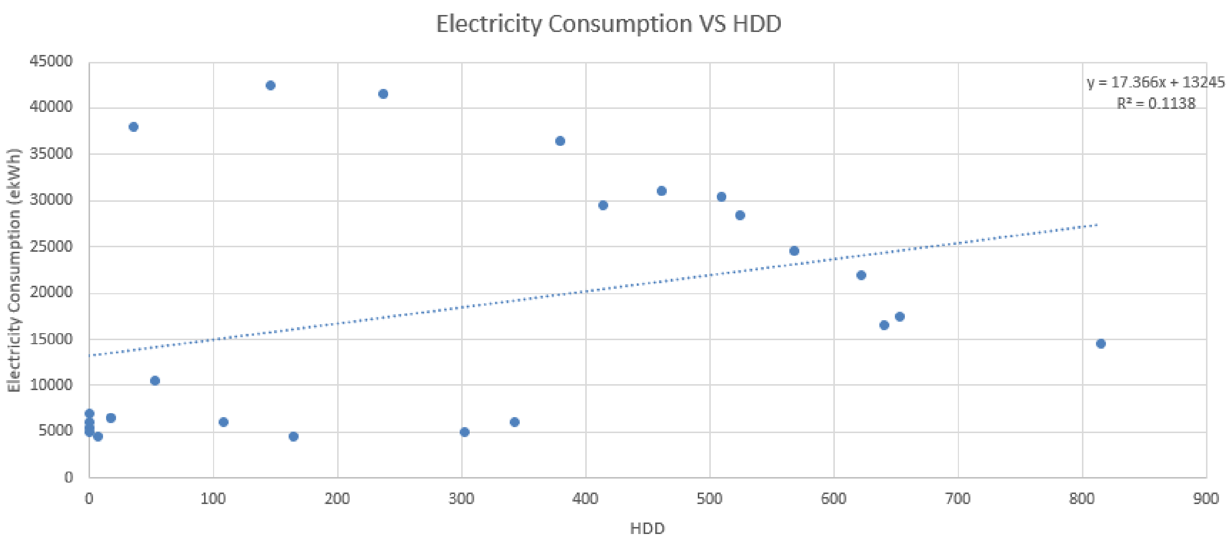

Figure 4 Electricity and Heating Degree Day Regression Analysis

Based on the analysis as shown in Figure 4 there is a low positive correlation between electricity consumption and cold weather (i.e. HDDs). This was expected as building heating is predominately provided by the furnaces and boiler.

3.4 Propane

The 24 months of propane utility data was collected, analysed, and then plotted to illustrate trends and identify any irregularities. In Figure 5 the monthly propane consumption is plotted against the HDDs and CDDs from January 2021 to December 2022.

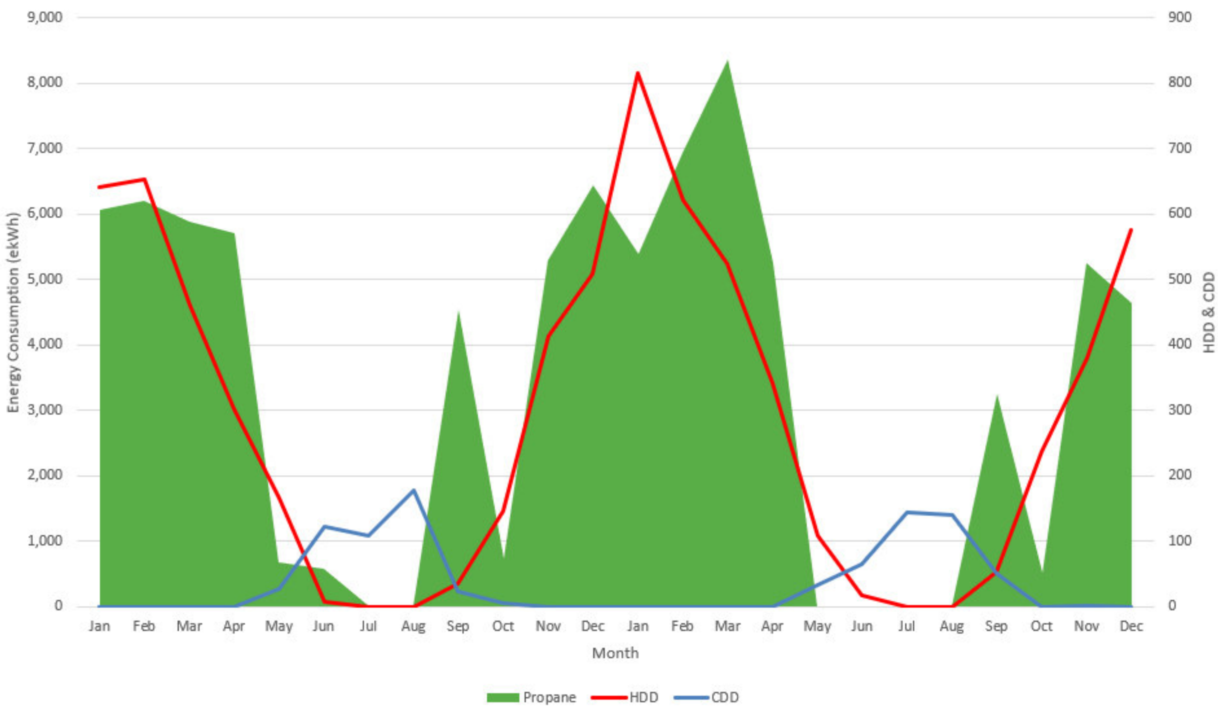

Figure 5 Monthly Propane Consumption (ekWh) vs HDD & CDD

The average monthly consumption for the period of this analysis is 3,407 L (2,926,470 ekWh). When comparing the seasonal averages, consumption was found to be highest in the spring at 8,352 L (71,744 ekWh) and lowest in summer months when additional propane was not purchased. This is expected, as space heating is typically not required during the summer season and the furnaces are used to heat the domestic water.

There appears to be a strong correlation between the heating degree days and propane consumption. A linear regression analysis was conducted on the building consumption data. Figure 6 below shows the line of regression developed through the correlation of consumption and heating degree days.

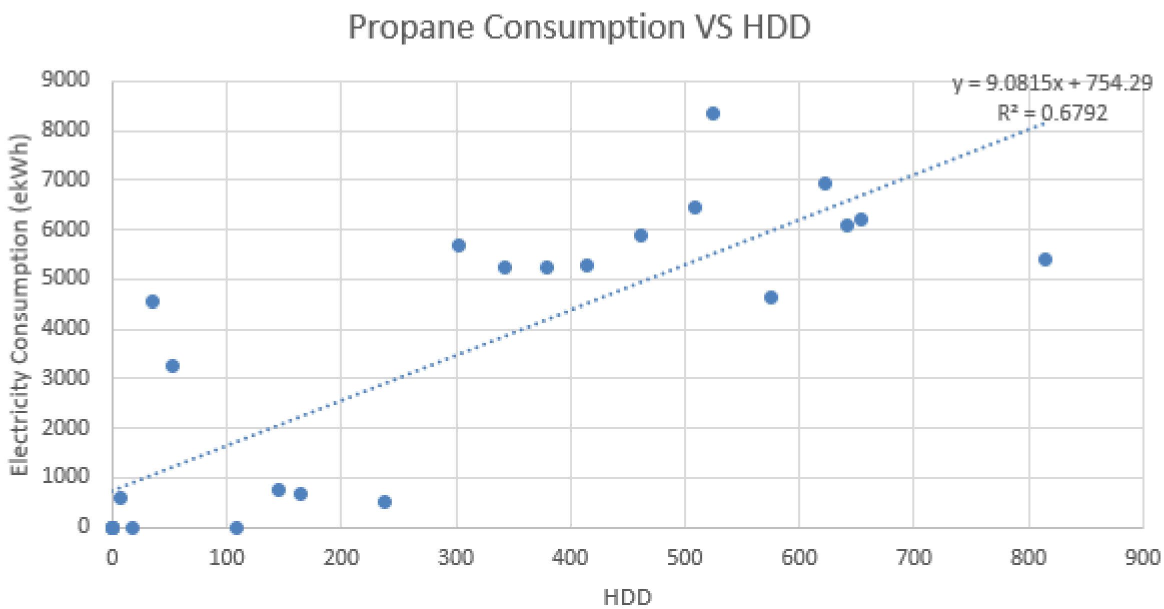

Figure 6 Propane and Heating Degree Day Regression Analysis

In this case, R-square value which is a correlation between ekWh/day to the HDD/Day is 0.6792, which shows a strong correlation between propane consumption and HDDs. The noticeable increase in Propane usage, which starts in August, and peaks in March, can be attributed to the heating cycle during the fall through spring months.

3.5 Annual Energy Consumption Breakdown by Type

Electricity and propane energy consumption figures have been converted to common units of energy (ekWh) to be able to compare the total amount of energy from each source.

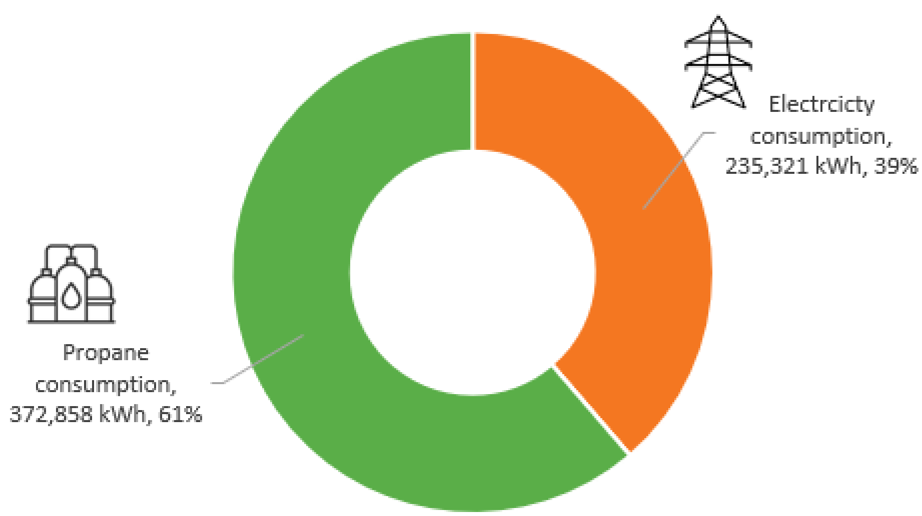

Figure 7 Annual Energy Consumption by Fuel Type

Based on the previous figure, propane accounts for 61% of all energy consumed, while electricity accounts for the other 39% of energy consumed. If we look at the cost of energy and compare the two, we can see a different story in Figure 8 below.

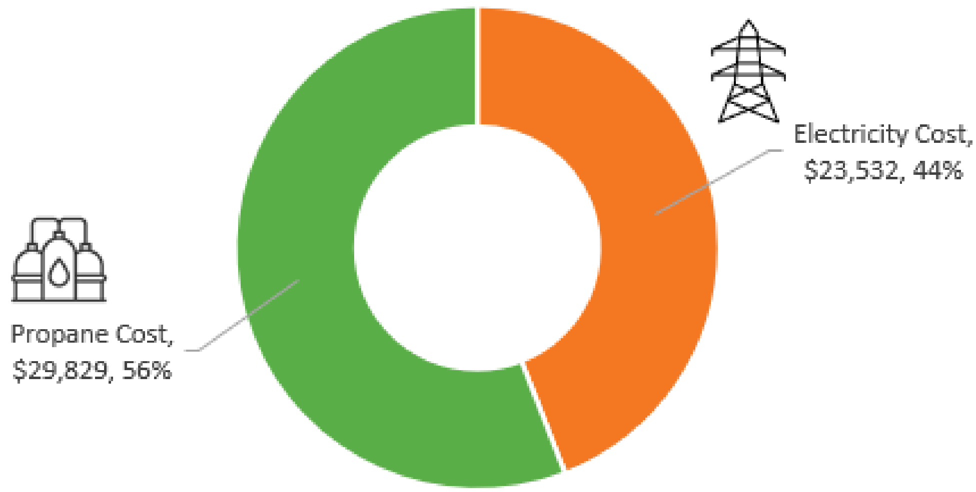

Figure 8 Annual Cost by Fuel Type

Based on the previous figure, propane accounts for 56% of all energy cost, while electricity accounts for the other 44% of energy costs.

3.6 Annual Energy Consumption Breakdown by Major End-Use

The total annual energy consumption of the facility was analysed and broken down into major end-use categories. The categories (also refer to the table, below) in this analysis include:

.1 Space Heating – This includes all space heating provided by any propane-fired equipment used to maintain the space temperature. Includes ventilation heating, and air conditioning systems.

.2 Domestic Hot Water – All domestic hot water used in building.

.3 Ventilation – This includes all energy consumed by the ventilation equipment (included cooling) such as the compressors and packaged air conditioning systems.

.4 Electricity equipment includes pumps, plug loads, and lighting.

- Pumps – All heating, cooling, and domestic water pumps.
- Plug Load (Equipment) – This includes all energy consumed by plugged-in equipment such as office and public building equipment.
- Lighting – All interior and some part of exterior lighting.

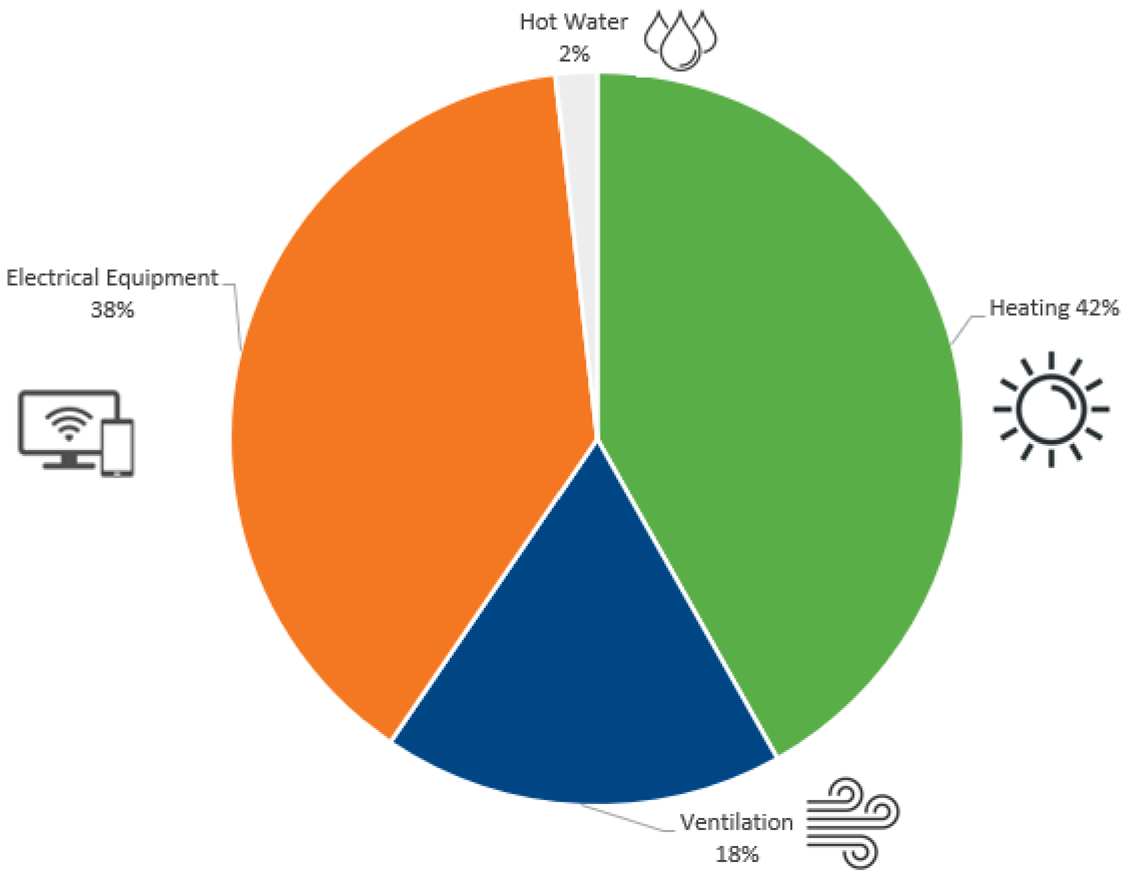

Figure 9 Annual Energy Consumption by End-Use

Table 3 summarizes the annual energy breakdown by major end-use in absolute energy consumption, as a percentage of the total energy consumed, based on the calculated energy consumption.

Table 3 Annual Energy Consumption by Major End-Use

Major End-Use	Propane (kWh)	Electricity (kWh)	Equivalent Energy (ekWh)	% Energy
Space Heating	254,522	-	254,522	42%
Ventilation (Included Cooling)	107,594	-	107,594	18%
Electric Equipment	-	235,322	235,322	38%
Hot Water	11,030	-	11,030	2%

Another way of looking at the same information is to consider the cost breakdown as shown in Figure 10 below. By combining these two assessments, we come to understand that while heat is the largest contributor to the building's energy consumption, the electrical equipment is the largest contributors to the building's energy costs.

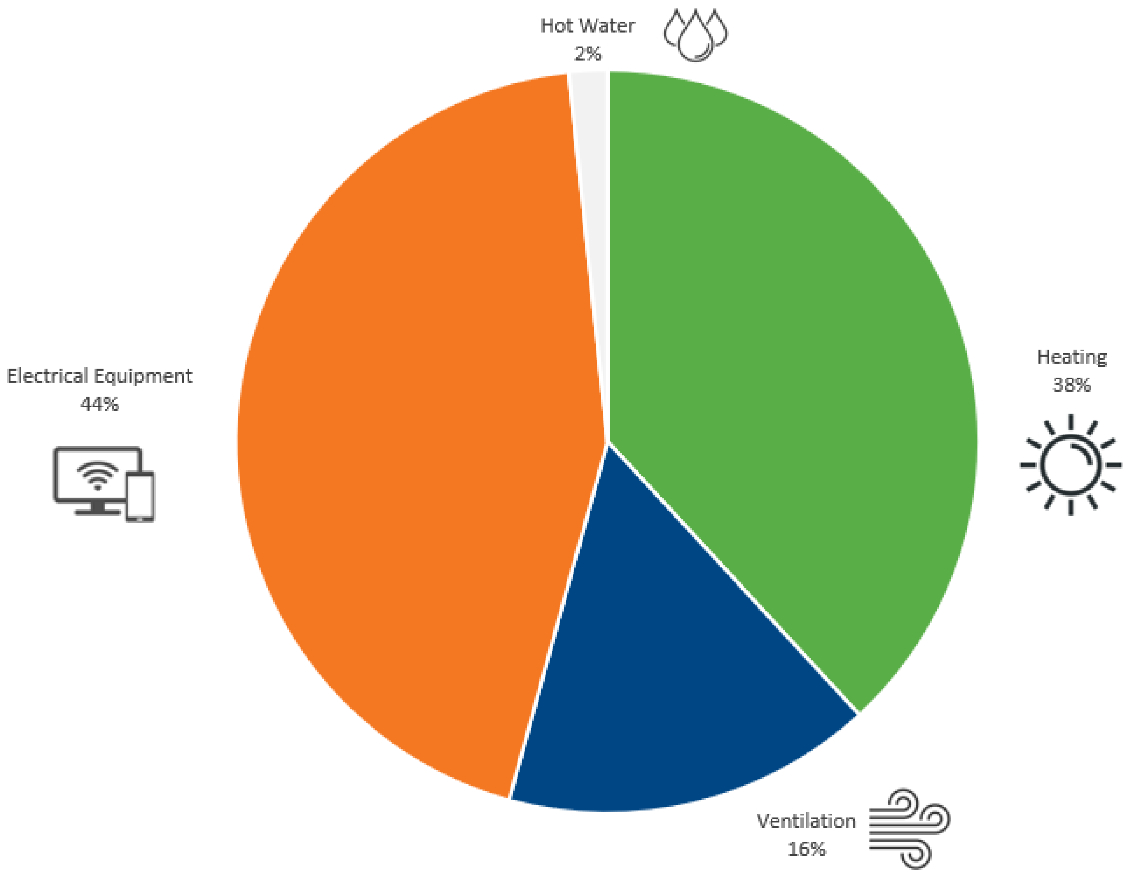

Figure 10 Annual Energy Cost by End-Use

3.7 Energy Performance Benchmarking

The site Energy Utilization Index (EUI) was calculated. The fundamental principal behind calculating EUI is dividing the total annual energy used (all energy utilities in common units) used on site by the gross floor area.

The EUI at this facility was compared to the Toronto Green Building Standard (TGBS) V4 performance targets for Commercial Office and to the Energy Star Portfolio Manager - Canadian Energy Use Intensity by Property Type Full Disclosure Report to assess the facility’s energy performance against similar buildings. Figure 11 shows how the calculated Site EUI compares to the Target EUI.

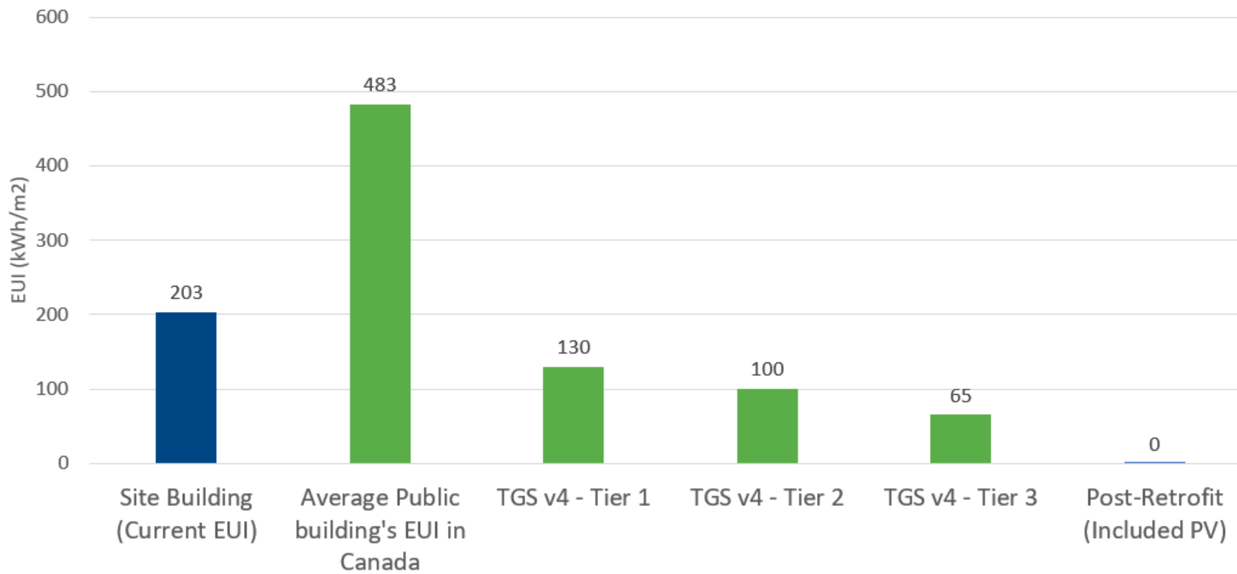

Figure 11 Comparison between the Average Public Building Type's EUI, Target EUI and Post-Retrofit EUI

The current EUI is 36% higher than the TGS v4 – Tier 1 for similar buildings noted in Toronto Green Standard Version 4. If the ECMs recommended in this report are carried out (Deep Retrofit), the EUI can potentially be reduced by 100%, reaching below the public building type's average EUI in Canada and TGS v4 Tier 1, 2, and 3 Target, which is intended for new construction projects. Only financially viable and assessable ECMs were recommended.

4 Assessment Findings

This section provides an overview of the ECMs analysed in this report. A series of ECMs were reviewed. For each measure, estimates of the annual savings in each of the following were determined: electricity consumption, propane consumption; total energy cost, and GHG emissions.

Incentives for electricity savings were estimated based on the Independent Electricity System Operator's (IESO) "Retrofit Program" as:

1. The greater of $400/kW of Demand Savings or $0.05/kWh of Annual Savings for Lighting retrofits
2. The greater of $800/kW of Demand Savings or $0.10/kWh of Annual Savings for all other electricity saving retrofits.

The details of their incentive criteria are not publicly available and therefore cannot be estimated for this report.

4.1 ECM- 1: Supplemental Wall Insulation (R35)

Based on provided architectural drawings, the insulation levels within the wall assembly were determined to be at approximately R25 for the block and R24.5 for the steel siding.

This ECM includes installing 50mm (2'') of Expanded Polystyrene to achieve a higher thermal resistant value (which will increase the R-Value at each area by R-35) and reduce heat loss from the building envelope. The additional insulation would be added to the exterior wall by over cladding. The improved cladding system will also increase the air tightness of the building assembly, further reducing energy loss. Table 6 summarizes the estimated energy savings associated with this measure.

Table 6 ECM-1 Supplemental Wall Insulation (R35)

Demand Reduction (kWh)	Annual Energy Savings (kWh)	Annual Cost Savings ($)	ECM Cost ($)	Incentives Available ($)	Simple Payback (years)	NPV (Assumed 30 years)	IRR
3.19	27,942	2,442	225,000	0	93	-190,086	-0.66%

4.2 ECM- 2: Triple Glazed Window Retrofit

ECM-2 provides a selection of triple-glazed, argon, filled replacement windows with a Low-e coating. With this assembly the R-value will increase from R-2 to R-6.

Based on the client provided pictures, the existing windows are relatively new and in good condition. As a result, there is not a strong business case for upgrading them to triple glazed windows at this time. This is a project that may be considered towards the end of the lifecycle of the existing windows (approximately 30 years). See Table 7 for the predicted energy and cost savings associated with this ECM.

Table 7 ECM- 2 Triple Glazed Window Retrofit

Demand Reduction (kWh)	Annual Energy Savings (kWh)	Annual Cost Savings ($)	ECM Cost ($)	Incentives Available ($)	Simple Payback (years)	NPV (Assumed 30 years)	IRR
0.65	5,655	494	35,000	0	70.8	-28,306	-0.59%

4.3 ECM- 3: Supplemental Roof Insulation (R60)

Based on the architectural drawings provided, the insulation levels within the old roofing assembly were determined to be approximately R-27.5. Whereas the new roofing assembly were determined to be around R-63.

Once the roof reaches the end of its useful service life, Pretium recommends installing additional roof insulation to achieve a minimum of R-60 for all roof areas. Table 8 summarizes the estimated energy savings associated with this measure.

Table 8 ECM-3 Supplemental Roof Insulation (R60)

Demand Reduction (kWh)	Annual Energy Savings (kWh)	Annual Cost Savings ($)	ECM Cost ($)	Incentives Available ($)	Simple Payback (years)	NPV (Assumed 15 years)	IRR
3.17	27,787	2,428	320,000	0	132	-291,352	-8.30%

4.4 ECM- 4: Upgrade All Light Bulbs to LED

The lighting is controlled manually with line voltage switches. While most of the fixtures are surface mounted fluorescents, a few are LEDs. The LED bulbs that can be used in standard fixtures are approximately 90% more efficient than their incandescent counterparts. We recommend all the lighting fixtures to be upgraded into LED lighting system. Therefore, this ECM has assumed every light bulb to be of 10 wattages. Table 9 summarizes the estimated energy savings associated with this measure.

Table 9 ECM-4 Upgraded All Light Bulbs to LED

Demand Reduction (kWh)	Annual Energy Savings (kWh)	Annual Cost Savings ($)	ECM Cost ($)	Incentives Available ($)	Simple Payback (years)	NPV (Assumed 25 years)	IRR
3.06	26,769	3,268	6,000	1752.3	1.3	25,779	80.50%

4.5 ECM- 5: Motion Controlled Lighting Retrofit

Separately from a lighting fixture retrofit, it is recommended to complete an upgrade to automated lighting controls from the current manual controls in building. A reduction of at least 30% in lighting power is anticipated when on occupancy controls. Table 8 summarizes the estimated energy savings associated with this measure. Table 10 summarizes the estimated energy savings associated with this measure.

Table 10 ECM-5 Motion Controlled Lighting Retrofit

Demand Reduction (kWh)	Annual Energy Savings (kWh)	Annual Cost Savings ($)	ECM Cost ($)	Incentives Available ($)	Simple Payback (years)	NPV (Assumed 25 years)	IRR
1.17	10,266	1,253	2,500	672	1.5	12,961	71.90%

4.6 ECM- 6: Door Replacement

Based on the architectural drawings provided, the thermal resistance of the door assembly was determined to be approximately R-1.8. Once the existing door reaches the end of its useful service life, Pretium recommends replacing with an insulated door to achieve a minimum of R-6. Table 11 summarizes the estimated energy savings associated with this measure.

Table 11 ECM-6 Door Replacement

Demand Generation (kW)	Annual Energy Savings (ekWh)	Annual Earnings/ Cost Savings ($)	ECM Cost ($)	Incentives Available ($)	Simple Payback (years)	NPV (Assumed 30 years)	IRR
0.99	8,700	760	13,800	0	18.2	-4,830	4.70%

4.7 ECM- 7: Existing Power Generation (598 PV Modules)

PV panels are an excellent way to lower the amount of electricity purchased and used from the electrical grid, significantly lowering energy costs. However, these systems are also expensive to install and maintain. A feasibility study would first be recommended to determine whether the roof area will be appropriate choice for the PV panel installation. In this ECM, we assumed 52 percent of roof area can be covered in PV modules. For the purpose of this analysis, we have selected Canadian Solar (Mono-si-CS6W-550MS).

Table 12 below summarizes the expected costs and earnings with installing a PV array to provide a demand generation of approximately 374,551 kWh/year.

Table 12 ECM-7: Existing Power Generation (598 PV Modules)

Demand Generation (kW)	Annual Energy Savings (ekWh)	Annual Earnings/ Cost Savings ($)	ECM Cost ($)	Incentives Available ($)	Simple Payback (years)	NPV (Assumed 30 years)	IRR
42.76	374,551	52,437	269,100	0	5.1	390,669	21.80%

4.8 ECM- 8: Existing Power Generation (285 PV Modules)

PV panels are an excellent way to lower the amount of electricity purchased and used from the electrical grid, significantly lowering energy costs. However, these systems are also expensive to install and maintain. A feasibility study would first be recommended to determine whether the roof area will be appropriate choice for the PV panel installation. In this ECM, we assumed 25 percent of roof area can be covered in PV modules. For the purpose of this analysis, we have selected Canadian Solar (Mono-si-CS6W-550MS).

Table 13 below summarizes the expected costs and earnings with installing a PV array to provide a demand generation of approximately 178,507 kWh/year.

Table 13 ECM-8: Existing Power Generation (285 PV Modules)

Demand Generation (kW)	Annual Energy Savings (ekWh)	Annual Earnings/ Cost Savings ($)	ECM Cost ($)	Incentives Available ($)	Simple Payback (years)	NPV (Assumed 30 years)	IRR
20.38	178,507	24,991	130,000	0	5.2	184,438	21.50%

4.9 ECM- 9: BAS (HVAC Controls) and Ventilation Upgrades

In the base case model, we assumed that the ventilation systems fan control is constant and running 24 hours a day, 7 days a week. This ECM assumes the installation of a Building Automation System (BAS) along with upgraded ventilation equipment. The BAS would allow all of the HVAC systems to operate based on occupancy schedule and space requirements, which would reduce energy consumption significantly. Table 14 summarizes the estimated energy savings associated with this measure.

Table 14 ECM- 9: BAS (HVAC Controls) and Ventilation Upgrades

Demand Generation (kW)	Annual Energy Savings (ekWh)	Annual Earnings/ Cost Savings ($)	ECM Cost ($)	Incentives Available ($)	Simple Payback (years)	NPV (Assumed 30 years)	IRR
3.73	32,663	1,498	100,000	0	66.8	-83,963	-7.70%

4.10 ECM- 10: Heat Pump System

This ECM includes converting the existing roof tops units to air source heat pumps (ASHP) which have significantly higher seasonal efficiency when compared to the existing rooftop units. This ECM results in a significant GHG reduction of 86.5 tonnes of Co^2 because of switching from Propane to Electricity. Table 15 summarizes the estimated energy savings associated with this measure.

Table 15 ECM- 10: Replaced to Heat Pump System

Demand Generation (kW)	Annual Energy Savings (ekWh)	Annual Earnings/ Cost Savings ($)	ECM Cost ($)	Incentives Available ($)	Simple Payback (years)	NPV (Assumed 30 years)	IRR
None	None	-7,712	120,000	0	None	-202,579	Negative

4.11 ECM- 11: Supplemental Wall Insulation (R45)

This ECM includes a further improvement of the wall assembly by installing 103mm (4'') of Expanded Polystyrene to achieve a thermal resistant value of R-45 and reduce heat loss from the building envelope. The additional insulation would be added to the exterior wall by over cladding. The improved cladding system will also increase the air tightness of the building assembly, further reducing energy loss. Table 16 summarizes the estimated energy savings associated with this measure.

Table 16 ECM-11 Supplemental Wall Insulation (R45)

Demand Reduction (kWh)	Annual Energy Savings (kWh)	Annual Cost Savings ($)	ECM Cost ($)	Incentives Available ($)	Simple Payback (years)	NPV (Assumed 30 years)	IRR
3.47	30,420	2,658	235,000	0	90	-196,990	0.78%

4.12 ECM- 12: Supplemental Roof Insulation (R70)

This ECM includes a further improvement of the roof assembly by installing additional insulation to achieve a minimum of R-70 for all of the roofing system. Table 17 summarizes the estimated energy savings associated with this measure.

Table 17 ECM-12 Supplemental Roof Insulation (R70)

Demand Reduction (kWh)	Annual Energy Savings (kWh)	Annual Cost Savings ($)	ECM Cost ($)	Incentives Available ($)	Simple Payback (years)	NPV (Assumed 15 years)	IRR
3.44	30,171	2,636	340,000	0	129	-308,893	-8.20%

4.13 Other Opportunities Considered

The following additional Energy Conservation Measures were modelled. However, given that the potential savings either could not be quantified, were extremely low, or the measures were cost prohibitive to implement, they were excluded from further analysis and were not included in this EA.

4.13.1 Parking Lot Solar Canopy Installation (285 Modules)

This ECM evaluated the option of installing PV units mounted at grade. The parking lot was selected as the location, and the system was assumed to be installed on structural framing to create a canopy above approximately 15% of the parking stalls. For the purpose of this analysis, we have selected Canadian Solar (Mono-si-CS6W-550MS). Table 18 below summarizes the expected costs and earnings with the installation of PV array to provide a demand generation of approximately 178,507 kWh/year.

Demand Reduction (kWh)	Annual Energy Savings (kWh)	Annual Cost Savings ($)	ECM Cost ($)	Incentives Available ($)	Simple Payback (years)	NPV (Assumed 15 years)	IRR
20.38	178,507	24,991	1,800,000	0	70	-1,413,812	-2.80%

4.13.2 Parking Lot Solar Canopy Installation (598 Modules)

This ECM option would take the same approach as above however 30% of parking stalls would be covered.

Table 19 below summarizes the expected costs and earnings with installing a PV array to provide a demand generation of approximately 374,551 kWh/year.

Demand Reduction (kWh)	Annual Energy Savings (kWh)	Annual Cost Savings ($)	ECM Cost ($)	Incentives Available ($)	Simple Payback (years)	NPV (Assumed 15 years)	IRR
42.76	374,551	52,437	1,900,000	0	36	-1,209,331	0.90%

4.13.3 Convert Building Energy Source from Propane to Natural Gas

Based on the simulation result, converted building energy source from propane to natural gas would save up to 12.48 percent of energy. However, it would increase the total greenhouse gas emission (GHG) by34%. Since achieving net zero (or near net zero) is desired, this option is excluded from the analysis.

4.13.4 Install Solar Thermal Collectors

A solar thermal collector can reduce building energy usage required for heating hot water. However, for this building occupancy the hot water demand is limited. In the case of this building, a solar water heater would only save 0.69% of the annual energy. Therefore, given the minimal saving, this option is excluded from the analysis.

4.13.5 Ice Generation Heat Recovery

Heat recovery systems using ice rink refrigeration waste heat was considered, but the nature of the existing building heating systems and loads do not lend themselves to this type of energy saving measure.

The waste heat from the ice rink would require installation of a dedicated heat exchanger and pumps. The expected water temperatures for heat recovery system is considered low grade heat and not well suited for hydronic building heating. It's best use would be for preheating of domestic water for showering, lavatory handwashing, and potentially ice resurfacing. The amount of heat available for recovery does not very well align with the domestic water loads in the building, nor does it completely replace the need for domestic water heating to store water at 140F as per building code requirements.

Most of the building heating is done using propane fired HVAC equipment, radiant heaters or electric type heaters which would require significant modification to retrofit for wastewater heat recovery heating systems. Other ECM's proposed at this time are already considering replacement of these systems with heat pump heating systems in lieu of propane or natural gas.

5 Conclusions and Recommendations

Table 20 summarizes the ECMs along with estimated costs, savings, GHG savings, simple payback, net present value, IRR, and Service Life.

Table 20 Summary of ECMs

ECM	Annual Electrical Savings (kWh)	Annual Propane Savings (ekWh)	% Total Annual Energy Savings	Annual GHG Savings (eTonnes CO2 eq.)	Annual Cost Savings ($)	ECM. Cost ($)	Incentives Available ($)	Simple Payback (Years)	Net Present Value ($)	IRR	Service Life (Years)
ECM 1 – Supplemental Wall Insulation (R35)	0	36,800	4.60%	9.8	2,442	225,000 *	0	93	-190,086	0.66%	60
ECM 2 – Triple Glazed Window Retrofit	0	7,448	0.93%	2.0	494	35,000	0	70.8	-28,306	-0.59%	40
ECM 3 – Supplemental Roof Insulation (R60)	0	36,593	4.60%	9.7	2,428	320,000	0	132	-291,352	-8.30%	25
ECM 4 – Upgraded All Light Bulbs to LED	35,046	-24,688	4.40%	-5.2	3,268	6,000	1,752	1.3	25,779	80.50%	15
ECM 5 – Motion Controlled Lighting Retrofit	13,440	-9,466	1.70%	-2.0	1,253	2,500	672	1.5	12,961	71.90%	25
ECM 6 – Door Replacement	0	11,459	1.40%	3.1	760	13,800	0	18.2	-4,830	4.70%	25
ECM 7 – Existing Power Generation (598)	374,551	0	61.60%	15.0	52,437	269,100	0	5.1	390,669	21.80%	30
ECM 8 – Existing Power Generation (285)	178,506	0	29.30%	7.1	24,991	130,000	0	5.2	184,438	21.50%	30
ECM 9 – BAS (HVAC Controls)	0	22,575	5.40%	6.0	1,498	100,000	0	66.8	-83,963	-7.70%	20
ECM 10 – Replaced to Heat Pump System	-224,925	358,332	None	86.5	-7,712	120,000	0	None	-202,579	Negative	20
ECM 11 – Supplemental Wall Insulation (R45)	0	40,064	5.00%	10.7	2,658	235,000 *	0	90	-196,990	0.78%	60
ECM 12 – Supplemental Roof Insulation (R70)	0	39,737	5.00%	10.6	2,636	340,000	0	129	-308,893	-8.20%	25
*: This ECM cost was provided by the Client. Clients indicated that pricing was based on conversations with local contractors.											

6 Scenario and Implementation Plan

Pretium has identified strategic implementation scenarios for the measures recommended in this assessment report. Some proposed measures may impact the savings of the others. To ensure there are no overlapping savings, it is recommended that the ECMs should be bundled as indicated in Table 21 below.

Table 21 ECM Bundles

ECM	Medium Retrofit	Deep Retrofit
ECM 1 – Supplemental Wall Insulation (R35)	X	
ECM 2 – Triple Glazed Window Retrofit	X	X
ECM 3 – Supplemental Roof Insulation (R60)	X	
ECM 4 – Upgraded All Light Bulbs to LED	X	X
ECM 5 – Motion Controlled Lighting Retrofit	X	X
ECM 6 – Door replacement	X	X
ECM 7 – Existing Power Generation (598 Modules)		X
ECM 8 – Existing Power Generation (285 Modules)	X	
ECM 9 – BAS (HVAC Controls)	X	X
ECM 10 – Replaced to Heat Pump system	X	X
ECM 11 – Supplemental Wall Insulation (R45)		X
ECM 12 – Supplemental Roof Insulation (R70)		X

Table 22 summarizes the bundled ECM scenarios.

Table 22 Bundled Summary

ECM	Annual Electrical Savings (kWh)	Annual Propane Savings (kWh)	Annual Propane Savings (L)	Annual GHG Savings (Tonnes CO_2 eq.)	Annual Cost Savings ($)	ECM. Cost ($)	Incentives Available ($)	Avg. Simple Payback (Years)	Net Present Value ($)
Medium Retrofit	36,183	372,858	43,406	100	29,807	952,300	32	-571,586	1.60%
Deep Retrofit	235,174	372,858	43,406	108	57,666	1,121,400	19	-372,314	5.30%

By implementing the medium retrofit the EUI is reduced to 67 kWh/m^2. However, by implementing the Deep Retrofit the EUI is reduced to 0 kWh/m^2. This option includes addressing both the mechanical systems and building envelope systems and as such results in a significant propane (and GHG) reduction. Since all the building envelope systems are included in this bundle, additional savings are anticipated based on overall improved air tightness of the building (we would recommend targeting near EnerPHit performance).

It should be noted that the estimated savings associated with each scenario may not match the aggregated sum of the included measures evaluated separately in cases where there is an overlap in the energy saved due to an interaction of the energy saving opportunities.

Implementation of the measures identified in this assessment will assist the Client to reduce risks associated with utility market volatility and unplanned capital maintenance expenditures.

It is recommended that the measures which are the simplest and have the least interruption to the occupants be implemented first and that the more costly and invasive projects be implemented as each of the elements reaches the end of its useful service life.

Table 23 ECM Implementation Plan Outline by Measure

ECM/Scenario		Design Period	Construction Period	Seasonal Requirements	Tenant Disruption
ECM 1	Supplemental Wall Insulation (R35)	3 - 5 months	5 – 6 months	Spring/ Summer	Exterior access required.
ECM 2	Triple Glazed Window Retrofit	4 months	3 - 4 months	Avoid Winter	Access needed at the interior and exterior of each window.
ECM 3	Supplemental Roof Insulation (R60)	2 months	3-4 months	Avoid Winter	Access needed to the roof.
ECM 4	Upgraded All Light Bulbs to LED	1 month	2 months	None	Access needed throughout the entire facility.
ECM 5	Motion Controlled Lighting Retrofit	2 - 3 months	2 months	None	Access needed throughout the entire facility.
ECM 6	Door replacement	2 - 3 months	1-2 months	None	Access needed at the interior and exterior of each door.
ECM 7	Existing Power Generation (850 Modules)	3 - 4 months	3 - 4 months	Spring/ Summer	Access needed to the roof, and electrical room.
ECM 8	Existing Power Generation (285 Modules)	3 - 4 months	3 - 4 months	Spring/ Summer	Access needed to the roof, and electrical room.
ECM 9	BAS (HVAC Controls) and Ventilation Upgrades	2 – 3 months	5 - 6 months	None	Access needed throughout the entire facility.
ECM 10	Heat Pump System	2 - 3 months	3 - 4 months	Spring/ Summer	Access needed to the roof.
ECM 11	Supplemental Wall Insulation (R45)	3 - 5 months	5 – 6 months	Spring/ Summer	Exterior access required.
ECM 12	Supplemental Roof Insulation (R70)	2 months	3-4 months	Avoid Winter	Access needed to the roof.

7 Qualifications

7.1 Limiting Conditions

Pretium makes no representations regarding the sufficiency for the Client's purposes of the procedures described in this report. The undertaking was to perform the work within the limits prescribed by the Client, with the usual thoroughness and competence of the engineering profession.

The assessment provided is based on visually observed defects at a limited number of locations and our experience with similar types of buildings. Deficiencies may exist at other areas not referenced in this report or that are not visually apparent given the level of evaluation. No responsibility is therefore assumed concerning these matters, or for failure to carry out technical or engineering techniques that would be required to discover any inherent or hidden conditions of the property, since such an investigation was not included in the scope of work. This report is not to be construed as a warranty of structural components or other components therein, or their fitness for a particular purpose or use.

The assessment is based, in part, on information provided by others. Unless specifically noted, Pretium has assumed that this information was correct, and has relied on it in developing the conclusions.

In addition to the use of and reliance on this report by Owner and Manager, any person who has received a reliance letter for this report may use and rely on this report as if it was prepared for such persons. Any use of or reliance on this report by any other person (i.e., a person other than any Owner, Manager or otherwise permitted person) is the sole and exclusive responsibility of such other person. Consultant accepts no responsibility for damages, if any, suffered by such other person as a result of the use of or reliance on this report.

The savings calculations are our estimate of potential savings and are not guaranteed. The impact of building changes in space functionality, usage, equipment retrofit, and weather should be considered when evaluating the savings.

7.2 Closure

The information contained in this report is accurate and complete in accordance with the Agreement for Professional Services and Terms of Engagement. All information contained herein is based on visual observations made during the on-site assessment and conclusions are based on our best engineering judgment and on our experience with similar buildings.

We trust that the above is satisfactory for your purposes. If you have any questions or comments concerning this report, please do not hesitate to contact our office.

Yours very truly,

Pretium Engineering Inc.

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