Municipal Airport

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

Prepared for: Charley Goheen

Township 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 , N3H 4R7

7 October 2020

Executive Summary

Municipal Airport Energy Audit

Wood PLC (Wood) was retained by the Township of Chapleau to conduct an energy audit on Chapleaus Municipal Airport located at 5th Concession Lot 11 Gallagher Township, Ontario. An energy assesment consistent with ASHRAE Level 2 guidelines was conducted for the Faciity. The site visit associated with this project was conducted on July 29th, 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 opportunties 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
			Fuel Oil	Electricity	Demand	Propane	Maintenance		
		($)	(L)	(kWh)	(kW)	(L)	($)	($)	(Years)
ECM-1	Infiltration Reduction	6,800	873 17.0%	938 2.7%	1 4.8%	-	-	1,271	5.3
ECM-2	Window Film Retrofit	3,200	-	4,602 13.1%	2 9.7%	-	-	571	5.6
ECM-3	Temperature Control Set Points	2,600	-	2,611 7.4%	1 4.8%	-	-	324	8.0
ECM-4	Terminal Heating System Upgrade	18,000	-	10,514 29.9%	5 24.7%	-	-	1,304	13.8
ECM-5	Garage Heating System Upgrade	10,000	5,140 100%	-	-	(3,517)	500	5,206	1.9
ECM-6	Vehicle Exhaust Hose	1,500	137 2.7%	-	0.1 0.5%	-	-	181	8.3
ECM-7	Interior LED Retrofit	1,500	(19) (0.4)%	646 1.8%	1 2.7%	-	20	75	20.0
Scenario 1		24,000	5,140 100%	8,584 24.4%	7 35.5%	(3,517)	520	6,290	3.8

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 Scenario 1.

Scenario 1, which contains:

- ECM-1: Infiltration Reduction;
- ECM-2: Window Film Retrofit;
- ECM-3: Temperature Control Set Points;
- ECM-6: Garage Heating System Upgrade; and
- ECM-7: Interior LED Retrofit.

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

- 8,584 kWh (24.4%) of electricity savings; and
- 5,140 L (100%) of fuel oil savings.

Implementation of the scenario includes a new propane use of 3,517 L.

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

- Recommissioning;
- Perimeter baseboard 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.

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Acronyms and Abbreviations

ACH	Air changes per hour
ASHRAE	American Society of Heating, Refrigeration and Air-Conditioning Engineers

BTU	British Thermal Unit
C	Celsius
ccASHP	Cold climate Air Source Heat Pump
CDD	Cooling Degree Day
CFL	Compact Fluorescent
CO_2e	Carbon Dioxide Equivalent
COP	Coefficient of Performance
DHW	Domestic Hot Water
DX	Direct expansion
ECM	Energy Conservation Measure
EUI	Energy Utilization Index
ft	Feet
ft^2	Square feet
g	Gram
GJ	Gigajoule
HDD	Heating Degree Day
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
MBH	Thousand BTU's per hour
NPV	Net Present Value
V	Voltage
W	Watt
Wood	Wood Environment & Infrastructure Solutions, Inc
U-Value	Thermal transmittance measured in $BTU/(hr \cdot ft^2 \cdot °F)$
UV	Ultra violet

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 Municipal Airport located at 5th Concession Lot 11 Gallagher Township, Ontario.

The assessment involved a review of approximately 346 m^2 (3,726 ft^2) of terminal floor, office space and a maintenace garage. 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 PUPOSE

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 – Asset Details;
- Appendix C – Lighting Inventory;
- 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	5th Concession Lot 11 Gallagher Township Ontario
Contact Person	Ms. Charley Goheen
Contact information	cgoheen@chapleau.ca
Utility Provider	HydroOne
Account No.	200108905204

1.3.2 Acknowledgements

Wood would like to acknowledge the contribution of the Township of Chapleau and Facility staff who 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 airport was constructed in 1965 and contains a terminal building, maintenance garage, NAV Canada weather station along with a 3,000ft and 5,000ft runway. It is designated as one of the Ministry of Natural Resources Strategic Forest Fire Water Bomber base and utilized by Orange Air Ambulance.

The airport terminal is available for use 365 days a year and is typically staffed by two (2) Township of Chapleau members from 8am to 2pm 5 days a week, Monday to Friday. The garage on site is supervised by a maintenance lead and operates similar to the airport with varying hours in the winter to accommodate snow plowing from inclement weather. Table 2-1 summarizes an overview of the building information

Table 2-1 General Building Information

Building Type	**Terminal & Garage**
General Occupants	2-3
Gross Floor Area	346 m^2
Floors	1
Year Built	1965
Occupancy schedule	8am to 4pm

2.2 BUILDING ENVELOPE

The terminal is a single story slab on grade building with the walls constructed of cedar siding, wood framing and either a gypsum board or wood cladding interior finish. It is expected the walls have 2 ½" of rigid board insulation. The ceilings are 9ft high with an attic space above and pitched roof with asphalt shingles. The terminal portion contains aluminum frame fixed insulated windows and the office portion contains wood framed hinged casement windows. A window on the South-East façade in the terminal has an impact crack.

The garage is constructed of sheet steel wall assemblies with roughly 4" of batt insulation. The front façade contains two (2) 14 feet by 12 feet roll up doors that are manually operated. The roof assembly consists of steel joists, 4" batt insulation and metal roof panels. There are two (2) windows which are aluminum frame double pane and the window on the South-West façade contains a broken pane. The exterior insulated steel doors have air gaps between the door and frame. The glass window in the South-East facing exterior door has been damaged and repaired with putty to fill in between the cracks in the glass. The roll up doors do not close flush with the floor and this along with the instances mentioned prior lead to a leaky building envelop.

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 Terminal & Garage Site Photos

Terminal – North-West façade

Terminal Interior

Garage – South East Façade

Garage Interior

2.3 MECHANICAL SYSTEMS

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

2.3.1 Heating, Ventilation and Air Conditioning

The terminal is heated with perimeter electrical baseboards controlled with manual thermostat set points of 20°C (68°F). There are no sources of air conditioning or ventilation supply to any of the terminal spaces and there are no exhaust fans throughout the building aside from the washroom unit.

The garage is heated with a 278.8 MBH fuel oil furnace from Inner-City Products Corp, model LHO5230BLAA. The furnace is switched on manually when workers are present. The structure is equipped with a ¾ HP fan to exhaust vehicle fumes when needed.

2.4 ELECTRICAL SYSTEMS

2.4.1 Domestic Hot Water

Domestic Hot Water (DHW) is available in the terminal via a Cascade 3.0 kW electric hot water heater serving the washroom faucets. There is no hot water in the Garage.

2.4.2 Lighting Systems

The terminal interior lighting systems is a mix of fluorescent tube (T-8) and LED fixtures. The LED fixtures in the terminal are controlled with a ceiling mounted infrared occupancy sensor which prevents fixtures from turning on when there is ample ambient light. All other interior light sources, including the garage, are operated by manual on/off switch. Exterior lighting consists of a combination of compact fluorescent (CFL) and LED wall packs on integrated photocell control. The runways are equipped with a fully automated remote-controlled lighting system that uses a combination of incandescent airport lamps and halogen navigation lamps. The incandescent lamps are becoming obsolete and the Facility will need to switch to alternative lamp types when the stock of these lamps run out.

2.4.3 Plug Loads

Plug loads are common items essential to facility operation. These include desktops, laptops, printers, fax machines and common office equipment. It also includes items commonly found in workspaces such as electric space heaters, coffee makers and radios.

3.0 UTILITY ANALYSIS AND BENCHMARKING

The following sections detail the energy 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 fuel oil consumption data for the years provided.

Table 3-1 Summary of Utility Data

Year	Electricity		Fuel Oil	
	Consumption (kWh)	Cost ($)	Consumption (L)	Cost ($)
Jan-2018 to Dec-2018	34,039	4,221	5,063	6,698
Jan-2019 to Dec-2019	33,780	4,189	5,111	7,412

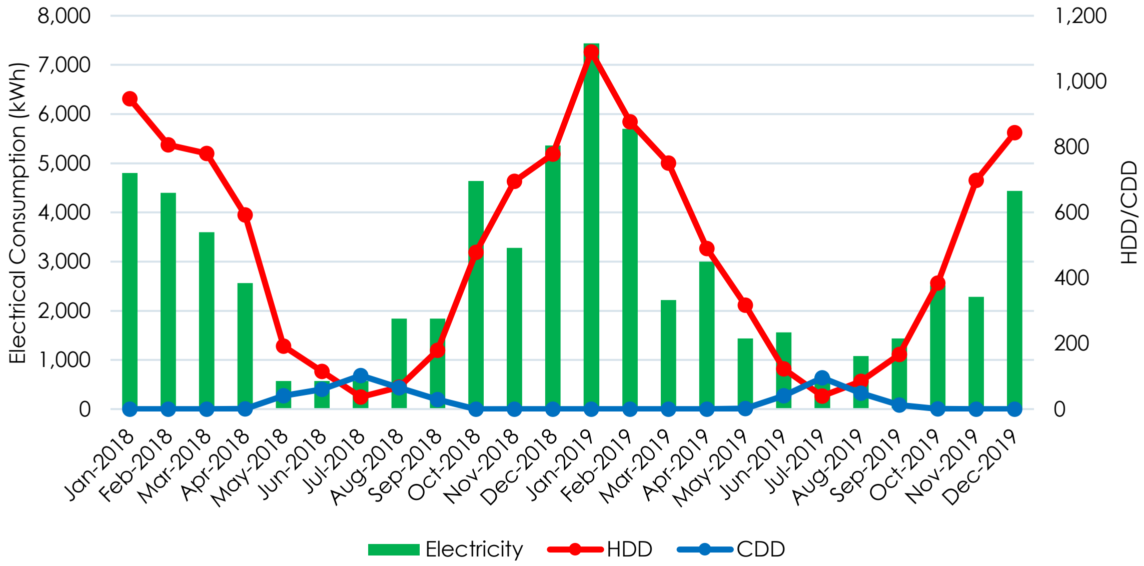
3.1 ELECTRICITY

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

Two (2) years of utility consumption data for electricity was provided from January 2018 to December 2019. A blended rate which accounts for transmission, use, regulatory fees, global adjustment and HST, was estimated at $0.135/kWh for the site.

The figure below illustrates the electrical consumption for the facility.

Figure 3-1 Monthly Electricity Consumption



The figure shows that electricity consumption peaks in the winter months; this is to be expected for a building in a heating dominated climate with electricity being the sole energy source used to heat the terminal building. There is a small baseload consisting of DHW heating, lighting, plug loads, and exhaust fans.

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-square value of 1 represents a perfect correlation, while a lower value indicates a lesser degree of influence between the variables. In general, an R-square 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-square 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.

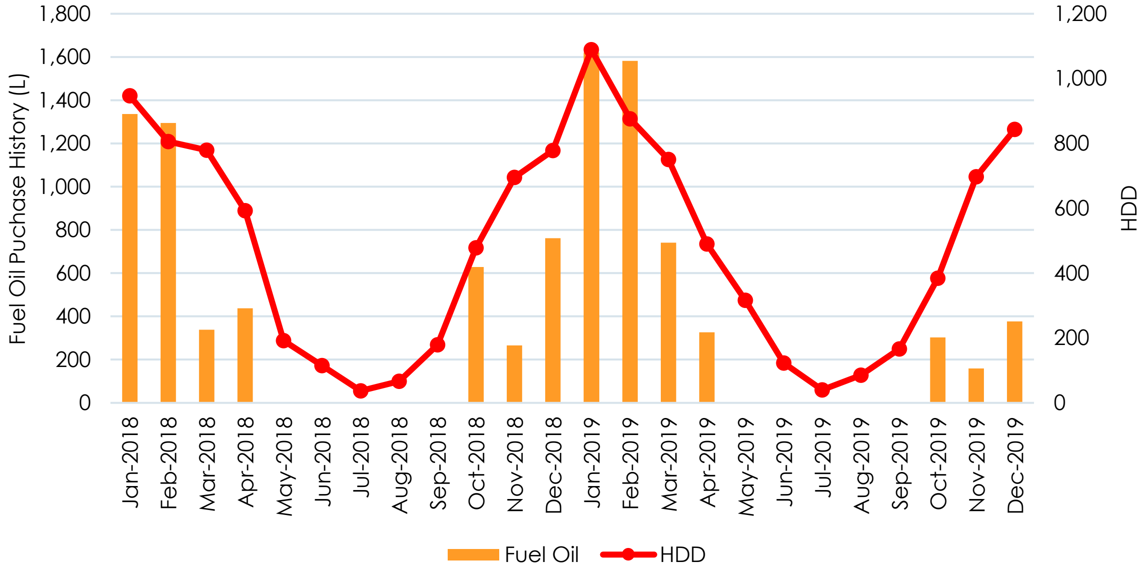
The calculated R-square of **0.77** for HDD and **0.44** for CDD shows the facilities electricity consumption is moderately influenced by a dropping outdoor air temperature. The correlation between CDD is poor as there is no air conditioning for the airport complex.

3.2 FUEL OIL

Fuel oil is purchased in bulk quantities for the heating furnace in the garage. A total of 5,063 and 5,111 L was purchased for 2018 and 2019 respectively. A rate of $1.32/L was estimated using the average retail price of fuel oil in Timmins Ontario as provided by Natural Resources Canada. Quantities of fuel oil purchased per month can be found in **Appendix E**.

The figure below illustrates the monthly quantities of fuel oil purchased for the facility.

Figure 3-2 Monthly Quantity of Fuel Oil Purchased



As can be seen in the figure above, fuel oil is purchased and used in the winter months; This is to be expected as this is when heating is needed for the garage. The actual monthly consumption is unknown but the consistent large quantities acquired in January and February indicate these are the peak months for consumption which correspond to the months with the highest heating degree days. A linear regression analysis has also been conducted in an effort to establish consumption for a typical year. The calculated R2 value of **0.69** indicates a weak correlation between fuel consumption and HDD but this is likely 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 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. The accuracy of the calibration changes between utility record datasets due to the variability of weather; the modeled consumption has been normalized against weather for **electricity**, removing peaks and lulls due to varying weather patterns and allowing for a more accurate calibration. 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 summarizes the simulated baseline year for the facility.

Table 3-2 Summary of Simulated Baseline Year Energy Consumption

Year	Electricity		Fuel Oil		Total			
	Consumption (kWh)	Cost ($)	Consumption (L)	Cost ($)	EUI (GJ/m^2)	EUI ($ekWh/ft^2$)	Cost Index ($\$/m^2$)	Cost Index ($\$/ft^2$)
Baseline	35,117	4,355	5,140	6,534	0.22	5.66	7.51	0.70

3.4 ANNUAL ENERGY CONSUMPTION BREAKDOWN BY FUEL TYPE

Electrical and fuel oil 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 Consumption Breakdown by Fuel Type

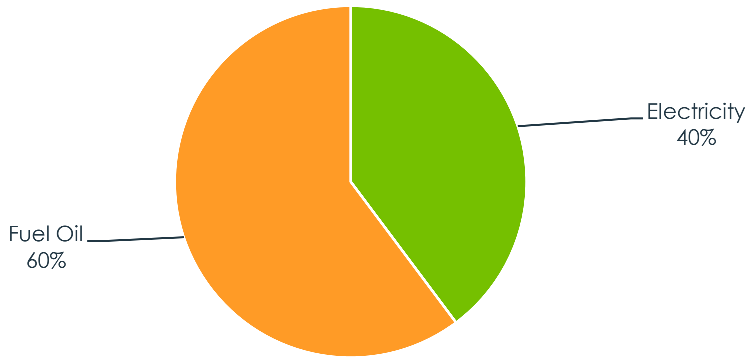
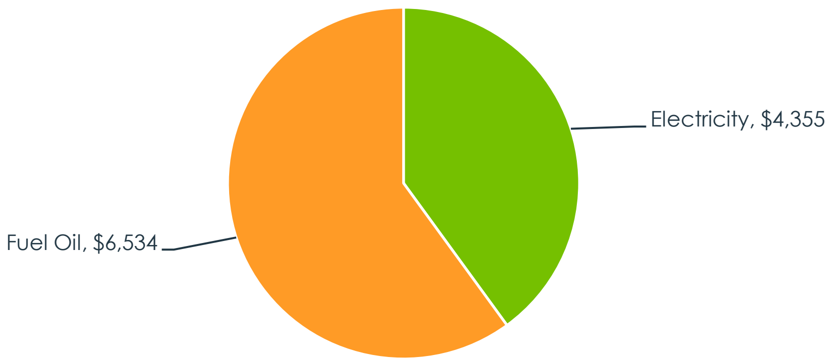


Figure 3-4 Annual Energy Cost by Fuel Type



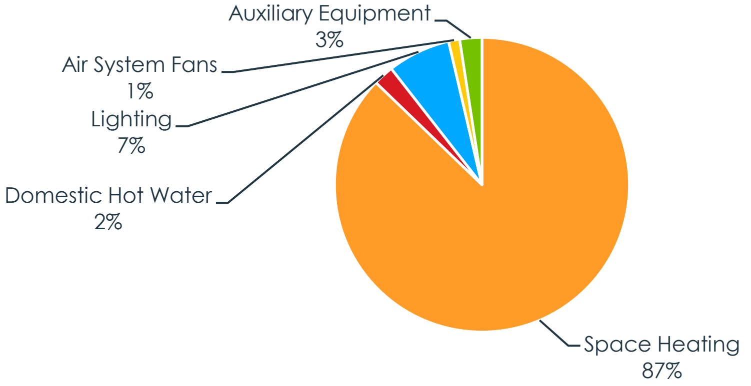
Electricity has been estimated to account for approximately 40% of all energy consumed at a cost of $4,355, while fuel oil accounts for the other 60% at a cost of $6,534. The cost per energy metric for fuel oil and electricity at the used rates are similar at $34.15/GJ and $34.44/GJ respectively.

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 perimeter electric heat to maintain the space temperature and by the furnace in the garage;
- **Domestic Hot Water** – All domestic hot water used in the terminal building;
- **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.

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

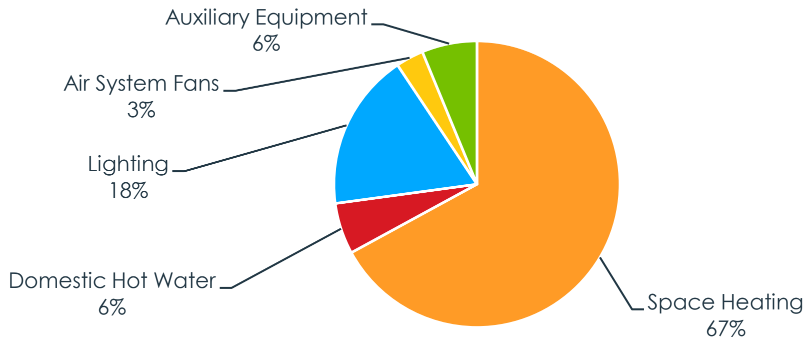


From the figure above, space heating is the end use that consumes the most energy at the facility with 87%. This is to be expected as there is fuel and electric sourced heating equipment on site and represent the largest opportunities for energy savings. Lighting is the next largest end user with 7%. Auxiliary equipment, domestic hot water and air system fans make up the remainder with a combined portion of 6%.

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



3.6 BUILDING ENERGY UTILIZATION INDEX

The Facility Energy Utilization Index (EUI) was calculated by dividing the total annual energy used (all energy utilities in common units) by the gross floor area. Benchmarking of the EUI against other facilities of similar size and use was not possible for this facility due to the makeup of the complex and lack of similar facilities in the same climate that have been audited. This metric will assist as a starting point for tracking site energy performance of a yearly basis going forward.

Table 3-3 Energy Utilization Index

GJ/m²	ekWh/ft²
0.22	5.69

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 consumption;
- Fuel switch consumption (where applicable);
- Total energy cost;
- Maintenance cost; and,
- GHG emissions.

The first four (4) 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	Emission Factor
Electricity	0.0000393 tonnes/kWh
Furnace Oil	2.72 tonnes/m^3

The following ECMs were reviewed:

- ECM-1: Infiltration Reduction;
- ECM-2: Window Film Retrofit;
- ECM-3: Temperature Set Points;
- ECM-4: Terminal Heating System – Heat Pumps;
- ECM-5: Vehicle Exhaust System;
- ECM-6: Garage Radiant Tube Heaters; and
- ECM-7: Interior Lighting Retrofit.

4.1 BUILDING ENVELOPE

4.1.1 ECM-1: INFILTRATION REDUCTION

Existing Condition

All structural components within the building envelope are bound to experience varying levels of air or heat exchange at transection. Infiltration into the building can also create a significant heating load source in the buildings. Due to the age, construction and usage, the Facility may experience large heating loads due to air leakage and excessive infiltration through door openings, window openings, cracks, and exhaust/plumbing penetrations which can increase heating energy.

Because of the constant variation in wind speed and pressure, along with actual air infiltration greatly varying throughout the year, the average infiltration rate for the terminal was assumed to 0.5 and 1.25 air changes per hour (ACH) respectively.

Proposed Condition

The installation or replacement of worn or broken weather stripping, window caulking, and foam sealants can contribute towards reducing air infiltration around doors, windows, piping, cracks, and exhaust/plumbing penetrations. The cracked and broken window panes on site require replacement.

Analysis

This measure was analyzed using the end-use model generated from Carrier's HAP software as a basis. The infiltration ACH for spaces with doors, walls and windows were reduced on average by 30% because of weather-stripping and caulking.

A detailed building envelope or thermography testing could be conducted to identify anomalies related to thermal bridges, air infiltration/exfiltration, and heat transfer due to design or construction of the building.

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

- For calculation purposes, weather-stripping and caulking of walls, windows and doors can reduce infiltration by a minimum of 30%; and
- Replacing worn and/or broken weather-stripping and caulking would not require additional modifications to the buildings structure.

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

Table 4-2 ECM-1: Infiltration Reduction Annual Energy Savings

Estimated Fuel Oil Savings		Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(L)	(%)	(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
873	17.0	938	2.7	0.9	4.8	-	1,271	2.5

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

Table 4-3 ECM-1: Infiltration Reduction Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
6,800	1,271	5.3	4,642	11.2	5.7

The measure offers a payback 5.3 years and provides a positive NPV and IRR.

The following table summarizes the costs associated with this measure.

Table 4-4 ECM-1: Infiltration Reduction Opinion of Probable Cost Breakdown

Item	Cost ($)
Door Seal (x12)	290
Loading Dock (x2)	3,300

Item	Cost ($)
Window Caulking	800
Installation	900
Engineering (11%)	580
Commissioning and Training (7%)	330
Contingency (10%)	600
TOTAL (to nearest hundredth)	**6,800**

4.1.2 ECM-2: WINDOW FILM RETROFIT

Existing Condition

The windows lack any sort of window film glazing and represent a weak link in the building envelope allowing substantial heat gain and heat loss in the summer and winter respectively.

Proposed Case

Window films can help insulate windows against excessive heat and cold. During the summer these films will rejects the suns heat and harmful UV rays. In the winter these films block heat from escaping improving comfort and reducing cold spots.

In terms of implementation the window film is applied directly onto the existing windows and there are no additional space requirements.

Analysis

This measure was analyzed using the end-use model generated from Carrier's HAP software as a basis. The overall window U-value of existing wood and aluminum framed windows was assumed to be 0.76 and 0.9 respectively. The U-value with films applied was reduced to 0.35 and 0.57 for wood and aluminum windows respectively.

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

- Films can be applied to windows throughout the Facility with minimum effort required; and
- Only windows in the terminal building were considered for application of films.

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

Table 4-5 ECM-2: Window Film Retrofit Annual Energy Savings

Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
4,602	13.1	1.8	9.7	-	571	0.5

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

Table 4-6 ECM-2: Window Film Retrofit Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
3,200	571	5.6	1,936	10.0	6.0

The measure has a payback of 5.6 years and will result in reduced run times of the perimeter heating equipment. This measure will also reject the suns heat and harmful UV rays during the summer improving comfort and reducing warm spots.

The following table summarizes the costs associated with this measure.

Table 4-7 ECM-2: Window Film Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	2,000
Installation	600
Engineering (11%)	290
Contingency (10%)	310
TOTAL (to nearest thousand)	**3,200**

4.2 HVAC

4.2.1 ECM-3: TEMPERATURE CONTROL SET POINTS

Existing Condition

The perimeter electric heat which serves terminal building are manually set to operate based on the set point of these spaces with local thermostats. The setpoints were observed to be 20°C (68°F).

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. 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 setpoints for the electric heating systems were simulated to heat to 20°C (68°F) during occupied hours and 15.5°C (60°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 with no variance;
- The existing electric heat can support programmable thermostats and will operate accordingly; and
- 5 sensors would be required for proper coverage within the spaces listed.

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

Table 4-8 ECM-3: Temperature Control Set Points Annual Energy Savings

Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
2,611	7.4	0.9	4.8	-	324	0.3

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

Table 4-9 ECM-3: Temperature Control Set Points Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
2,600	324	8.0	314	2.2	8.8

This measure offers savings with a moderate payback of eight (8) years. A positive NPV and IRR suggest that the township can further look at investigating the opportunity to provide automated control to the existing heating system.

The following table summarizes the costs associated with this measure.

Table 4-10 ECM-3: Temperature Control Set Points Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	2,000
Engineering (11%)	240
Commissioning and Training (7%)	140
Contingency (10%)	220
TOTAL (to nearest hundredth)	**2,600**

4.2.2 ECM-4: TERMINAL HEATING SYSTEM UPGRADE

Existing Condition

The terminal is currently served by electric resistance heating in the form of perimeter baseboard heaters.

Proposed Case

Cold climate air to air source heat pumps (ccASHP) can be used to provide heating. A split system can be purchased for the terminal lobby, office, and maintenance office to provide zoned climate control. The electric heat may be retained in case there is a need for backup heat source and can be used if supplemental heating is required on very cold days.

In terms of implementation, heat pumps should always be installed by licensed, trained professionals. Upgrades to the building envelope to improve insulation and air tightness should be addressed before installing new equipment to ensure the right size of equipment is installed for the building heating load. Outdoor units can be ground mounted or wall mounted and in either scenario there is adequate space at the facility to do so. A small space needs to be allocated to the indoor coil, but it is versatile as it can be mounted either on the floor, wall or ceiling. The sensors would be tied into programmable thermostats to control each zone individually. Consideration will need to be given to the details of wiring the sensor to the controller. Several vendors carry ccASHP in their product line and they require periodic maintenance to maintain proper operation such as keeping the outdoor unit free from snow, ice and debris. As the system will be largely automated little training will be required.

Analysis

This measure was analyzed using the end-use model generated from Carrier's HAP software as a basis. The electric fan coils and unit heaters throughout the Facility were replaced with split DX fan coils that have an average coefficient of performance (COP) rating of 3.2 and a backup electric auxiliary heating that initiates at 4.4°C (40°F).

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

Table 4-11 ECM-4: Terminal Heating System Upgrade Annual Energy Savings

Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
10,514	29.9	4.6	24.7	-	1,304	1.1

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

Table 4-12 ECM-4: Terminal Heating System Upgrade Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
18,000	1,304	13.8	(1,199)	-0.9	N/A

The measure has a payback greater than 10 years. A negative NPV and IRR does not justify implementation on energy savings alone but provides the township with energy saving potentials based on an increase in the COP with modern technology heat pumps and an option to consider once the perimeter heating system reaches it end of life expectancy.

The following table summarizes the costs associated with this measure.

Table 4-13 ECM-4: Terminal Heating System Upgrade Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	13,900
Engineering (11%)	1,500
Commissioning and Training (7%)	1,000
Contingency (10%)	1,600
TOTAL (to the nearest thousand)	**18,000**

4.2.3 ECM-5: GARAGE HEATING SYSTEM UPGRADE

Existing Condition

The garage is currently served by fuel oil furnace. The unit is nearing the end of its expected life and requires routine maintenance to ensure proper operation. It is expected the unit is over sized for the space needs.

Proposed Case

A properly sized radiant tube heater can provide the adequate heat to the space and would run off of propane. This would require the installation of a 1,000 L propane fuel storage tank outside the facility, connection gas piping and some duct work.

Analysis

This measure was analyzed using the end-use model generated from Carrier's HAP software as a basis and a hand calculation for the proposed case. The constant air volume fuel oil furnace with 82% efficiency was replaced with a radiant tube heater to provide 12.7°C (55°F) tempered air to the space. The unit was sized based on the ASHRAE 90.1 2013 energy standard and a base case efficiency of 80%.

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

Table 4-14 ECM-5: Garage Heating System Upgrade Annual Energy Savings

Estimated Propane Use		Estimated Fuel Oil Savings		Estimated Electricity Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(L)	(%)	(L)	(%)	(kWh)	(%)	($)	($)	(t CO_2e)
3,517	-	5,140	100	-	-	500	4,706	8.8

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

Table 4-15 ECM-5: Garage Heating System Upgrade Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
10,000	5,206	1.9	36,856	48.3	2.0

The measure has a simple payback under two (2) years with positive NPV and IRR which suggest that the township can further look at investigating the opportunity to replace the fuel oil furnace by installing propane fired radiant tube heaters which are one of the most efficient form of heat available for this purpose. A rate of $0.5954/L is used for propane including purchase cost and GHG carbon tax.

The following table summarizes the costs associated with this measure.

Table 4-16 ECM-5: Garage Heating System Upgrade Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	8,000
Engineering (11%)	900
Commissioning and Training (7%)	450
Contingency (10%)	850
TOTAL (to the nearest thousand)	**10,000**

4.2.4 ECM-6: VEHICLE EXHAUST SYSTEM

Existing Condition

A ¾ HP exhaust fan on the South-West wall operates to exhaust vehicle fumes from the garage when necessary. This results in infiltration of air into the building from various sources like unsealed doors and windows. In cold weather this air needs to be heated resulting in increased heating energy.

Proposed Condition

Vehicle exhaust kits can be purchased and utilized on operating vehicles inside the garage to directly exhaust vehicle fumes. These systems can be tailored to a variety of different vehicle exhaust types and will limit the volume of tempered air being exhausted.

Analysis

This measure was analyzed using the end-use model generated from Carrier's HAP software as a basis. The infiltration ACH for the garage was reduced by 5% or the equivalent of 45 CFM.

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

- The wall exhaust fan ventilates 1,080 cfm and runs for 1 hour per day;
- The power consumption from the vehicle exhaust system and existing wall exhaust are equivalent. Electrical savings are from reduction in radiant tube heater fan power.

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

Table 4-17 ECM-6: Vehicle Exhaust System Annual Energy Savings

Estimated Fuel Oil Savings		Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(L)	(%)	(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
137	2.7	-	-	0.1	0.5	-	181	0.4

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

Table 4-18 ECM-6: Vehicle Exhaust System Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
1,500	181	8.3	132	1.6	9.1

This measure can eliminate a safety hazard for staff and conserves conditioned air from being ventilated outdoors when the exhaust fan runs.

The following table summarizes the costs associated with this measure.

Table 4-19 ECM-6:Vehicle Exhaust System Opinion of Probable Cost Breakdown

Item	Cost ($)
Project Cost	1,130
Engineering (11%)	140
Commissioning and Training (7%)	100
Contingency (10%)	130
TOTAL (to the nearest thousand)	**1,500**

4.3 LIGHTING

4.3.1 ECM-7: INTERIOR LED RETROFIT

Existing Condition

The lighting systems at the facility account for 7% of the total baseline electricity usage amounting to roughly 6,200 kWh/yr. It is assumed this consumption is split between interior Facility lighting and exterior building/runway lighting. The terminal offices, mechanical room and garage use fluorescent T8 lamps rated at 28 W each.

Proposed Condition

The T8 lamps could be replaced with 16 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.

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:

- Maintenance and Terminal office
- Mechanical rooms; and
- Garage

In terms of implementation, a relatively small space needs to be allocated to the occupancy sensor, as it needs to be mounted either on the wall or ceiling. The sensors would be tied into the controller to control each zone individually. Consideration will need to be given to the details of wiring the sensor to the controller. Several vendors carry occupancy sensors in their product line and they require little maintenance to maintain proper operation. As the system will be largely automated little training will be required.

Analysis

This measure was analyzed using the end-use model generated from the HAP software as a basis. The lighting wattages of the specified areas, after implementing interior lighting LED retrofit, were reduced by 10% based on the ASHRAE 90.1-2013 requirements for power adjustment percentages for automatic lighting controls. This was modified in the HAP software model to reduce the occupied time of each space, which simulated 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 T8 lamps will utilize 16 W LED lamps;
- Minimum effort required to upgrade fixture with low ceiling heights;
- Lifting and hoisting equipment rental is required for high ceiling hung lamp replacement;
- Occupancy sensors will reduce the lighting operating hours by approximately 50%; and,
- 5 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: Interior Lighting Retrofit Annual Energy Savings

Estimated Fuel Oil Savings		Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(L)	(%)	(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
(19)	(0.4)	646	1.8	0.5	2.7	12	55	0.01

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

Table 4-21 ECM-7: Interior Lighting Retrofit Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
1,500	75	N/A	(825)	<0	N/A

The measure offers savings with a poor payback of 20 years although swapping the interior conventional lighting systems in favour of LED equivalents with occupancy sensors can provide a 50-60% reduction in kWh. 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	1,200
Engineering (11%)	120
Commissioning and Training (7%)	80
Contingency (10%)	100
TOTAL (to nearest hundredth)	**1,500**

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
Infiltration Reduction	1-2 Weeks	1-2 Weeks	None	None
Window Film Retrofit	2-3 Weeks	1-2 Months	None	Low
Temperature Control Set Points	1-2 Weeks	None	None	None
Terminal Heating System Upgrade	3-4 Months	4-6 Months	Ideally Summer	High
Garage Heating System Upgrade	3-4 Months	4-6 Months	Ideally Summer	High
Vehicle Exhaust System	2-4 Weeks	2-4 Weeks	Ideally Summer	Low
Interior LED Retrofit	4-8 weeks	1-2 Months	None	Moderate
Scenario 1	4-5 Months	6-8 Months	Ideally Summer	Low – Terminal High - Garage

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.

Perimeter Baseboard Heater Maintenance

Baseboard 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. Occupants should also ensure units remain free from obstructions such as window treatments, carpet, and other items.

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

Garage Ceiling Fan Upgrade

Ceiling fans assist with air destratification by reducing the stack, or chimney effect of heat loss and also serve to distribute heated air more evenly throughout a space. It is recommended the Township of Chapleau replace the ceiling fan in the garage with a high volume low speed (HVLS) destratification fan.

Lighting Retrofit

The incandescent lamps used by the Facility for the runways are becoming obsolete and the Facility will need to switch to alternative lamp types when the stock of these lamps run out. Due to the low energy consumption of these bulbs, the business case for an LED retrofit is poor for the amount of kWh savings expected. A complete retrofit is expected to be in the range of $350,000 for material alone.

Solar Photovoltaic Panels

There exists strong potential to install solar photovoltaic (PV) panels on the surrounding ground area. A high level study was conducted using the National Renewable Energy Laboratory's (NREL) PVWatts ®

software tool to establish a preliminary estimate of the electricity production potential of a roof mounted solar PV system. The site footprint was assessed, and a ground mount installation was proposed in the field South-West of the terminal building. The assumption was made that 95% of the existing Facility electricity consumption could be offset.

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

Table 7-1 Estimated solar PV generation potential

System Type	Required Panel Space (m^2)	Estimated System Size (kW)	Array Azimuth (deg)	Array Tilt (deg)	Potential Array Output (kWh/yr)
Roof mount	130	25	180	40	33,800

Based on results from the PVWatts simulations, it is estimated, based on PV system physical and design characteristics summarized above, that 33,800 kWh could potentially be generated at the airport. It is assumed that 95% of the facility load (daytime portion) could be offset accounting for 33,360 kWh of savings against the simulated baseline year. Hardware (solar panels, inverters, racking systems, balance of system) costs and soft costs (installation labour, deposit upgrade etc.) make up the installation cost of a PV system. To inform capital cost estimates and expected ongoing operation and maintenance costs, wood applied an installed cost per watt of $2.34/W, based on market guidance and past engineering experience, along with 11% engineering fee, 7% commissioning and training and 10% contingency.

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

Table 7-2 Solar PV System Financial Analysis

Opinion of Probable Cost	Net Cost Savings	Simple payback	Net Present Value	IRR	Discounted payback
($)	($)	(years)	($)	(%)	(years)
84,000	4,137	20.3	2,081	0.2	26.2

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.

Implementation Scenario 1

The following ECMs are included in this scenario:

- ECM-1: Infiltration Reduction;
- ECM-2: Window Film Retrofit;
- ECM-3: Temperature Control Set Points;
- ECM-6: Garage Heating System Upgrade; and
- ECM-7: Interior 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 Use		Estimated Fuel Oil Savings		Estimated Electricity Savings		Estimated Demand Savings		Estimated Maintenance Savings	Estimated Total Cost Savings	Estimated GHG Reduction
(L)	(%)	(L)	(%)	(kWh)	(%)	(kW)	(%)	($)	($)	(t CO_2e)
3,517	-	5,140	100	8,584	24.4	6.6	35.5	520	5,770	9.6

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)
24,000	6,290	3.8	57,061	22.9	4.0

The scenario upgrades components and systems in major Facility end users including the building envelope, heating system and lighting system and offers a payback under five (5) years with a positive NPV and IRR.

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	18,700
Engineering (11%)	2,100
Commissioning and Training (7%)	1,200
Contingency (10%)	2,000
TOTAL (to nearest hundredth)	**24,000**

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

ECM	Measure	Opinion of Probable Cost	Estimated Savings					Estimated Total Savings	Simple Payback
			Fuel Oil	Electricity	Demand	Propane	Maintenance		
		($)	(L)	(kWh)	(kW)	(L)	($)	($)	(Years)
ECM-1	Infiltration Reduction	6,800	873 17.0%	938 2.7%	1 4.8%	-	-	1,271	5.3
ECM-2	Window Film Retrofit	3,200	-	4,602 13.1%	2 9.7%	-	-	571	5.6
ECM-3	Temperature Control Set Points	2,600	-	2,611 7.4%	1 4.8%	-	-	324	8.0
ECM-4	Terminal Heating System Upgrade	18,000	-	10,514 29.9%	5 24.7%	-	-	1,304	13.8
ECM-5	Garage Heating System Upgrade	10,000	5,140 100%	-	-	(3,517)	500	5,206	1.9
ECM-6	Vehicle Exhaust Hose	1,500	137 2.7%	-	0.1 0.5%	-	-	181	8.3
ECM-7	Interior LED Retrofit	1,500	(19) (0.4)%	646 1.8%	1 2.7%	-	20	75	20.0
Scenario 1		24,000	5,140 100%	8,584 24.4%	7 35.5%	(3,517)	520	6,290	3.8

Notes:
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 the implementation scenario. This includes the following ECMs:

Implementation Scenario 1

- ECM-1: Infiltration Reduction;
- ECM-2: Window Film Retrofit;
- ECM-3: Temperature Control Set Points;
- ECM-6: Garage Heating System Upgrade; and
- ECM-7: Interior LED Retrofit.

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

- 8,584 kWh (24.4%) of electricity savings; and
- 5,140 L (100%) of fuel oil savings.

Implementation of the scenario includes a new propane use of 3,517 L.

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 Municipal Airport located at 5th Concession Lot 11 Gallagher Township, 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 Municipal Airport located at 5th Concession Lot 11 in Gallagher Township, 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 seven (7) ECMS including one (1) fuel switch opportunity. Wood has presented a strategic implementation scenario for the measures recommended in this assessment report. The scenario is estimated to reduce site electricity use by 24.4%, swap 5,140 L of fuel oil usage with 3,517 L of propane and provide an overall cost savings relative to the baseline year of $6,290.

Additional recommendations include the following building management and behavioral opportunities:

- Recommissioning;
- Perimeter baseboard 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 Municipal Airport 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	0.18	$/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	Qty	Phase	Voltage	Amps	HP	Demand (kW)
Base Board Heater	Terminal	Westcan Electrical	N/A	2	1	240			1.75
Base Board Heater	Terminal Washroom	N/A	N/A	1	1	240			0.5
Base Board Heater	Terminal Office	N/A	N/A	1	1	240			2
Base Board Heater	Supers Office	N/A	N/A	1	1	240			2
Base Board Heater	Supers Office	N/A	MK-IV-3473	1	1	240			1
Base Board Heater	Mech/Storage Rm	N/A	MK-IV-3473	1	1	240			2
Exhaust	Washroom	N/A	N/A	1	1	120	0.2		0.024
Exhaust	Garage	N/A	N/A	1	1	120		0.75	0.56
Ceiling Fans	Garage	N/A	N/A	1	1	120	0.6		0.072
Hot Water Heater	Office Closet	Cascade 40	152A	1	1	240			3
Well Pump		N/A	N/A	1	1	120		0.25	0.19
Oil Furnace	Garage	Inner-City Products Corp	LHO5230BLAA	1	1	115	16		1.84
Oil Furnace Blower Fan Motor	Garage	GE Motor	5KC46LNO254X	1	1	115	13.2	0.75	0.56
Oil Pump	Garage	Suntec	A2VA-7116	1	1	115		0.167	0.12

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	Qty	Fixture Housing	Fluorescent Lamp Type	Lamps	Lamp Length (ft)	Lamp Watts	Ballast	Fixture Watts	Total Watts
Super Office	2	Surf, 1x4	T8, Super lamp	2	4	28	Electronic	48	96
Mech Room	1	Surf, 1x4	T8, Super lamp	2	4	28	Electronic	48	48
Terminal Office	2	Surf, 1x4	T8, Super lamp	2	4	28	Electronic	48	96
Garage	6	Susp, linear	T8, Super lamp	2	4	28	Electronic	48	288
Garage Storage	2	Surf, 1x4	T8, Super lamp	2	4	28	Electronic	48	96

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

Space	Qty	Fixture Housing	Fixture Type	Lamps #	Lamp Watts	Total Watts
Terminal	7	Surf, linear	LED	1	24	168
Terminal	1	Surf, linear	LED	1	24	24
Terminal	1	Surf, panel	LED	1	12	12
Terminal Exterior	1	Surf, sconce	LED	1	19	19
Garage Exterior	2	Surf, sconce	LED	1	18.5	37
30W Airport Lamp	60	Ground Mount	Incandescent	1	30	1800
40W Airport Lamp	53	Ground Mount	Incandescent	1	40	2120
Philips Tubular Navigation Lamp	24	Ground Mount	Navigation Lamp	1	100	2400
Runway VASI Landing Lights	16	Ground Mount	Halogen Incandescent	4	200	12800

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.

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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)	Propane Consumption (L)
Jan-2018	31	4,800	1,336.7
Feb-2018	28	4,400	1,294.6
Mar-2018	31	3,600	338.5
Apr-2018	30	2,560	437.1
May-2018	31	573	0
Jun-2018	30	573	0
Jul-2018	31	573	0
Aug-2018	31	1,840	0
Sep-2018	30	1,840	0
Oct-2018	31	4,640	628.5
Nov-2018	30	3,280	265.6
Dec-2018	31	5,360	762.3
Jan-2019	31	7,440	1,620.4
Feb-2019	28	5,700	1,582.7
Mar-2019	31	2,220	741.6
Apr-2019	30	3,000	327.1
May-2019	31	1,440	0
Jun-2019	30	1,560	0
Jul-2019	31	660	0
Aug-2019	31	1,080	0
Sep-2019	30	1,440	0
Oct-2019	31	2,520	303.1
Nov-2019	30	2,280	159.5
Dec-2019	31	4,440	376.7