Recreation Centre

Service Delivery – Energy Audit – Final Report
Project Location: Township of Chapleau
Wood Project Number: BE20102014

Prepared for:

Township of Chapleau
20 Pine Street W. P.O. Box 129

7 October 2020

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Prepared by:

Wood Environment & Infrastructure Solutions, a Division of Wood Canada Limited
900 Maple Grove Rd, Unit 10, Cambridge ON, N3H 4R7

7 October 2020

Executive Summary

Recreation Centre Audit

Wood PLC (Wood) was retained by the Township of Chapleau to conduct an energy audit on the Recreation Centre located at 4 Maple St, Chapleau Ontario. An energy assessment consistent with ASHRAE Level 2 guidelines was conducted for the facility. The site visit associated with this project was conducted on July 28th, 2020 by Nathan Sokolowski.

The aim of this study was to analyze the current energy performance of the Facility, conduct an onsite energy assessment, and produce a list of Energy Conservation Measures (ECMs) complete with relevant Opinion of Probable Costs.

The summary table below presents a list of opportunities identified during the energy assessment of the site Facility along with estimated costs, savings and simple payback.

Table E-1 Summary of ECMs

ECMs	Measure	Opinion of Probable Cost	Estimated Savings				Estimated Total Savings	Simple Payback
			Propane	Electricity	Demand	Maintenance		
		($)	(L)	(kWh)	(kW)	($)	($)	(Years)
ECM-1	Thermostat Commissioning	700	1,004 6.2%	9,655 1.0%	23 11.1%	-	1,995	0.4
ECM-2	Temperature Control Set Points	5,100	-	12,412 1.2%	10 4.7%	-	1,796	2.8
ECM-3	Lobby & Lounge Heating	31,000	(3,868) (23.9)%	114,283 11.3%	70 34.2%	-	14,232	2.2
ECM-4	Spectator Heating	33,000	(4,637) (28.7)%	65,877 6.5%	118 57.6%	-	6,770	4.9
ECM-5	Arena De-Super Heater	32,000	4,133 25.6%	12,194 1.2%	2 0.9%	-	4,225	7.6
ECM-6	Floating Head Pressure Control	19,000	-	48,775 4.8%	7 3.6%	-	7,057	2.7
ECM-7	Fluorescent Tube LED Retrofit	9,000	-	4,081 0.4%	5 2.2%	400	990	9.1
ECM-8	Ice & Curling Rink LED Retrofit	45,000	-	163,677 16.1%	35 17.2%	350	24,031	1.9
ECM-9	Exterior LED Retrofit	500	-	1,887 0.2%	- 0.0%	20	293	1.7
Scenario 1		70,000	1,004 6.2%	236,401 23.3%	75 36.7%	370	35,171	2.0
Scenario 2		105,000	(3,945) (24.4)%	201,574 19.9%	190 93.0%	420	27,236	3.9

Notes:

(1) It should be noted that the estimated savings associated with each scenario may not match the aggregated sum of the included measures evaluated separately. This is due to interactive effects between measures.

Wood recommends that the Township proceeds with the implementation of the following conservation measures:

Scenario 1, which contains:

- ECM-1: Thermostat Commissioning;
- ECM-2: Unit Heater Temperature Control Set Points;
- ECM-6: Floating Head Pressure Control;
- ECM-8: Ice & Curling Rink Lighting Retrofit; and
- ECM-9: Exterior LED Retrofit.

By implementing the recommended measures listed above, the following potential savings may be anticipated relative to the simulated baseline year:

- 236,401 kWh (23.3%) of electricity savings; and
- 1,004 L (6.2%) of propane savings.

Wood recommends that the Township proceeds with the following building management and behavioral opportunities:

- Re-commissioning;
- Unit heater maintenance;
- Staff Training and Occupant Awareness; and
- Procurement Policy.

Wood recommends that the Township investigate further possibility of implementing the following opportunity/opportunities:

- Solar Photovoltaic Panels.

Further analysis is required to determine the potential savings and costs of these measures more accurately. It is recommended that the Township move forward to review the potential to incorporate these measures into the existing site energy and environmental management strategy.

Table of contents

List of figures

List of tables

Acronyms and Abbreviations

ACH	Air changes per hour
BTU	British Thermal Unit
C	Celsius
CAV	Constant Air Volume
CDD	Cooling Degree Day
CO_2e	Carbon Dioxide Equivalent
ECM	Energy Conservation Measure
EUI	Energy Utilization Index
ft	Feet
ft^2	Square feet
g	Gram
GJ	Gigajoule
HDD	Heating Degree Day
HID	High Intensity Discharge
HP	Horse Power
HST	Harmonized sales tax
IRR	Internal Rate of Return
kW	Kilowatt
kWh	Kilowatt hour
L	Litre
LED	Light emitting diode
m	Meter
m^2	Square meter
m^3	Cubic meter
MUA	Make Up Air
NPV	Net Present Value
UH	Unit Heater
V	Voltage
W	Watt
Wood	Wood Environment & Infrastructure Solutions, Inc
WWTL	Wastewater Treatment Lagoon
U-Value	Thermal transmittance measured in BTU/(hr·ft^2·°F)

1.0 Introduction

Wood Environment & Infrastructure Solutions, a Division of Wood Canada Limited (Wood) was retained by the Township of Chapleau (client) to conduct energy audits for six (6) township buildings. This report is specific for the Recreation Centre located at 4 Maple St, Chapleau Ontario.

The assessment involved a review of approximately 5,253 m^2 (56,540 ft^2) of recreation space including an ice rink, spectoator area, curling rink, curling lounge, baseball diamond, community hall and flexible exhibit/meeting space. This revealed the potential for the implementation of energy management measures which may improve the overall efficiency of the facility.

Our assessment methodology can be found in **Appendix A**.

1.1 PURPOSE

The Purpose of this project is to conduct an energy assessment on the Town's owned facilities to assess and determine energy usage for equipment/facility consumption and operational performance. The goal of the energy assessment is to provide recommendations based on behavioral, operational, facility, equipment performance and how the facilities can be improved to reduce energy consumption and overall operating costs. The assessment will identify both operating and capital improvements and provide a detailed analysis on simple payback and energy consumption reductions.

1.2 SCOPE OF ASSESSMENT

The detailed energy assessment consists of an on-site facility assessment, a utility analysis, and a detailed review and analysis of Energy Conservation Measures (ECMs). The energy assessment report is organized as follows:

- Facility description;
- Utility analysis and benchmarking;
- ECMs; and
- Conclusions and recommendations.

The Township of Chapleau provided the following documents to Wood for review:

- Utility records; and
- Facility drawings (floor plans).

The following appendices referenced below provide further background that form part of this report:

- Appendix A – Assessment Methodology;
- Appendix B – Assest Details;
- Appendix C – Lighting;
- Appendix D – Modeling methodology; and
- Appendix E – Utility data summary.

1.3 BACKGROUND

1.3.1 Client Information

The following table summarizes key client information related to this assignment.

Table 1-1 Key Client Information Summary

Customer Name	**Township of Chapleau**
Site Address	4 Maple St, Chapleau Ontario
Contact Person	Ms. Charley Goheen
Contact information	cgoheen@chapleau.ca
Utility Provider	Chapleau Hydro
Account Number	05503500

1.3.2 Acknowledgements

Wood would like to acknowledge the contribution of the Township of Chapleau and Facility staff whose help was invaluable in completing this assignment.

2.0 FACILITY DESCRIPTION AND CONDITION

The following sections summarize the observations made during the site investigation.

2.1 OVERVIEW

The Recreation Centre was constructed in 1978. The facility ice and curling rinks operate from the end of August to the beginning of April the following year between the hours of 4:00 PM to 11:00 PM on weekdays and 8:00 AM to 11:00 PM on weekends. The ice rink is consistently used during this period rotating between hockey, figure skating and public skating. The four-sheet curling rink is used on a less frequent basis typically hosting 8 to 16 people for approximately two (2) hours per day on a 3 day week schedule and up to six (6) hours per day on the weekend. Occupancy at the curling rinks increases during bonspiels filling up each ice sheet and the curling lounge for the entire day/evening. Ice maintenance occurs on Mondays starting at 8am where the ice re-surfacer is used to shave the ice, edge corners and flood the rink to prepare it for the upcoming week.

The Facility baseball diamond hosts a mixed slow pitch league and recreational T-ball games five (5) days a week during the summer with illumination available for evening games, yet the majority of activity occurs during the daytime.

The community hall operates intermittently throughout the year to accommodate a wide range of events including concerts, celebrations, galas, weddings, legion events, work events, art exhibits, fall fairs and trade shows. The capacity for the facilities is listed below, yet rarely reached for the small community of Chapleau and surrounding areas.

Table 2-1 General Building Information

Building Type	**Hockey rink, curling, lounge, community hall, servery/café**
Space Capacity	Community hall – 275 Curling lounge – 175 Curling Rink – 300 Ice Rink – 830 Ice Rink Spectator Area - 250
General Staff	1-2 full time, 5-8 part time

Gross Total Floor Area	5,253 m^2
Floors	1 + Office/Mechanical Penthouse
Year Built	1978

2.2 UPGRADES/CHANGES

An interior renovation was completed in 2018 on the community hall, curling lounge/area, and ice rink lobby which included upgrades to the floor, wall and ceiling finishes, LED lighting retrofits, the inclusion of a barrier free accessible washroom and a fully equipped servery/kitchen for the community hall.

At the time of the audit, the following work was in progress:

Inspection of Curling Rink brine distribution headers

- Walkway above header pipes was removed to clean debris from trench and inspect support headers to ensure no brine leaks.
- Ice re-surfacer bay floor replacement
- Cracked concrete slab was removed along with snow melt pit. New plumbing drain to be added and finished with fresh concrete slab floor.
- Cooling tower replacement
- An EVAPCO eco-ATC-127A induced draft counterflow cooling tower with expanded dry operation was being acquired to replace the Baltimore Aircoil Company (B.A.C) VCL-102 centrifugal fan cooling tower.

2.3 BUILDING ENVELOPE

The Facility is a steel frame construction with walls of concrete block and exterior metal sheet cladding. The community hall and curling lounge have a combination of exterior sheet cladding and painted stucco finish. The east wall of the community hall contains an extra drywall interior layer. The metal roofing system is insulated with approximately 3" of rigid board that is supported on heavy steel girders and structural steel columns. Both arenas are equipped with low emissive ceilings.

The Recreation Centre lobby and ice rink lobby have vestibule style double doors equipped with handicap operators. Only the ice rink lobby has exterior windows that are double pane and fixed. Select photos representative of the general building envelope construction and interior are presented below and captured under Figure 2-1 in the table of contents.

Figure 2-1 Recreation Centre Site Photos

Curling Rink & Lounge Entrance – North façade

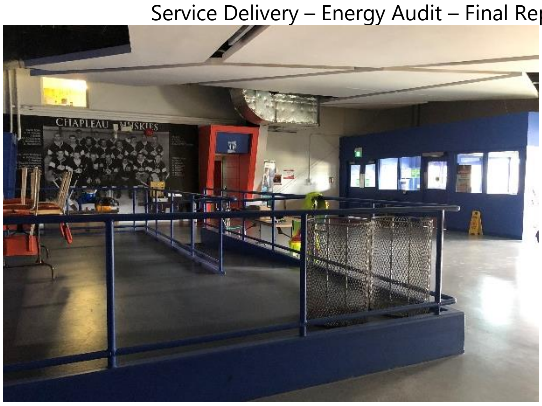
Compressor Room & Ice Re-surfacer Bay – West Façade

Ice Rink Lobby – South Façade

Curling Rink

Ice Rink

Curling Lounge



Ice Rink Lobby

Community Hall

Baseball Diamond

2.4 MECHANICAL SYSTEMS

The following mechanical systems and components were identified during the site visit.

2.4.1 Process Equipment

The compressor room located off the ice re-surfacer bay cools brine water using two (2) 50HP Mycom N6WA ammonia compressors in a duty standby arrangement. The system pumps chilled brine water through a series of distribution pipes underneath the ice bearing concrete slabs to remove heat and freeze the ice and curling rink surfaces. The brine pumps for the ice rink and curling rink are 20 HP and 7.5 HP respectively. The brine water cycles through the sub surface pipes and back to a chiller evaporator barrel filled with ammonia refrigerant where a heat exchange occurs; This is where the brine water is cooled by the ammonia to and subsequently the ammonia is warmed by the brine water. Extracted heat in the ammonia is then dissipated via an outdoor cooling tower with the compressor acting as a pump to circulate ammonia. The entire ice plant process is accomplished with three (3) separate fluid loops for brine, ammonia and condenser water. The decommissioned centrifugal cooling tower used a 10 HP motor with v-belts and is scheduled to be replaced with an induced draft counter flow cooling tower with dry flow operation by the fall of 2020. Other process equipment include a 5 HP condenser water pump and a 5 HP sub floor pump to prevent permafrost heaves from damaging the ice rink surface and distribution piping.

2.4.2 Heating, Ventilating and Air Conditioning

The ice rink lobby and curling lounge are each conditioned with a 30 kW Aerotherme UNF-30 electric furnaces and controlled by programmable wall mounted thermostats located in the respective zone. The curling lobby also has three (3) secondary heating units in the form of 2kW electric baseboard heaters with built in thermostats. The community hall is conditioned with a 120 MBH Carrier propane fired furnace on a programmable thermostat and the servery has an ICE (Industrial Commercial Equipment) BMA-112 make up air unit (MUA) with a maximum burner input of 399 MBH (propane). Typical occupied setpoints are 20°C (68°F) and un-occupied setpoints are 18°C (64.4°F). Two (2) roof penetrations above the penthouse mechanical room are for the fresh air supply on the MUA unit and exhaust for the servery fume hoods.

Electric heat is used exclusively throughout the ice and curling rinks. The dressing rooms, locker-rooms and corresponding corridors are on electric heat using 5HP ceiling mounted forced air units controlled manually with on/off switch or analog thermostats. The spectator gallery in the ice arena utilizes electric radiant infrared heaters which are manually switched on when crowded with spectators. There are two (2) Cimco dehumidification units which remove high moisture buildup within the ice rink and will operate when the outdoor temperature is above -5°C (23°F).

The facility contains six (6) mushroom cap exterior wall mounted ventilators that exhaust air from the community hall, curling rink, curling lounge, snack bar fume hoods and south dressing rooms. The hockey rink has two, 3 HP Baldor exhaust fans that are needed to exhaust fumes from the space when lift equipment is operated indoors to swap out lights. The curling rink is also equipped with 2 fans for similar purposes. Other ¼ and ½ HP exhaust fans are situated in dressing/locker rooms, bathrooms and the compressor room.

2.4.3 Building Controls

The Facility is not equipped with a Building Automatic System (BAS). The furnaces are controlled with programmable thermostats and the UHs are controlled by local manual thermostats and switches.

2.4.4 Domestic Hot Water

Domestic Hot Water (DHW) is provided to the facility by two (2) propane Bock modulating condensing commercial water heaters rated at 300 MBH. The boilers supply hot water to faucets throughout the facility including showers for the dressing rooms. There is also a 285L capacity RHEEM 125 MBH propane based water heater with a second tank to double the storage capacity, to supply 48.88°C (120°F) water for the ice re-surfacer.

2.5 ELECTRICAL SYSTEMS

The following electrical systems and components were identified during the site visit.

2.5.1 Lighting Systems

Lighting in the community hall, curling lounge, ice rink lobby and surrounding corridors were upgraded to LED fixtures during the 2018 renovation. The tube lamps are approximately 16W each and are typically surfaced mounted 1 ft by 4 ft troffers or recessed pendant or pot fixtures. The community hall, curling lounge and ice rink lobby are controlled with 3-way light/dimmer switches and the corridors and nearby storage/mechanical rooms are equipped with occupancy sensors.

Spaces that utilize fluorescent tube (T-8 & T-12) include the washroom core, penthouse, ice rink snack bar, the mechanical/storage rooms, and the dressing/locker rooms. The T8 lamps are rated at 32 W each and the T12 lamps are rated at 34W or 60W each depending on 4 ft and 8 ft lengths respectively. The hockey rink, curling rink and baseball diamond utilize high wattage fixtures summarized in the table below. Exterior lighting at the Recreation Centre is comprised of 70W and 150W HPS wall packs on integrated photocell control.

Table 2-2 High Bay Light Fixtures on Site

Area	Fixture Type and Wattage
Ice Rink	1000W Metal Halide and 500W Incandescent
Curling Rink	400W Metal Halide
Baseball Diamond	400W Metal Halide

2.5.2 Plug Loads

Plug loads include desktops, laptops, printers, projectors and common office equipment. It also includes audio visual equipment, telephones, televisions, speakers or equipment in the designated servery and snack bars such as pop machines, refrigerators and coffee makers.

3.0 UTILITY ANALYSIS AND BENCHMARKING

The following sections detail the utility analysis that was performed for the Facility, and includes a utility analysis, a comparison to a benchmark, and a breakdown of energy consumed by fuel type and major end-use. Table 3-1 summarizes the electricity and propane consumption data for the years provided.

Table 3-1 Summary of Utility Data

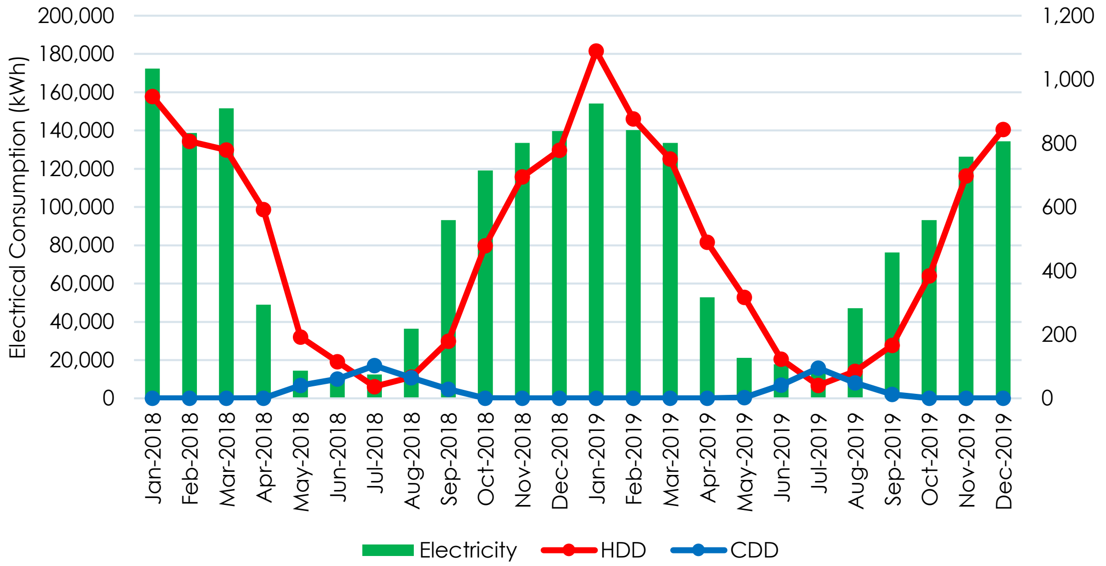
Year	Electricity		Propane	
	Consumption (kWh)	Cost ($)	Consumption (L)	Cost ($)
Jan-2018 to Dec-2018	1,069,920	154,801	18,478	16,630
Jan-2019 to Dec-2019	1,013,280	146,606	11,802	12,213

3.1 ELECTRICITY

There is one (1) electricity meter on site which measures the purchased energy for the building, as well as the exterior lighting. Collected utility data can be found in **Appendix E**.

Utility data was provided for a period of two (2) years from January 2018 to December 2019. A review of electricity costs from 2019 Chapleau Hydro invoices yielded a blended rate of $0.14/kWh which accounts for transmission, use, regulatory fees, global adjustment and HST. The figure below illustrates the electrical consumption for the facility.

Figure 3-1 Monthly Electricity Consumption



The figure shows that electricity consumption tends to have the highest peaks in the winter months; this is to be expected for a building in a heating dominated climate that has sources of electric heating and a large process load which is a contributor during the winter period represented by the ice plant. There is approximately a 20,000 kWh baseload between May and July consisting of lighting and plug loads.

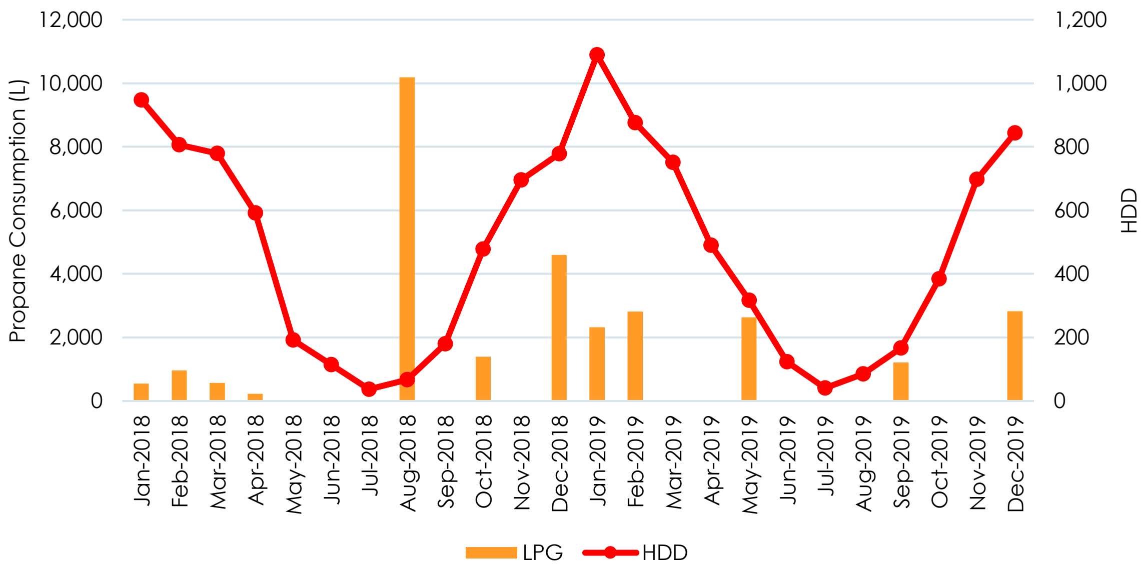
To establish a baseline year, a linear regression analysis (R-squared analysis) was completed on the electricity data The R-square value is a measure of the degree of correlated agreement between the electricity consumed and the dependent variable chosen, in this case CDD and HDD. An R-squared value of 1 represents a perfect correlation, while a lower value indicates a lesser degree of influence between the variables. In general, an R-squared value indicates a strong correlation between 0.8 and 1; a moderate correlation between 0.7 and 0.8; and a weak correlation below 0.7. By using an R-squared analysis to correlate energy usage to outdoor temperature, it may be possible to normalize data to a typical year, thereby removing the effects of temporary peaks or lulls due to varying weather patterns and determine how closely energy consumption is related to the weather.

The calculated R-squared of **0.78** for HDD and **0.53** for CDD indicates the facilities electricity consumption is moderately influenced by a dropping outdoor air temperature; This is misleading as the months requiring heating also correspond to the months where the ice plant equipment run frequently for making ice. The correlation between CDD is poor as there is no air conditioning for the complex. As such, the utility data was averaged for each month that was provided and was used as the baseline year.

3.2 PROPANE

Propane is purchased in bulk quantities. A total of 18,478 and 11,802 L was purchased for 2018 and 2019 respectively. A rate of $0.5954/L was used for propane including purchase cost and GHG carbon tax. Quantities of propane purchased per month can be found in **Appendix E**. The figure below illustrates the monthly quantities of propane purchased for the facility.

Figure 3-2 Monthly Record of Propane Purchased



As can be seen in the figure above, propane is commonly purchased and used in the winter months; This is to be expected as this is when space heating is required for the facility and ice re-surfacing water is needed for the ice rinks. A large spike occurred in August 2018 and this can be attributed to the period when the renovation was complete and the introduction of propane based MUA unit, furnace and DHW heaters. A linear regression analysis has also been conducted in an effort to establish consumption for a typical year. The calculated R-squared value of **0.001** indicates a weak correlation between fuel consumption and HDD; This is due to the fact this data is based on bulk purchase and not actual monthly consumption. As such, the utility data was averaged for each month that was provided and was used as the baseline year.

3.3 SIMULATED BASELINE YEAR

Using a combination of Carrier's Hourly Analysis Program (HAP 5.11) software, Natural Resources Canada's RETScreen software and Microsoft Excel based calculations, a baseline energy simulation was created and calibrated against the modeled energy consumption described previously to within the target of 20% of the annual consumption value. This model has been used as the basis for the end-use breakdowns in the subsequent sections. The modeling methodology can be found in **Appendix D.**

Table 3-2 Summary of Simulated Baseline Year Energy Consumption

Year	Electricity		Propane	
	Consumption (kWh)	Cost ($)	Consumption (L)	Cost ($)
Baseline	1,014,231	146,743	16,165	9,625

3.4 ANNUAL ENERGY CONSUMPTION BREAKDOWN BY TYPE

Electrical and propane energy consumption figures have been converted to common units (GJ) of energy to be able to compare the total amount of energy from each source at the Facility. The following figures show the fuel type breakdown by both consumption and cost.

Figure 3-3 Annual Energy (GJ) Consumption Breakdown by Fuel Type

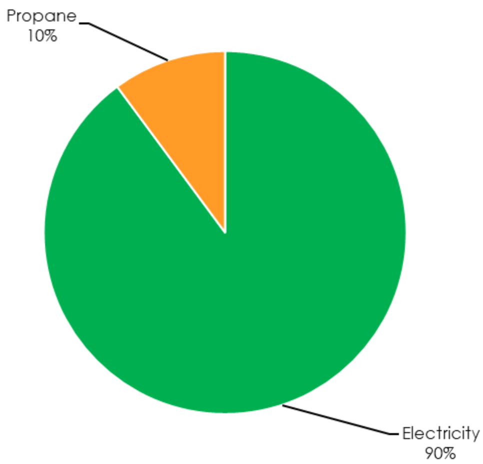
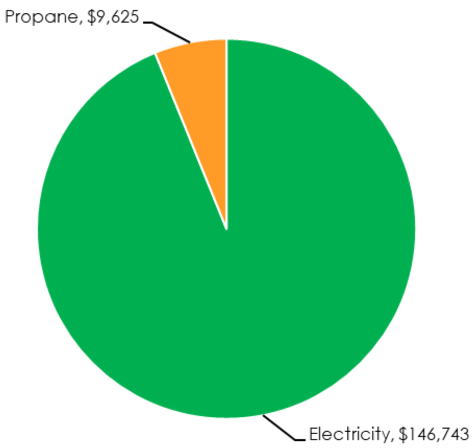


Figure 3-4 Annual Energy Cost by Fuel



Electricity has been estimated to account for approximately 90% of all energy consumed at a cost of $146,743 while propane accounts for the other 10% at a cost of $9,625. The cost per energy metric for propane and electricity at the used rates are $23.37/GJ and $40.19/GJ respectively.

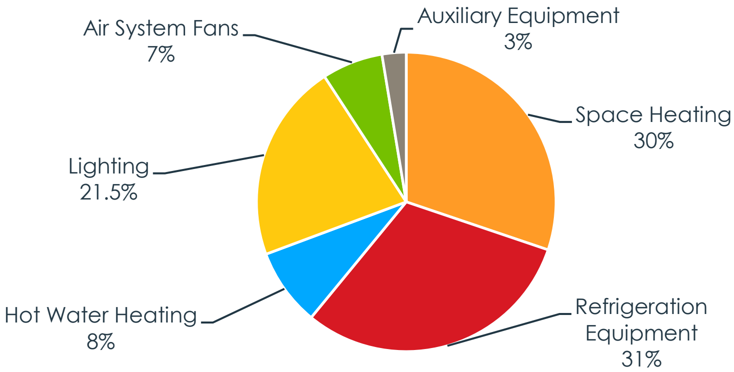
3.5 ANNUAL ENERGY CONSUMPTION BREAKDOWN BY MAJOR END-USE

The total annual energy consumption of the Facility was analyzed and broken down into major end-use categories. These categories included in this analysis consist of:

- **Space Heating** – This includes all space heating provided by propane furnaces and MUA units as well as electric furnaces and unit heaters;
- **Refrigeration Equipment** – All equipment for the ice plant responsible for making ice for the skating & curling rinks;
- **Domestic Hot Water** – All domestic hot water used in building, including for ice re-surfacing;

- **Lighting** – All interior and exterior lighting;
- **Air System Fans** – All exhaust fans serving the facility; and
- **Auxiliary Equipment** – This includes all energy consumed by all plugged in equipment such as computers and telephones as well as any miscellaneous equipment that may be installed, such as snack bar appliances and the kitchen equipment.

Figure 3-5 Annual Energy Consumption Breakdown by Major End-Use

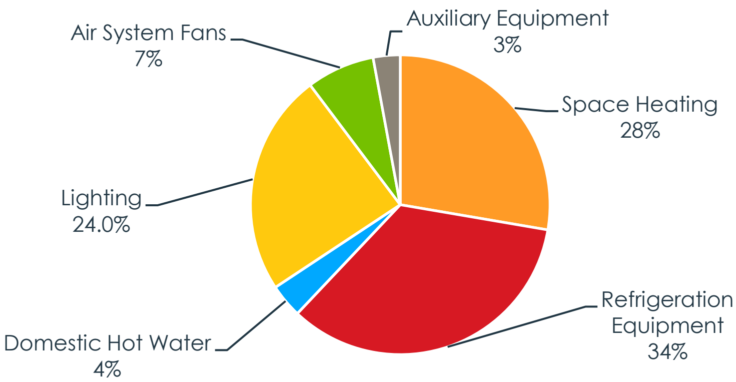


From the figure, refrigeration and space heating are the end users that consume the most energy at the facility with 31% and 30% respectively. The building recently switched to a propane furnace to heat the community hall but the majority of heating throughout the facility is electric based which represent large energy saving opportunities. The ice plant operates similar to the heating equipment from September to April and is composed of compressors, pumps, and heat rejection equipment which require significant horsepower to operate. Lighting is the next largest end user and the high bay fixtures in the ice and curling rinks consume the majority of electricity in this category. Hot water heating consumes 8% of the energy at the facility with the majority of this portion dedicated to ice re-surfacing. Air system fans represents 7% of the total energy consumed and this includes dehumidification for the ice rink. The remaining 3% is auxiliary equipment.

Electrical Energy Consumption by Major End-Use

An estimation of the electricity consumption by major end-use has been made based on the listing of identified equipment on site, the estimated run hours, and any diversity in use that can be foreseen. The breakdown is shown in the figure below.

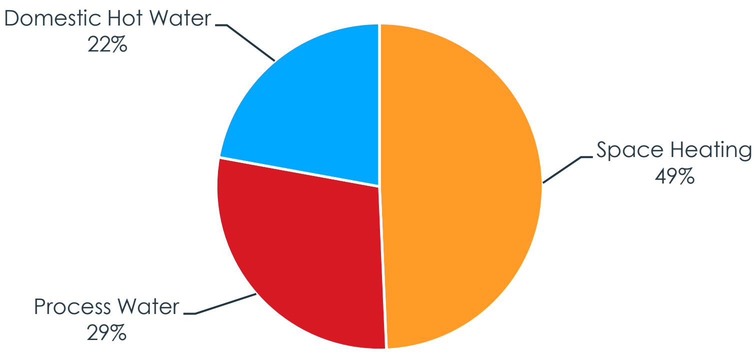
Figure 3-6 Annual Electricity Consumption Breakdown by Major End-Use



Propane Energy Consumption by Major End-Use

An estimation of the propane consumption by major end-use has been made based on the listing of identified equipment on site, the estimated run hours, and any diversity in use that can be foreseen. The breakdown is shown in the figure below.

Figure 3-7 Annual Propane Consumption Breakdown by Major End-Use



3.6 BUILDING ENERGY PERFORMANCE BENCHMARKING

The facility Energy Utilization Index (EUI) was calculated by dividing the total annual energy used by the gross floor area. The table below compares the EUI at the Facility to the Office of Energy Efficiency (OEE) benchmarks for the **arts, entertainment and recreation sector** to assess the Facility's energy performance against similar buildings.

Table 3-3 EUI Benchmarking

Calculated in Utility Analysis		Energy Star Portfolio Manager Benchmark	
GJ/m²	ekWh/ft²	GJ/m²	ekWh/ft²
0.75	19.40	1.48	38.21

Based on the analysis, the EUI for the estimated baseline year for the facility is approximately 49% less than the OEE benchmark. This is likely due to the seasonal arena operation. It should be noted that the OEE benchmark is created from all arts, entertainment, and recreation buildings regardless of type (community centre, art gallery or sports centre), location, operational schedule, HVAC system, and building envelope design; as a result, it should be viewed as a *guide* instead of a direct comparison with identical buildings within the same geographic area.

4.0 ASSESSMENT FINDINGS

This section provides an overview of the ECMs analyzed in this report. For each measure, estimates of the annual savings in each of the following were determined:

- Electricity demand and consumption;
- Fuel switch consumption;
- Total energy cost;
- Maintenance cost; and,
- GHG emissions.

The first three (3) items were determined using the simulated baseline model wherever possible. For some measures, hand calculations were used when the model was not able to simulate the measure. The maintenance cost premiums were estimated using commercial cost estimating software or based on Wood's experience with similar projects.

GHG emission reductions were calculated based on the results from the detailed analysis. The following table lists the GHG emission factors used.

Table 4-1 Energy Source Emission Factors

Energy Source	CO2e Emission Factor
Electricity	0.0000393 tonnes/kWh
Propane	1.55 tonnes/m^3

The following ECMs were reviewed:

- ECM-1: Thermostat Commissioning;
- ECM-2: Unit Heater Temperature Control Set Points;
- ECM-3: Curling Lounge & Ice Rink Lobby Heating;
- ECM-4: Spectator Heating;
- ECM-5: Arena De-super Heater;
- ECM-6: Floating Head Pressure Control;
- ECM-7: Fluorescent Tube Lighting Retrofit;
- ECM-8: Ice & Curling Rink Lighting Retrofit; and
- ECM-9: Exterior LED Retrofit.

4.1 HVAC

4.1.1 ECM-1: THERMOSTAT COMMISSIONING

Existing Condition

During the site visit, town staff confirmed that the programmable thermostats installed during the 2018 reno in the community hall, curling lounge and ice rink lobby had never been programmed with night-time setbacks. Typical occupied setpoints are 20°C (68°F) and un-occupied setpoints are 18°C (64.4°F).

Proposed Condition

A competent HVAC technician can program night time setback for existing thermostats.

Analysis

This measure was analyzed using the end-use model generated from Carrier's HAP software as a basis. The heating set points in the spaces were simulated to heat to 20°C (68°F) during occupied hours and 16°C (60.8°F) during unoccupied hours.

The following assumptions were made during the analysis of this measure:

- The base case thermostats' set points are maintained at the suggested temperature throughout the year with no variance;
- The proposed case thermostats' set points are maintained at the suggested occupied and un-occupied temperature setpoint throughout the year; and
- Cost assumes an HVAC specialist is brought in to program thermostats.

The following table summarizes the estimated energy savings associated with this measure.

Table 4-2 ECM-1: Thermostat Commissioning Annual Energy Savings

Estimated Propane Savings		Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(L)	(%)	(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
1,004	6.2	9,655	1.0	22.6	11.1	0	1,995	2.5

The following table summarizes the financial analysis associated with this measure.

Table 4-3 ECM-1: Thermostat Commissioning Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
700	1,995	0.4	17,254	277.6	0.4

This measure is low cost and can be implemented with little difficulty if a staff member is trained to utilize the existing programmable thermostats.

The following table summarizes the costs associated with the measure.

Table 4-4 ECM-1: Thermostat Commissioning Opinion of Probable Cost

Item	Cost ($)
Project Cost	220
Engineering	80
Commissioning and Training	300
Contingency	100
TOTAL (to nearest hundredth)	**700**

4.1.2 ECM-2: UNIT HEATER TEMPERATURE CONTROL SET POINTS

Existing Condition

The existing ceiling and wall mounted UHs which serve the dressing rooms, locker rooms, mechanical /electrical rooms and connecting hallways are programmed to operate based on the space temperature and set point of the spaces are controlled by local manual thermostats. The temperature control set points for these spaces are 18°C (64.4°F) and these spaces are typically occupied less than 10% of the time. This can contribute towards wasting energy by conditioning to higher heating set points during unrequired times. It should be noted that the thermostats are not locked-out and anyone in the building can adjust the temperature set point to whatever they see fit.

Proposed Condition

The existing manual thermostats can be upgraded to programmable thermostats to allow adjusting of temperature that best suit the space and its scheduling needs, as well as maintain a constant temperature in the given space.

The temperature setting for dressing room and locker room areas, mechanical and electrical rooms can have an approximate minimum heating temperature set points between 12-15 °C (54-59 °F). This control strategy will save energy by reducing the amount of heating required within the spaces. These thermostats also provide the opportunity to program night time setbacks which will save energy by reducing the amount of heating required within the spaces during unoccupied hours.

In terms of implementation, there are no additional space requirements for the programmable thermostats, as they should be able to directly replace the existing manual thermostats in the same space. The programmable thermostats are typically reliable with proper maintenance, and there are several vendors that carry them as part of their product line.

Analysis

This measure was analyzed using the end-use model generated from Carrier's HAP software as a basis. The heating set points in the spaces were simulated to heat to 15°C (59°F) during occupied hours and 12°C (53.6°F) during unoccupied hours.

The following assumptions were made during the analysis of this measure:

- The base case thermostats' set points are maintained at 18°C (64.4°F) temperatures throughout the year with no variance;
- The proposed case thermostats' set points are maintained at the suggested occupied and un-occupied temperature setpoint throughout the year; and,

- A total of 10 programmable thermostats is required for the dressing rooms, change rooms, and corresponding access corridors
- The existing UHs can support programmable thermostats and will operate accordingly.

The following table summarizes the estimated energy savings associated with this measure.

Table 4-5 ECM-2: Temperature Set Points Annual Energy Savings

Estimated Propane Savings		Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(L)	(%)	(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
-	-	12,412	1.2	9.5	4.7	-	1,796	1.2

The following table summarizes the financial analysis associated with this measure.

Table 4-6 ECM-2: Temperature Set Points Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
5,100	1,796	2.8	13,937	31.6	3.0

The payback for this measure is under three (3) years with a positive NPV and IRR. The following table summarizes the costs associated with this measure.

Table 4-7 ECM-2: Temperature Control Set Points Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	3,950
Engineering (11%)	450
Commissioning and Training (7%)	250
Contingency (10%)	465
TOTAL (to nearest hundredth)	**5,100**

4.1.3 ECM-3: CURLING LOUNGE & ICE RINK LOBBY HEATING

Existing Condition

The curling lounge and ice rink lobby are currently served by electric furnaces.

Proposed Condition

A dedicated outdoor air system could provide tempered air into the suggested spaces using propane as the fuel source. There is adequate propane storage on site to fuel two (2) additional propane fired MUA systems.

Analysis

This measure was analyzed using the end-use model generated from Carrier's HAP software as a basis. The electric furnaces were replaced with a Constant Air Volume (CAV) make up air unit to provide 20°C

(68°F) tempered air to the curling lounge and ice rink lobby. The units were sized based on the ASHRAE 90.1 2013 energy standard using an average efficiency of 80%.

The following table summarizes the estimated energy savings associated with this measure.

Table 4-8 ECM-3: Curling Lounge & Ice Rink Lobby Heating Annual Energy Savings

Estimated Propane Savings		Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(L)	(%)	(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
-3,868	-23.9	114,283	11.3	69.8	34.2	-	14,232	5.4

The following table summarizes the financial analysis associated with this measure.

Table 4-9 ECM-3: Curling Lounge & Ice Rink Lobby Heating Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
31,000	14,232	2.2	152,408	42.9	2.2

This measure offers attractive financials with a simple payback of 2.2 years. The availability of propane storage on site and past conversion to propane based equipment, such as the implementation of the propane furnace for the community hall or conversion of DHW from electric to propane, suggest that the township can further look at investigation the opportunity to upgrade these heating systems in the near future.

The following table summarizes the costs associated with this measure.

Table 4-10 ECM-3: Curling Lounge & Ice Rink Lobby Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	23,500
Engineering (11%)	2,600
Commissioning and Training (7%)	1,700
Contingency (10%)	2,800
TOTAL (to the nearest thousand)	**31,000**

4.1.4 ECM-4: SPECTATOR HEATING

Existing Condition

The spectator stands in the ice rink are currently served by electric radiant heaters. These heaters are assumed to run for 2.5 hours per day from September to April or approximately 560 hours annually.

Proposed Condition

A properly sized radiant tube heater system can provide the adequate heat to the stands and would run off propane. This would require gas piping and connection to the existing propane tank.

Analysis

This measure was analyzed using Microsoft Excel based calculations. The existing electric radiant heaters with a total demand of approximately 150 kW were replaced with four (4) 30 ft radiant tube heaters with an input capacity of 50 MBH each.

The following assumptions were made during the analysis of this measure:

- A duty factor of 75% was applied to the electric heaters meaning 75% of the units would be turned on during the designated operating hours.

The following table summarizes the estimated energy savings associated with this measure.

Table 4-11 ECM-4: Spectator Heating Annual Energy Savings

Estimated Propane Savings		Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(L)	(%)	(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
-4,637	-28.7	65,877	6.5	118	57.6	-	6,770	-0.6

The following table summarizes the financial analysis associated with this measure.

Table 4-12 ECM-4: Spectator Heating Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
33,000	6,770	4.9	78,123	17.7	5.2

The measure offers savings with a simple payback under five (5) years. A positive NPV and IRR suggest that the township can further look at investigating the opportunity to replace the existing electric heat by installing propane fired radiant tube heaters which are one of the most efficient form of heat available for this purpose.

The following table summarizes the costs associated with this measure.

Table 4-13 ECM-4: Spectator Heating Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	25,700
Engineering (11%)	2,800
Commissioning and Training (7%)	1,800
Contingency (10%)	3,000
TOTAL (to the nearest thousand)	**33,000**

4.2 PROCESS EQUIPMENT

4.2.1 ECM-5: ARENA DE-SUPER HEATER

Existing Condition

Currently, waste heat from ice plant operation is recovered only for under slab heating.

Proposed Condition

A desuperheater, a type of heat exchanger, could be installed between the compressors and the cooling tower to recover waste heat and use it to heat ice re-surfacing water.

Speaking to implementation, space would need to be assigned to the physical desuperheater, and the necessary piping would need to be installed. These systems are fairly common and are installed in various municipal arena sites. Many vendors carry these types of products. As the system, will be largely automated, minimal training will be required.

Analysis

This measure was analyzed using Natural Resources Canada's RETScreen software. Superheat recovery was added to the ice plant.

The opinion of probable cost for this measure was assumed to be similar to past vendor quotation of similar Arena. The following table summarizes the estimated energy savings associated with this measure.

The following table summarizes the estimated energy savings associated with this measure.

Table 4-14 ECM-5: Arena De-Super Heater Annual Energy Savings

Estimated Propane Savings		Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(L)	(%)	(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
4,133	25.6	12,194	1.2	1.9	0.9	-	4,225	7.6

The following table summarizes the financial analysis associated with this measure.

Table 4-15 ECM-5: Arena De-Super Heater Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
32,000	4,225	7.6	22,445	8.0	8.3

The measure offsets the need for propane to heat re-surfacing water for the ice re-surfacer by utilizing waste heat recovery and provides a moderate payback of 7.6 years with a positive NPV and IRR.

The following table summarizes the costs associated with this measure.

Table 4-16 ECM-5: Arena De-Super Heater Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	19,800
Installation	5,000

Item	Cost ($)
Engineering (11%)	2,400
Commissioning and Training (7%)	1,600
Contingency (10%)	3,000
TOTAL (to the nearest thousand)	**32,000**

4.2.2 ECM-6: FLOATING HEAD PRESSURE CONTROL

Existing Condition

An EVAPCO eco-ATC-127A induced draft counterflow cooling tower with expanded dry operation was being commissioned to replace the Baltimore Aircoil Company (B.A.C) VCL-102 centrifugal fan cooling tower. The original condenser for the ice plants utilized a fixed head pressure control strategy and the condenser fans operated at constant speed.

Potential Energy Savings

An EVAPCO eco-ATC-127A induced draft counterflow cooling tower with expanded dry operation was commissioned to replace the older condenser unit. A floating head pressure control strategy has adopted with the implementation of the new induced draft counterflow cooling tower that contains Variable Frequency Drives (VFDs) on the condenser fans. As the outdoor air temperature decreases, head pressure would be allowed to decrease to a set minimum through a reduction in fan speed, resulting in an unloading of the compressors and significant energy savings.

In terms of implementation, sufficient space will be required at the condenser or Motor Control Centre (MCC) to house the VFDs. When locating the VFDs, consideration needs to be given to the manufacturer's specifications for ambient conditions. In addition, consideration will need to be given to the details and space requirements of wiring the VFD to the RTU and/or MCC, as well as the local ice plant controller. Programming will be required to integrate the VFDs with the ice plant control system and set a minimum head pressure. Several vendors carry VFDs as part of their product line, and they are typically reliable throughout their expected life with proper maintenance. As much of the system will be automated, training requirements will be minimal.

Analysis

This measure was analyzed using Natural Resources Canada's RETScreen software. The head pressure control strategy was changed from fixed to floating.

Capital costs were estimated using the commercially available cost estimating software RSMeans CostWorks. In addition to capital costs, an 11% allowance for engineering cost, 7% for commissioning and training cost, and 10% for contingency cost was also included. The following table summarizes the estimated energy savings the township can anticipate with implementing this control strategy when the new EVAPCO eco-ATC-127A is operational.

The following table summarizes the estimated energy savings associated with this measure.

Table 4-17 ECM-6: Floating Head Pressure Control Annual Energy Savings

Estimated Propane Savings		Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(L)	(%)	(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
-	-	48,775	4.8	7.4	3.6	-	7,057	4.9

The following table summarizes the financial analysis associated with this measure.

Table 4-18 ECM-6: Floating Head Pressure Control Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
19,000	7,057	2.7	44,521	32.7	2.8

The application of a control sequence to the ammonia compressors will provide energy savings with a payback under 3 years.

The following table summarizes the costs associated with this measure.

Table 4-19 ECM-6: Floating Head Pressure Control Opinion of Probable Cost

Item	Cost ($)
Project Cost	14,700
Engineering (11%)	1,600
Commissioning and Training (7%)	1,000
Contingency (10%)	1,700
TOTAL (to the nearest thousand)	**19,000**

4.3 LIGHTING

4.3.1 ECM-7: FLUORESCENT TUBE LED RETROFIT

Existing Condition

The washroom core, penthouse, ice rink snack bar, mechanical/storage rooms, and the dressing/locker rooms use fluorescent T8 lamps rated at 32 W each or T12 fixtures rated at 34W or 60W each depending on length.

Proposed Condition

The 4 ft T8 and T12 lamps could be replaced with 16 W LED lamps and the 8 ft T12 lamps could be replaced with 36 W LED lamps.

Note that since LED lamps have a longer service life than fluorescent lamps, maintenance savings will be achieved through fewer lamp replacements.

There are no additional space requirements for the new lamps, as they should be able to directly replace the existing lamps in the same space as the current fixtures. Depending on the style of the fixture, the entire fixture may need to be replaced rather than the lamp only; it is also possible that Town staff may wish to replace the fixture for cosmetic reasons. A mock up of lighting fixtures is recommended prior to implementation to ensure aesthetics.

LED lamps and fixtures are widely available from several vendors. Energy Star or Design Lighting Consortium (DLC) lamps and fixtures should be selected to ensure compliance with incentive programs.

As there is little difference in the operation and maintenance of the new LED lamps no training will be required.

The Facility can utilize occupancy sensors with override capability to enable lighting setbacks in these areas when they are not being used, or when Facility personnel inadvertently keeps the lights on. This configuration would reduce energy consumption by only having the lights on when the space is occupied. However, it is important that manual switches be readily accessible in case of emergency situations to control the lighting in the space or due to failure of the occupancy sensors.

The following list of spaces could be equipped with occupancy sensors:

- Washroom core;
- Penthouse;
- Ice rink snack bar;
- Mechanical and storage rooms; and
- Dressing and locker rooms

Analysis

This measure was analyzed using the end-use model generated from Carrier's HAP software as a basis. The lighting wattages of the affected areas were reduced to simulate the effect of the lower wattage LED lamps. The lighting schedule occupied hours were reduced for the spaces listed to simulate the effect of utilizing occupancy sensors to turn off lighting in these areas when unoccupied.

The following assumptions were made during the analysis of this measure:

- Existing lamp lifetime is 5 years and are replaced at the rate of 20% per year;
- Proposed LED lamp lifetime is 10 years;
- Proposed LED lamps replacing 4 ft T8 and T12 lamps will utilize 16 W LED lamps;
- Proposed LED lamps replacing 8 ft T12 lamps will utilize 36 W LED lamps;
- Minimum effort required to upgrade fixture with low ceiling heights;
- Occupancy sensors will reduce the lighting operating hours by approximately 50%; and,
- 17 sensors would be required for proper coverage within the spaces listed.

The following table summarizes the estimated energy savings associated with this measure.

Table 4-20 ECM-7: Fluorescent Tube LED Retrofit Annual Energy Savings

Estimated Propane Savings		Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(L)	(%)	(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
-	-	4,081	0.4	4.5	2.2	400	590	0.4

The following table summarizes the financial analysis associated with this measure.

Table 4-21 ECM-7: Fluorescent Tube LED Retrofit Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
9,000	990	9.1	(85)	<0	N/A

The measure offers savings with a moderate payback of 9.1 years. A negative NPV and IRR suggest the township can implement this measure on a lamp per lamp basis when existing lamps fail.

The following table summarizes the costs associated with this measure.

Table 4-22 ECM-7: Interior Lighting Retrofit & Controls Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	14,900
Engineering (11%)	1,600
Commissioning and Training (7%)	1,000
Contingency (10%)	1,800
TOTAL (to nearest hundredth)	**19,000**

4.3.2 ECM-8: ICE & CURLING RINK LED RETROFIT

Existing Condition

The ice rink uses a combination of metal halide lamps rated at 1000 W each and incandescent lamps rated at 500 W each. The curling rink uses metal halide lamps rated at 400 W each. These lights are manually operated and typically on from 8:30am to 11:30pm from September to April.

Proposed Condition

The ice rink and curling rink metal halides could be replaced with 130 W LED lamps and 105 W LED lamps respectively. The 500W incandescent lights used in the ice rink can be replaced with 35 W LED lamps.

Analysis

This measure was analyzed using the end-use model generated from Carrier's HAP software as a basis. The lighting wattages of the affected areas were reduced to simulate the effect of the lower wattage LED lamps.

The following assumptions were made during the analysis of this measure:

- Existing lamp lifetime is 5 years and are replaced at the rate of 20% per year;
- Proposed LED lamp lifetime is 10 years;
- Proposed LED lamps replacing 1000 W and 400 W metal halide lamps will utilize 130 W and 105 W LED lamps;
- Proposed LED lamps replacing 500 W incandescent lamps will utilize 25 W LED lamps; and
- Lifting and hoisting equipment rental is required for high bay lamp replacement;

The following table summarizes the estimated energy savings associated with this measure.

Table 4-23 ECM-8: Ice & Curling Rink LED Retrofit Annual Energy Savings

Estimated Propane Savings		Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(L)	(%)	(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
-	-	163,677	16.1	35.2	17.2	350	23,681	16.4

The following table summarizes the financial analysis associated with this measure.

Table 4-24 ECM-8: Ice & Curling Rink LED Retrofit Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
45,000	24,031	1.9	171,308	49.7	1.9

This measure offers attractive financials and a payback under two (2) years due to the efficiency gain using LED technology over incandescent light sources or conventional high bay metal halide lamps.

The following table summarizes the costs associated with this measure.

Table 4-25 ECM-8: Ice & Curling Rink Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	34,500
Engineering (11%)	3,800
Commissioning and Training (7%)	2,400
Contingency (10%)	4,100
TOTAL (to nearest hundredth)	**45,000**

4.3.3 ECM-9: EXTERIOR LIGHTING RETROFIT

Existing Condition

The exterior lamps at the Facility currently use HPS fixtures with lamps rated at 70 W and 150 W each.

Proposed Condition

The 70 W and 150 W HPS lamps could be retrofitted with 22 W and 50 W LED lamps respectively.

Analysis

This measure was analyzed using the end-use model generated from Carrier's HAP software as a basis. The lighting wattages of the exterior building were reduced to simulate the effect of the lower wattage LED lamps.

The following assumptions were made during the analysis of this measure:

Existing lamp lifetime is 5 years and are replaced at the rate of 20% per year;

- Proposed LED lamp lifetime is 10 years;
- Proposed LED lamps replacing HPS lamps will utilize 22 W and 50 W LED lamps; and
- Minimum effort required to upgrade fixtures around building exterior.

The following table summarizes the estimated energy savings associated with this measure.

Table 4-26 ECM-9: Exterior Lighting Retrofit Annual Energy Savings

Estimated Propane Savings		Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(L)	(%)	(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
-	-	1,887	0.2	-	-	20	273	0.2

The following table summarizes the financial analysis associated with this measure.

Table 4-27 ECM-9: Exterior Lighting Retrofit Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
500	293	1.7	2,137	55.0	1.8

This measure offers attractive financials and a payback of two (2) years due to the efficiency gain using LED technology over conventional light sources such as HPS lamps.

The following table summarizes the costs associated with this measure.

Table 4-28 ECM-9: Exterior Lighting Retrofit Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	370
Engineering (11%)	50
Commissioning and Training (7%)	35
Contingency (10%)	45
TOTAL (to nearest hundredth)	**500**

5.0 IMPLEMENTATION GUIDELINES

It is recommended that the measures that are the simplest and have the least interruption to the occupants be implemented first. It is important to consider phasing as a means of implementation in order avoid occupant disruption, levels of expenditure, and time to implement. The following table summarizes the implementation guidelines for each measure, which are high level timeline estimates and can vary considerably.

Table 5-1 ECM Implementation Plan Outline by Measure

ECM/Scenario	Design Period	Construction Period	Seasonal Requirements	Occupant Disruption
Thermostat Commissioning	1-2 Weeks	None	None	None
Unit Heater Temperature Control Set Points	1-2 Weeks	None	None	None
Curling Lounge & Ice Rink Lobby Heating	3-4 Weeks	4-8 Weeks	Ideally summer	Moderate
Spectator Heating	2-4 Weeks	3-4 Weeks	Ideally summer	None
Ammonia Waste Heat De-Super Heater	3-4 Weeks	3-4 Weeks	Ideally summer	High
Floating Head Pressure Control	3-4 Weeks	3-4 Weeks	Ideally summer	None
Interior LED Retrofit	4-8 Weeks	3-4 Weeks	None	Moderate
Exterior LED Retrofit	1-2 Week	3-4 Weeks	None	Moderate
Scenario 1	2-3 Months	1-2 Months	Ideally summer	Moderate
Scenario 2	3-4 Months	2-4 Months	Ideally summer	High

6.0 BUILDING MANAGEMENT AND BEHAVIOURAL OPPORTUNITIES

Re-commissioning

Re-commissioning is the process of returning the building systems to their design specifications after the Facility has been in operation for a period of time, typically about five years, as well as updating operations to match the current needs of the Facility.

It is recommended the building undergo re-commissioning again in the near future.

Unit Heater Maintenance

Electric heaters should be cleaned once a year to keep them working safely and efficiently. Debris such as dirt, dust, garbage and hair can accumulate on the fins. The heater cover should be removed and any visible debris inside the unit should be cleaned using a vacuum, soft brush or even a steam pressure cleaner. If any of the fins are bent or damaged, they should be straighten using a pair of needle-nose pliers, metal scrapper or putty knife. The motor shaft should turn freely with bearings lubricated to ensure adequate operation and motors using belt drives should have the belt tension checked. Electrical connections should be tightened to ensure they are secure and have not vibrated loose from operation during the heating season.

Staff Training and Occupant Awareness

Equipment operation practices and policies can also have a significant impact upon energy consumption. There is generally ample opportunity for energy savings from general equipment left on when not in use. An energy efficiency awareness program should be put in place to encourage staff to frequently check temperature set points if heating is not required, similarly if lights are manually left on when not in use at the end of the day, and for the weekends.

Procurement Policy

Purchasing efficient products reduces energy costs without compromising quality. It is strongly recommended that a procurement policy be implemented as a key element for the overall energy management strategy at the Township. An effective policy would direct procurement decisions to select EnergyStar® qualified equipment in contracts or purchase orders. For products not covered under EnergyStar®, the EnerGuide labeling should be reviewed to select products with upper level performance in their category. Improved energy performance will involve the investment in energy efficient equipment coupled with a user education and awareness program.

7.0 OTHER OPPORTUNITIES CONSIDERED

Arena daylighting

Daylighting is the practice of using natural sunlight to light an area to reduce energy cost associated with lighting systems. Natural light can be introduced to the ice rink by replacing portions of the metal sheet cladding with translucent polycarbonate or acrylic cladding. The south facing exterior wall of the ice rink just below the low-e ceiling is the suggested location for implementation of translucent façade panels should the town wish to consider daylighting strategies. The implementation of daylighting will require photocells to turn lights off or dim light sources when daylighting from the translucent panels is adequate for the space. The photocell thresholds can be specified or adjusted based on occupancy levels to ensure the adequate amount of lux is provide to the space.

Daylighting can also be accomplished with solar tubes that can be installed on the roof to capture and reflect sunlight down a sheet metal tube into the space below. Both translucent cladding and solar tube installations require proper flashing to prevent leaks.

Ball diamond lighting retrofit

The lighting energy consumption associated with the illuminated ball diamond can be reduced by 60-70% by replacing the existing 400W metal halide lamps with LED equivalents. It is assumed the lamps operate approximately 300 hours per year which amounts to an annual consumption of roughly 4,700 kWh. Due to the low operating hours of the lamps, it is not economical to replace the current lighting system with LED lamps and swapping out the existing lamps with LED lamps on an as fail basis will lead to irregular lighting profiles. Implementing this measure will have a financial payback that is greater than the life of the asset and is not justified on energy savings alone.

Solar Photovoltaic Panels

A solar photovoltaic system was considered for the roof of the curling rink and ice rink. The opportunity was determined to be unsuitable for the Facility as the structural condition of the roof is not capable to handle the weight of the solar panels. The Facility currently has issues with regards to snow loading on the roof and the combined weight considering the addition of solar panels would no be suited with the current structural state of the existing roof.

8.0 IMPLEMENTATION SCENARIO

Wood has identified strategic implementation scenarios for the measures recommended in this assessment report.

It should be noted that the estimated savings associated with each scenario may not match the aggregated sum of the included measures evaluated separately. This is due to interactive effects between measures.

Scenario-1

The following ECMs are included in this scenario.

- ECM-1: Thermostat Commissioning;
- ECM-2: Unit Heater Temperature Control Set Points;
- ECM-6: Floating Head Pressure Control;
- ECM-8: Ice & Curling Rink Lighting Retrofit; and
- ECM-9: Exterior LED Retrofit.

The following table summarizes the estimated energy savings associated with this scenario.

Table 8-1 ECM-Scenario 1: Annual Energy Savings

Estimated Propane Savings		Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(L)	(%)	(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
1,004	6.2	236,401	23.3	75.0	36.7	370	34,801	25.2

The following table summarizes the financial analysis associated with this implementation scenario.

Table 8-2 ECM-Scenario 1: Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
70,000	35,171	2.0	246,579	46.5	2.1

The scenario considers conservation measures that optimize equipment operation with added control and two (2) lighting efficiency measures providing a simple payback under two (2) years. The following table summarizes the costs associated with this implementation scenario.

Table 8-3 ECM-Scenario 1: Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	54,100
Engineering (11%)	5,900
Commissioning and Training (7%)	3,800
Contingency (10%)	6,400
TOTAL (to nearest hundredth)	**70,000**

Scenario-2

The following ECMs are included in this scenario.

- ECM-3: Curling Lounge & Ice Rink Lobby Heating
- ECM-4: Spectator Heating
- ECM-5: Arena De-super Heater
- ECM-7: Fluorescent Tube Lighting Retrofit
- ECM-9: Exterior LED Retrofit

The following table summarizes the estimated energy savings associated with this scenario.

Table 8-4 ECM-Scenario 2: Annual Energy Savings

Estimated Propane Savings		Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(L)	(%)	(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
-3,945	-24.4	201,574	19.9	190	93.0	420	26,816	14.1

The following table summarizes the financial analysis associated with this implementation scenario.

Table 8-5 ECM-Scenario 2: Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
105,000	27,236	3.9	140,151	20.2	4.0

The scenario groups energy efficiency opportunities related to the conversion of electric based heating systems to propane base systems along with waste heat recovery from the ice plant and two (2) lighting LED retrofit options. The scenario offers significant kWh savings with a simple payback under four (4) years. The following table summarizes the costs associated with this implementation scenario.

Table 8-6 ECM-Scenario 2: Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	81,000
Engineering (11%)	8,600
Commissioning and Training (7%)	5,500
Contingency (10%)	9,600
TOTAL (to nearest hundredth)	**105,000**

9.0 CONCLUSIONS AND RECOMMENDATIONS

Several ECMs were identified during the detailed energy assessment**.** The following table summarizes all the ECMs that were reviewed along with estimated costs, savings, and simple payback.

Table E-1 Summary of ECMs

ECMs	Measure	Opinion of Probable Cost	Estimated Savings				Estimated Total Savings	Simple Payback
			Propane	Electricity	Demand	Maintenance		
		($)	(L)	(kWh)	(kW)	($)	($)	(Years)
ECM-1	Thermostat Commissioning	700	1,004 6.2%	9,655 1.0%	23 11.1%	-	1,995	0.4
ECM-2	Temperature Control Set Points	5,100	-	12,412 1.2%	10 4.7%	-	1,796	2.8
ECM-3	Lobby & Lounge Heating	31,000	(3,868) (23.9)%	114,283 11.3%	70 34.2%	-	14,232	2.2
ECM-4	Spectator Heating	33,000	(4,637) (28.7)%	65,877 6.5%	118 57.6%	-	6,770	4.9
ECM-5	Arena De-Super Heater	32,000	4,133 25.6%	12,194 1.2%	2 0.9%	-	4,225	7.6
ECM-6	Floating Head Pressure Control	19,000	-	48,775 4.8%	7 3.6%	-	7,057	2.7
ECM-7	Fluorescent Tube LED Retrofit	9,000	-	4,081 0.4%	5 2.2%	400	990	9.1
ECM-8	Ice & Curling Rink LED Retrofit	45,000	-	163,677 16.1%	35 17.2%	350	24,031	1.9
ECM-9	Exterior LED Retrofit	500	-	1,887 0.2%	- 0.0%	20	293	1.7
Scenario 1		70,000	1,004 6.2%	236,401 23.3%	75 36.7%	370	35,171	2.0
Scenario 2		105,000	(3,945) (24.4)%	201,574 19.9%	190 93.0%	420	27,236	3.9

Notes:

(1) It should be noted that the estimated savings associated with each scenario may not match the aggregated sum of the included measures evaluated separately. This is due to interactive effects between measures.

Wood recommends that the Township proceeds with the suggested ECMs stated in implementation scenario 1. This includes the following ECMs:

Scenario 1, which contains:

- ECM-1: Thermostat Commissioning;
- ECM-2: Unit Heater Temperature Control Set Points;
- ECM-6: Floating Head Pressure Control;
- ECM-8: Ice & Curling Rink Lighting Retrofit; and
- ECM-9: Exterior LED Retrofit.

By implementing the recommended measures listed above, the Facility has a potential savings of 236,401 kWh (23.3%) and 1,004L (6.2%) of propane that may be anticipated relative to the simulated baseline year.

10.0 STUDY LIMITATIONS

It must be noted that an energy audits prime goal is to identify the energy savings opportunities that likely meet the Township of Chapleau's minimum payback criteria. Energy savings and installation costs are estimates only. Detailed designs are always recommended before proceeding, along with final complete payback analysis.

This report documents work that was performed using methods and procedures that are generally consistent with the ASHRAE level 2 guidelines, subject to the level of investigative effort outlined in this report and generally accepted and prevailing industry standards at the time and location in which the services were provided. No other representations, warranties, or guarantees are made, including no assurance that this work has uncovered all potential issues associated with the identified property that may impact energy consumption or implementation of proposed measures.

This report provides an evaluation of potential for energy conservation opportunities at the Recreation Centre located at 4 Maple St, Chapleau Ontario, that was assessed at the time the work was conducted and is based on information obtained by and/or provided to Wood at that time. There are no assurances regarding the accuracy and completeness of this information. All information received from the client or third parties in the preparation of this report has been assumed by Wood to be correct. Wood assumes no responsibility for any deficiency or inaccuracy in information received from others.

Activities at the property or additional information subsequent to Wood's assessment may have significantly altered the potential and feasibility of the opportunities or conclusions identified within the report.

Conclusions made within this report consist of Wood's professional opinion as of the time of the writing of this report and are based solely on the scope of work described in the report, the limited data available, and the results of the work. The savings calculations are our estimate of saving potentials and are not a guarantee. The impact of building changes in space functionality, operations, usage, equipment retrofit, and weather need to be considered when evaluating the savings.

This report has been prepared for the exclusive use of the client identified herein and any use by any third party is prohibited. Wood assumes no responsibility for losses, damages, liabilities or claims, howsoever arising, from third party use of this report.

This report is limited by the following:

- Our interpretation of the objective and scope of works during the study period;
- The information provided by the Municipality; and
- Measures identified in this report are subject to the professional engineering design process before being implemented.

The recommendations and our opinion of probable costs associated with these recommendations, as presented in this report, are based on walk-through non-invasive observations of the parts of the building which were readily accessible during our visual review. Conditions may exist that are not as per the general condition of the system being observed and reported in this report. Opinions of probable costs presented in this report are also based on information received during interviews with operations and maintenance staff.

The opinions of probable costs are intended for global budgeting purposes only. The scope of work and the actual costs of the work recommended can only be determined after a detailed examination of the site element in question, understanding of the site restrictions, understanding of the effects on the ongoing operations of the site/building, definition of the construction schedule, and preparation of tender documents. We expressly waive any responsibilities for the effects of any action taken as a result of these endeavors unless we are specifically advised of prior to, and participate in the action, at which time, our responsibility will be negotiated.

11.0 CLOSURE

Wood conducted an Energy Audit at the Recreation Centre located at 4 Maple St in Chapleau Ontario. Electricity conservation and efficiency measures were investigated, provided, and assessed in terms of energy savings, fuel switch opportunities and utility cost savings along with capital project costs and financial analysis. Through our analysis we have identified nine (9) ECMs including two (2) fuel switch opportunities and one (1) heat recovery opportunity.

Wood has presented two (2) strategic implementation scenarios for the measures recommended in this assessment report. Scenario 1 is estimated to reduce site electricity and propane consumption by 23.3% and 6.2% respectively and considers conservation measures which optimize equipment operation coupled with LED retrofits for the arenas and building exterior. The overall annual cost savings for scenario 1 relative to the baseline year is $35,171.

Scenario 2 is estimated to increase propane consumption by 24.4% and reduce electricity consumption by 19.9%. Scenario 2 considers the replacement of two (2) electric furnaces and multiple electric radiant heaters with propane based alternatives and couples these opportunities with an interior fluorescent LED retrofit and building exterior LED retrofit. The overall annual cost savings for scenario 2 relative to the baseline year is $27,236.

Wood recommends proceeding with scenario 1. Additional recommendations include the following building management and behavioral opportunities:

- Recommissioning;
- Unit heater maintenance;
- Staff Training and Occupant Awareness; and
- Procurement Policy.

Wood Environment & Infrastructure Solutions

a Division of Wood Canada Limited,

Prepared by:	Reviewed by:
Name: Nathan Sokolowski, CEM, P.Eng.	**Name: Ayman Nicola, M.Sc., C.E.T., P.Eng.**
Signature: Nathan Sokolowski	**Signature:** Ayman Nicola

Appendix A

Appendix A Assessment Methodology

Site Visits

The visit included a detailed interview with technical staff regarding the buildings' function as well as discussing any issues that were persistent and opportunities for operational optimization. A comprehensive tour of the site was also conducted to evaluate the HVAC, lighting, and controls systems.

Utility Analysis

An analysis of the Recreation Centre's consumption provides a good starting point from which to:

- Identify potential energy conservation measures (ECMs); and,
- Develop a baseline against which ECM performance can be quantified.

The consumption (and demand) registered on historical data for the utility meter can also be examined to identify issues that are affecting the energy performance of the site.

Utility data for electricity was provided by the Township of Chapleau dating back to 2018 for the Chapleau Hydro utility meter.

Utility Rates

In terms of savings related to the identified measures, a blended rate is used which effectively assumes that reduction in consumption will only reduce the cost by the rate that applies to the last unit of energy used. The blended rates naturally include all fees, taxes, and bulk charges which may be included in each utility provider's billings. These rates are listed the table below.

Table A-1 Utility Rates (January 2018 – December 2019)

Item	Value	Units
Electricity Rate	0.145	$/kWh

Envelope System Assessment

The envelope and architectural assessment involves a non-intrusive visual inspection of the facility and a review of any available drawings to determine the condition and type of construction. Special attention will be paid to doors and windows during this review.

Mechanical System Assessment

The mechanical portion of the assessment involves taking a comprehensive inventory of mechanical components and an accurate appraisal of operational times and efficiencies for each mechanism. This is inclusive of all HVAC, Domestic Hot Water, and process related equipment. The Building Automation System (BAS) and/or manual equipment controls will be inventoried and assessed for integration. Sequence of operations will be examined for improvement opportunities.

Electrical System Assessment

A comprehensive assessment of the site's lighting includes a detailed review the existing fixtures and controls throughout the site. Consideration is also given to operational hours and the diligence of occupants at switching OFF manually operated lighting. A comprehensive assessment of the site's other electrical equipment including motors, transformers and process equipment.

Energy Conservation Measure Identification and Analysis

Each measure proposed for implementation on this project has been selected based on its viability, as measured against the following criteria:

- costs and savings within overall criteria for evaluation guidelines;
- appropriateness for tasks performed in the space;
- condition of existing systems;
- consistency of application (all areas of similar function are consistent);
- equipment approval by facilities personnel; and,
- impact on occupant behaviour and general acceptance of changes.

The energy savings calculations are based on a best estimate of the anticipated reductions taking into consideration direct savings from electrical consumption and electrical demand where appropriate. Savings associated with heating and cooling measures are calculated relating to heating and cooling degree-days for the site which are taken from the most appropriate local weather data source, which assumes an average balance point[1] temperature of 18°C (64.4 °F).

Costs associated with implementing the respective measures are estimated based on the approximate 'capital cost' for the materials and labor (including demolition and installation). Costs are determined from previous project experience and/or through published cost estimate data (RS Means…). All costs represent Wood's opinion on probable cost and are provided as approximate estimates to give economies of scale. Further investigation and detailed costing should be carried out prior to implementation.

For any systems or equipment that are on site and not functioning (not consuming energy) no energy conservation measures have been considered. The scope of this exercise is to find opportunities to reduce energy consumption and where there is no possibility to do so, no measures have been discussed in the report.

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).

[1] The balance point temperature is the external temperature at which the building's heating equipment is initiated.

Appendix B

Appendix B **Asset Details**

The table below presents the equipment inventory for the Facility at the time of the site visit.

Description	Location	Manufacturer	Model	Quantity	Phase	Voltage	Amps	HP	Demand (kW)
Base Board Heater	Ref Room	N/A	N/A	1	1	208	4.2		1.50
Base Board Heater	Skate Sharpening Storage	N/A	N/A	1	1	208	4.2		1.50
Base Board Heater	Curling Lounge	N/A	N/A	3	1	208			2
Base Board Heater	Ice Rink Concession	N/A	N/A	1	1	208			2
Suspended Electric Heater	Stands	GE	GK9-72-NS	36	3	600	4.1		4.30
Fan Force Htr	Front Entrance	Dimplex	RFV 842051	4	3	347	11.5		4
Unit Heater	Ice Rink Dressing Room	Stelpro	SHU0563 CT	4	3	600	4.8		5
Unit Heater	Dressing Room Hallway	Titan	EUL15883C	2	3	600	4.8		5
Unit Heater	Figure Skating Dressing Room	Stelpro	SHU0563 CT	4	3	600	4.8		5
Unit Heater	Curling Locker Rm Male	Stelpro	SHU0563 CT	1	3	600	4.8		5
Unit Heater	Curling Locker Rm Female	Westcan	UH271563-2-24	2	3	600	14.4		15
Unit Heater	Compressor Room	Not Available	Not Available	1	3	600	5.0		25
Unit Heater	Ice Re-surfacer Bay	Titan	EJ45B83C	1	3	600	15.0		15
Unit Heater	Curling Rink	Titan	EUL15883C	2	3	600	15.0		15
Unit Heater	Curling Hallway	Titan	EUL15883C	6	3	600	15.0		15
Electric Furnace	Mechanical Room	Aerotherme	UNF-30	1	3	600	30.0		30
Electric Furnace	Mechanical Room	Aerotherme	UNF-30	1	3	600	30.0		30

Description	Location	Manufacturer	Model	Quantity	Phase	Voltage	Amps	HP	Demand (kW)
Dehumidifier	Ice Rink	Cimco	N/A	2	3	600			
Make Up Air Unit	Servery	Industrial Commercial Equipment	BMA-112	1	1	120	1.5	3.0	2.24
Make Up Air Unit	Not in service	General Electric	51767GBX2	1	1	115	7.8	0.5	0.37
Ceiling Fans	Curling Rink			8	1	120	0.6		0.072
Window A/C	Super Office	KoolKing	KWH101CEIA	1	1	115	8.03		0.92345
Exhaust	Ice Rink	Baldor	M3611P5	2	3	575	2.6	3	2.24
Exhaust	Ice Rink Snack Bar	Penn Ventilator	Domer	1	1	115	6.0	0.5	0.37
Exhaust	Ice Rink Lobby	N/A	N/A	1	1	115		0.5	0.37
Exhaust	Community Hall	Penn Ventilator	Domer	1	1	115	6.0	0.5	0.37
Exhaust	Mechanical Room	Penn Ventilator	Domer	1	1	115	6.0	0.5	0.37
Exhaust	Curling Lounge	Penn Ventilator	Domer	1	1	115	6.0	0.5	0.37
Exhaust	Compressor Room	General Electric	SKH43MG2710	1	1	115	5.7	0.3	0.70
Exhaust	Ice Rink Dressing Rooms	N/A	N/A	5	1	115		0.5	0.37
Exhaust	Skate Sharpening	N/A	N/A	1	1	115		0.5	0.37
Exhaust	South Dressing Rooms	Jenn Air	N/A	2	1	115		0.25	0.19
Exhaust	Curling Lockers	N/A	N/A	2	1	115		0.5	0.37
Exhaust	Core Washroom	N/A	N/A	3	1	115		0.3	0.25
Reciprocating Compressor #1	Compressor Room	Mycom	N6WA	1					
Compressor motor # 1	Compressor Room	Super Max	WH0504FFHT	1	3	575	47.2	50	37.28

Description	Location	Manufacturer	Model	Quantity	Phase	Voltage	Amps	HP	Demand (kW)
Reciprocating Compressor #2	Compressor Room	Mycom	N6WA	1					
Compressor motor # 2	Compressor Room	WEG NEMA Premium	326T	1	3	575	47.9	50	37.28
Sub Floor Pump	Compressor Room	US Electrical Motor	184T	1	3	575	5.5	5	3.73
Brine Pump(Ice Rink)	Compressor Room	Tatung Extra Max	WJO204FFHC	1	3	575	19.7	20	14.91
Brine Pump(Curling)	Compressor Room	Tatung Super-Max Plus	WH7Y54IFH CS	1	3	575	7.8	7.5	5.59
Condensor Pump	Compressor Room	Armstrong	3X2X8	1	3	575	5.1	5	3.73
City Water Pump	Compressor Room	FR-56J-65	8VB56T34D5697B P	1	3	575	1.3	0.8	0.56
Cooling Tower	Roof	US Electrical Motor	6206-2RS-J/C3	1	3	575	6.6	10	7.46
Fume Hood	Ice Rink Snack Bar	Ridalco	N/A	1	1	120		0.75	0.56
Refrigerator	Ice Rink Snack Bar	N/A	N/A	2	1	120			1
Chest Frezzer	Ice Rink Snack Bar	N/A	N/A	2	1	120			1.25
Commercial Fridge/Cooler	Ice Rink Snack Bar	N/A	N/A	1	1	115	3.9		0.4485
Coffee Brewer	Ice Rink Snack Bar	N/A	N/A	1	1	120			1.66
Pop Vending Machine	Ice Rink Snack Bar	N/A	N/A	2	1	120			0.96
Pop Vending Machine	Curling Hallway	N/A	N/A	1	1	120			0.96
Fume Hood	Curling Bar	N/A	N/A	1	1	120		0.75	0.56
Coffee Brewer	Curling Bar	N/A	N/A	1	1	120			1.66
Ice Cube Machine	Curling Bar	N/A	N/A	1	1	120			1
Commercial Fridge/Cooler	Curling Bar	N/A	N/A	1	1	115	3.9		0.4485
Stove	Curling Bar	N/A	N/A	1	1	120			2.5
Projector	Community Hall	N/A	N/A	1	1	120	1.5		0.18

Description	Location	Manufacturer	Model	Quantity	Phase	Voltage	Amps	HP	Demand (kW)
Audio System	Community Hall	N/A	N/A	1	1	120	15		1.8
PA System	Rec Centre	N/A	N/A	1	1	120	15		1.8
							Breaker Size		
Dishwasher	Servery	N/A	N/A	1	1	120	20		Max-
Hot box	Servery	N/A	N/A	1	1	120	20		Max-
Exhaust Hood	Servery	N/A	N/A	1	1	120	15		Max-
Convection Gas Oven	Servery	N/A	N/A	1	1	120	15		Max-
Coffee Maker	Servery	N/A	N/A	1	1	120			
Fryer	Servery	N/A	N/A	1	1	120			
Hot Food Table	Servery	N/A	N/A	1	1	120	20		Max-
Roll-In Refrigerator	Servery	N/A	N/A	2	1	120	15		Max-
Reach-In Refrigerator	Servery	N/A	N/A	1	1	120	15		Max-
Reach-In Freezer	Servery	N/A	N/A	1	1	120	15		Max-
Walk In Beer Cooler (Evap Fan)	Servery	N/A	N/A	1	1	115	2.5		
Walk In Beer Cooler (Comp)	Servery	N/A	N/A	1	1	208	33		
									BTU/hr
Propane Furnace	Mechanical Room	Carrier	59SC5A120S241220	1	1	115	14.9	1.0	120,000
Propane Hot Water Heater	Mechanical Room	Bock	OT300LP-A	2	1	120			300,000
Propane Hot Water Heater	Ice Re-surfacer Bay	RHEEM	G75-125	1	1	120	0.3		125,000

Appendix C

Appendix C **Lighting Inventory**

The table below presents the existing fluorescent lighting at the facility at the time of the site visit.

Space	Fixture #	Fixture Housing	Fluorescent Lamp Type	Lamps	Lamp Length (ft)	Lamp Watts	Ballast	Fixture Watts	Total Watts
Penthouse	4	Rec, 2x4 trofer	T8, Rapid start	2	4	32	Electronic	60	240
Penthouse	1	Surf, 1x4	T12, Energy efficient	2	4	34	Mag-ES	72	72
Penthouse	2	Surf, linear	T12, Energy efficient	2	8	60	Mag-ES	123	246
Dressing Rooms	1	Surf, linear	T12, Energy efficient	2	8	60	Mag-ES	123	123
Dressing Rooms	1	Susp, 1x4	T12, Energy efficient	2	4	34	Mag-ES	72	72
Dressing Rooms	15	Susp, 1x4	T8, Instant start	1	4	32	Electronic	31	465
Dressing Rooms	1	Susp, 1x4	T12, Energy efficient	2	4	34	Mag-ES	72	72
Dressing Rooms	2	Susp, linear	T12, Energy efficient	2	8	60	Mag-ES	123	246
Dressing Rooms	1	Susp, 1x4	T12, Energy efficient	2	4	34	Mag-ES	72	72
Hockey Lobby	4	Surf, 1x4	T8, Rapid start	2	4	32	Electronic	60	240
Hockey Lobby	1	Surf, linear	T12, Energy efficient	2	8	60	Mag-ES	123	123
Hockey Lobby	2	Surf, 1x4	T12, Energy efficient	2	4	34	Mag-ES	72	144
Hockey Lobby	3	Surf, 1x4	T8, Rapid start	2	4	32	Electronic	60	180
Ice Plant	1	Surf, 1x4	T8, Rapid start	2	4	32	Electronic	60	60
Ice Plant	1	Susp, 1x4	T12, Energy efficient	2	4	34	Mag-ES	72	72
Dressing Rooms	1	Susp, 1x4	T12, Energy efficient	2	4	34	Mag-ES	72	72
Dressing Rooms	1	Susp, linear	T12, Energy efficient	2	8	60	Mag-ES	123	123
Dressing Rooms	2	Susp, linear	T12, Energy efficient	2	8	60	Mag-ES	123	246

Dressing Rooms	4	Susp, linear	T12, Energy efficient	1	8	60	Mag-ES	62	248
Dressing Rooms	1	Susp, linear	T12, Energy efficient	2	8	60	Mag-ES	123	123
Dressing Rooms	1	Susp, linear	T12, Energy efficient	1	4	34	Mag-ES	43	43
Dressing Rooms	2	Susp, 1x4	T12, Energy efficient	2	4	34	Mag-ES	72	144

Appendix D

Appendix D Modelling Methodology

The building simulation program Carrier HAP version 5.11 was used to simulate how each recommendation would perform under the existing buildings characteristics. The program uses typical weather data along with input from the user of the building's HVAC equipment, building occupancy schedule, envelope materials, plug loads, and process loads to simulate design alternatives.

The Facility's internal gains were entered in the baseline model using occupancy counts and estimating electrical appliances such as computers, copiers, and printers amongst others; the ASHRAE Fundamentals 2013 Handbook was used as a guide for estimating the loads from this equipment.

To determine the Facility's lighting load consumption, lighting counts were taken on site and verified against the electrical reflected ceiling drawings, the lighting inventory was then used to determine the interior, exterior, and perimeter lighting loads. Where lighting information could not be obtained ASHRAE Fundamentals 2013 Handbook was used as a guide.

The Facility's HVAC components were generated in the model using a combination of manufacturer specifications, mechanical drawings, schedules, and equipment asset details for the HVAC systems. A combination of manufacturer specifications and nameplates were used for units within the Facility. In addition, the building operator's description of the Facility's HVAC sequences of operations and BAS information and setpoints were also accounted for in the model.

To ensure that the baseline model was operating similarly to the existing building, the Facility's baseline consumption based on the utility billing data was compared to the building simulation's energy consumption outputs. This comparison was done both analytically by comparison to total consumption and visually by comparing monthly trends to expected consumption.

Appendix E

Appendix E Utility Data Summary

The table below presents the collected utility data for the site.

Month-Year	Days in Billing Period	Electricity Consumption (kWh)	Electricity Cost ($)
Jan-2018	31	172,320	-
Feb-2018	28	138,720	-
Mar-2018	31	151,680	-
Apr-2018	30	48,960	-
May-2018	31	14,400	-
Jun-2018	30	9,600	-
Jul-2018	31	12,480	-
Aug-2018	31	36,480	-
Sep-2018	30	93,120	-
Oct-2018	31	119,040	-
Nov-2018	30	133,440	-
Dec-2018	31	139,680	-
Jan-2019	31	154,080	$18,615.13
Feb-2019	28	140,160	$17,372.24
Mar-2019	31	133,440	$13,508.59
Apr-2019	30	52,800	$5,177.28
May-2019	31	21,120	$3,355.86
Jun-2019	30	17,760	$2,877.09
Jul-2019	31	16,800	$3,443.14
Aug-2019	31	47,040	$5,631.22
Sep-2019	30	76,320	$12,191.42
Oct-2019	31	93,120	$19,734.38
Nov-2019	30	126,240	$23,245.58
Dec-2019	31	134,400	$21,453.77

Month-Year	Days in Billing Period	Electricity Demand (kW)
Jan-2019	31	412.8
Feb-2019	28	422.4
Mar-2019	31	326.4
Apr-2019	30	192
May-2019	31	96
Jun-2019	30	76.8
Jul-2019	31	86.4
Aug-2019	31	278.4
Sep-2019	30	240
Oct-2019	31	307.2
Nov-2019	30	316.8
Dec-2019	31	336

Month-Year	Days in Month	Propane Consumption (L)
Jan-2018	31	545.3
Feb-2018	28	961.9
Mar-2018	31	567.5
Apr-2018	30	224.5
May-2018	31	0
Jun-2018	30	0
Jul-2018	31	0
Aug-2018	31	10,184.7
Sep-2018	30	0
Oct-2018	31	1,398.6
Nov-2018	30	0
Dec-2018	31	4,595.1
Jan-2019	31	2,322.6
Feb-2019	28	2,810.4
Mar-2019	31	0
Apr-2019	30	0
May-2019	31	2,632.7
Jun-2019	30	0
Jul-2019	31	0
Aug-2019	31	0
Sep-2019	30	1,208.8
Oct-2019	31	0
Nov-2019	30	0
Dec-2019	31	2,827.4