Submission to

Peace River Regional District

Energy Audit Report for the Moberly Lake Fire Hall

Version: Draft

August 25, 2021

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Executive Summary

Peace River Regional District retained FCAPX a Division of Roth IAMS Ltd (FCAPX) to complete an energy assessment (EA) of the Moberly Lake Firehall, which is located at 6492 Lakeshore Dr, Moberly Lake, BC V0C 1X0. The goal of the EA is to analyze the current energy performance of the facility and provide a list of potential energy conservation measures (ECMs) complete with relevant implementation costs with the aim of reducing energy consumption. The site visit for the energy assessment was conducted on June 17, 2021.

The EA involved a review of the buildings, which form the subject facility. The facility was constructed in parts with the original apparatus hall constructed in 1983 and measuring approximately 110m^2, followed by an addition in 1991 measuring approximately 300m^2. The total floor area of the facility is approximately 410 m^2 (4,411 ft^2). The current annual utility consumption for this facility is approximately 16,849 kWh of electricity and 133 GJ of propane. This equates to an annual greenhouse gas (GHG) emissions of 9.1 Tonnes CO2e per year. The EA revealed the potential for the implementation of energy management measures, which will improve the overall efficiency of the facility.

An analysis of the existing energy consumption profile of the facility was undertaken, and the calculated Energy Utilization Index (EUI) was compared against similar buildings to determine the performance of the facility. The calculated EUI for the firehall is 0.47 GJ/m2. which is significantly lower than 1.04 GJ/m2, the overall EUI for similar buildings under the British Columbia Other Services Secondary Energy Use and GHG Emissions by End-Use 2012-2018.

The table on the following page summarizes potential ECMs that were identified for the Firehall. It is recommended that, prior to implementation, PRRD carefully review the potential ECMs.

By implementing the ECMs listed in Table 1, a potential annual savings of 22 GJ of Propane, and 1,517kWh of electricity may be achieved.

The anticipated GHG savings, based upon emission factors appropriate for British Columbia, with the implementation of all the proposed ECMs, is estimated to be 1.14 Tonnes CO2e/year, which is equivalent to a 12.5% reduction overall.

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

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Table 1
Summary of Potential Energy Conservation Measures - Moberly Lake Fire Hall

Propane	$ 19.850	per GJ
Fuel Oil	$ -	per L
Electricity	$ 0.142	per kWh
Carbon Tax	$ 45.00	per CO2 eq tonne

Province	British Columbia
Escalation Rate (Energy)	0%
Discount Rate	7%

		Utility Savings			Emissions Savings				Financial Analysis					
Measure Number	**Description**	**Natural Gas (GJ)**	**Electricity (kWh)**	**Total ($)**	**Electricity (CO2 eq tonnes/yr)**	**Natural Gas (CO2 eq tonnes/yr)**	**Total (CO2 eq tonnes/yr)**	**Total Savings ($)**	**Total Project Cost ($)**	**SPB[1] (Years)**	**Effective Measure Life (Years)**	**Net Present Value ($)**	**Internal Rate of Return (%)**	**Discounted Payback DPB (Years)**
ECM-1	High Efficiency LPG (Propane) DHW Heater	- 5	1,517	$ 122	0.02	- 0.24	- 0.22	$ 113	$ 4,500	40.0	15	-$ 3,475	-10.32%	N/A
ECM-2	Replace furnace with high efficiency condensing Furnace	13		$ 258	-	0.65	0.65	$ 287	$ 7,500	26.1	25	-$ 4,150	-0.33%	N/A
ECM-3	Night set back for Administration offices	11		$ 218	-	0.55	0.55	$ 243	$ 750	3.1	25	$ 2,084	32.40%	3.6
ECM-4	Replace radiant tube heaters with high efficiency heaters	3		$ 60	-	0.15	0.15	$ 66	$ 8,000	120.6	25	-$ 7,227	-9.65%	N/A
	Recommended Measure Bundle	**22**	**1,517**	**$ 658**	**0.02**	**1.12**	**1.14**	**$ 710**	**$ 20,750.00**	**29.24**	**22.8**	-$ 12,900.95	**-2.35%**	N/A

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1 INTRODUCTION

1.1 PURPOSE AND OBJECTIVE

Peace River Regional District retained Roth IAMS Ltd to conduct an energy assessment of the Moberly Lake Firehall, located at 6492 Lakeshore Dr, Moberly Lake, BC V0C 1X0. The purpose for the energy audit was to assist Peace River Regional District in identifying ways to reduce their energy consumption as part of their municipal energy management and GHG reduction plan.

The scope of this study was to analyze the current energy performance of the subject building, provide a list of potential energy conservation measures (ECMs) complete with relevant implementation costs, and simple payback.

The site visit for the EA was conducted on June 17, 2021.

The report has taken into consideration past retrofit work and future capital maintenance requirements in the development of energy conservation measures to ensure an effective and viable energy audit report. Our assessment involved a review of the approximately 410m² (4,411ft²) facility and revealed the potential for the implementation of energy management measures, which would improve the overall efficiency.

1.2 SCOPE OF WORK

The detailed energy consumption assessment consisted of an on-site facility assessment, a utility analysis, and a review and analysis for potential Energy Conservation Measures (ECMs).

The energy assessment report is organized as follows:

- Facility description;
- Utility analysis and benchmarking;
- Energy conservation measures; and,
- Conclusions and recommendations.

The following documents were provided by Peace River Regional District to Roth IAMS for consideration.

- Utility records;
- Maintenance records;
- Previously completed assessment reports (energy, and condition assessments); and,
- Facility drawings and floor layouts.

1.3 Background

Through the energy audit, Peace River Regional District plans to review options to reduce electricity and gas consumption, especially with the ongoing renewal/replacement of systems, some of which are either at or near the end of expected useful life. The findings will be used as part of the overall energy management plan to achieve a reduction in greenhouse gas (GHG) emissions.

The Peace River Regional District, Charlie Lake Firehall was constructed in two phases. The original building was constructed in 1977, and the addition was added in 1987.

The EA subject facility generally includes all areas of the building including Administration offices, lunchroom, washrooms, and vehicle bay. The gross floor area of the facility is approximately 410m² (4,411ft²).

1.4 Key Client Information Summary

Table 2: Key Client Information Summary

Customer Name	PRRD – Moberly Lake Firehall
Site Address	6492 Lakeshore Dr, Moberly Lake, BC V0C 1X0
Contact Person	Trish Morgan
Contact Information	250-784-3600
	Trish.morgan@prrd.bc.ca

1.5 Acknowledgements

Roth IAMS would like to acknowledge the contribution of the following individuals whose help was invaluable in completing this assignment.

- Trish Morgan – Peace River Regional District

1.6 Definitions and Abbreviations

Definitions of key terms and abbreviations can be found in **Appendix A**.

1.7 Energy Assessment Team

The following individuals represented the energy assessment team.

- Curtis Loblick, P.Eng., CEM
- Tim Hobson, M.Sc. Tech., CEM
- Inder Gerwal, Facility Assessor

1.8 Assessment Methodology

1.8.1 Utility Analysis

An analysis of the utility 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 each utility meter can also be examined to identify issues that are affecting the energy performance of the site.

1.8.2 Documentation Review

One of the first steps is to review any available existing documentation. This includes drawings, operation and maintenance manuals, control sequences and previous reports. This helps to understand the current state of the facility.

1.8.3 Site Visits

The site visit includes a detailed interview with technical staff regarding the building's function as well as discussing any issues that were persistent and opportunities for operational optimization. A comprehensive tour of the site is conducted to gather current information and evaluate the Building Envelope, Mechanical and Electrical systems. The following three sections speak specifically to these areas.

1.8.4 Building Envelope System Assessment

The envelope and architectural assessment involve 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.

1.8.5 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. The sequence of operations will be examined for improvement opportunities.

1.8.6 Electrical System Assessment

A comprehensive assessment of the site's lighting includes a detailed review of the existing fixtures, lighting levels 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.

1.8.7 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;
- The condition of existing systems;
- The 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 the best estimate of the anticipated reductions taking into consideration direct savings from electrical and gas consumption and electrical demand where appropriate. The savings for most of the recommendations were calculated through simple standard energy savings calculations and spreadsheets.

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

1.8.8 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).

2 FACILITY DESCRIPTION

The following sections summarize observations made during the site investigation.

2.1 OVERVIEW

The Moberly Lake Firehall is located at 6492 Lakeshore Dr, Moberly Lake, BC V0C 1X0. Construction years and the total area of the facility have been estimated based on the data provided by the client. The facility was constructed in parts with the original apparatus hall constructed in 1983 and measuring approximately 110m^2, followed by an addition in 1991 measuring approximately 300m^2, for a total floor area of 410m^2 (4,411ft^2). The facility includes vehicle bay, an administration area, two washrooms, and an upstairs lunchroom.

Table 3: Charlie Lake Firehall Salient Features

Asset Name	Year Built	Floor Area (square meters)	Floor Area (square footage)	Building Usage
Firehall	1983	110	1,183	Vehicle Bay.
Addition	1991	300	3,228	Administration area, two washrooms, and an upstairs lunchroom
Total		**410**	**4,411**	

Figure 1 is a schematic map showing the location and relative size of the different uses in the building.

2.2 OWNER-SUPPLIED REFERENCE MATERIAL

In this report, reference is made to information that has been either collected on site, reported by operations staff and occupants, or through available documents. The reported condition pertains to information provided by the building's operations and maintenance personnel or tenants.

Documents available for review included:

- Utility records including Electricity (Jan 2020 – Feb 2021) and Propane (Jan 2020 – Mar 2021).

2.3 BUILDING ENVELOPE

The building is conventional wood framing with a pitched, wood roof clad in metal roofing resting atop a concrete slab-on-grade. Painted metal siding is provided on all exterior elevations. Metal exterior doors are provided at entrances and exits.

View of the building

2.4 MECHANICAL SYSTEMS

Following is a description of the mechanical systems and components that were identified during the assessment. Mechanical equipment is located in mechanical rooms.

2.4.1 Domestic Hot Water Systems

There is an electric domestic water heater installed in the mechanical room. It is manufactured by GSW (Model: 6ET175PS) and has a tank capacity of 175 litres. The heating input rating is 3000 Watts.

There is a domestic water pump installed in the mechanical room to pull water from the exterior buried domestic water tank. The pump is rated at $^1/_2$ HP and is manufactured by Diamond.

Electric DHW heater

Domestic water booster pump

2.4.2 Heating Systems

There is a propane propane-fired forced-air furnace installed to provide heating and ventilation to the lunchroom. It is manufactured by American Standard (Model: AUD060C924H3) and has a heating input rating of 60 MBH. A simple adjustable wall mounted thermostat provides control of the furnace which is set at 20°C.

There are two (2) propane propane-fired radiant tube heaters installed in the vehicle bays. Technical specifications were not available but estimated to be approximately 80 MBH each.

There are two (2) suspended electric unit heaters installed in the 1983 vehicle bay. The ratings were unknown but estimated to be approximately 10 kW each.

The administration area and the washrooms are provided with electric baseboard heaters. The ratings were unknown

Main heating boiler

Propane fired radiant tube heater

Suspended electric unit heater in the Vehicle Bay

Typical electric baseboard heater in the washrooms

2.4.3 Ventilation Systems

Ceiling-mounted exhaust fans are installed in the washrooms to serve as ventilation for these spaces. The fans are all residential style of fractional HP

View of ceiling mounted bathroom exhaust fan

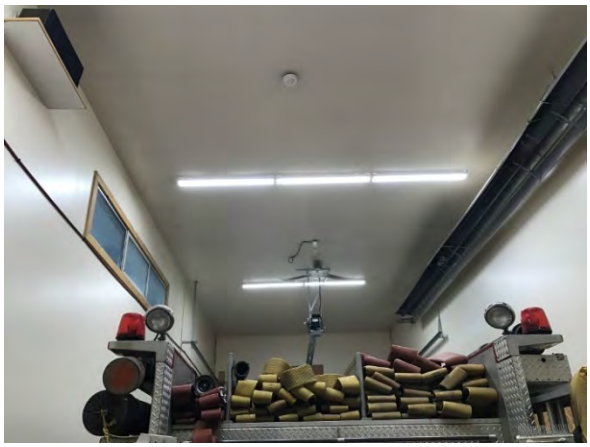
2.5 Electrical Systems

2.5.1 Lighting Systems

Interior lighting is primarily provided via ceiling-mounted LED fixtures. Lighting in the washrooms and stairwell is provided via incandescent fixtures. There is a 4-lamp halogen fixture installed in the kitchenette in the lunchroom. All lighting is controlled by wall mounted switches.

There are wall-mounted combination exit and emergency lighting battery packs installed over exits to direct and illuminate the path of emergency egress.

Exterior lighting is primarily provided via wall-mounted LED fixtures. There are incandescent fixtures installed on the north and south elevations.



Fluorescent T8 Lighting in the facility

Newer LED lighting in the Apparatus Room

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2.5.2 Other Systems

A breathing air generator is installed in the vehicle bay. The compressor rating was unknown but based on the unit installed at the Charlie Lake firehall, is estimated to provide 7.5cfm and equipped with a 7.5HP motor and provides breathing air for the portable tanks.

Breathing air generator

3 UTILITY ANALYSIS AND BENCHMARKING

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

The utility analysis of the facility provides a good starting point from which to identify potential energy conservation opportunities. Billing data was gathered in order to generate the facility utility baseline. The baseline represents a correlation between the weather-corrected utility consumption and the actual recorded data. This baseline provides an illustration of how effective the existing equipment and systems are operating in comparison to changes in the weather. The potential for improved operation relative to the facility baseline presents an indication of the opportunity for utility savings. In creating a baseline, the utility consumption is compared to Heating Degree Days (HDD) and Cooling Degree Days (CDD). By examining this graphically we can see how closely the energy consumption relates to changes in the weather. The result is the development of energy and cost indices, which are then compared with the Office of Energy Efficiency (OEE) and Energy Star benchmarks, to assess the facility's performance against similar buildings.

3.1 CURRENT UTILITY CONSUMPTION

Moberly Lake Firehall electricity and propane consumption data used in the analysis was provided by PRRD. According to information provided, there are two (2) electricity meters for the facility. Propane is delivered by tanker and only deliveries are recorded. As actual monthly use of propane gas is not provided it has not been possible to accurately analyse fuel consumption throughout the year.

The following table summarizes the utility (electricity and propane) consumption data from the most recent year of utility data provided.

Summary of Utility Data January 2020 to December 2020

Table 4: Summary of Utility Data

Year	Electricity		Natural Gas		Total	
	Consumption (kWh)	Cost ($)	Consumption (GJ)	Cost ($)	EUI (GJ/m2)	Cost Index ($/m2)
2020	16,849	$2,395	133	$2,632	0.47	$12.26

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3.2 Utility Price Structure

In terms of savings related to the identified measures, a blended rate, which effectively assumes that a reduction in consumption will reduce the cost by the rate that applies to the last unit of energy, was used. The blended rates include all components of the bill including energy, transmission, delivery, capacity, and line losses. However, taxes are excluded. These rates are listed in the table below.

Table 5: Summary of Blended Rates		
Electricity	**Demand**	**Natural Gas**
Rate ($/kWh)	**Rate ($/kW)**	**Rate ($/GJ)**
$0.1422	-	$19.85

3.3 Electricity

Electricity data was reviewed for the most recent 12 months (we typically analyse 36 months but only 12 months was available). The electricity utility data were analyzed and plotted to illustrate trends and identify any irregularities. It should be noted that electricity is billed bi-monthly, so it was not possible to split usage on a monthly basis

The figure below illustrates the electrical consumption data for the facility.

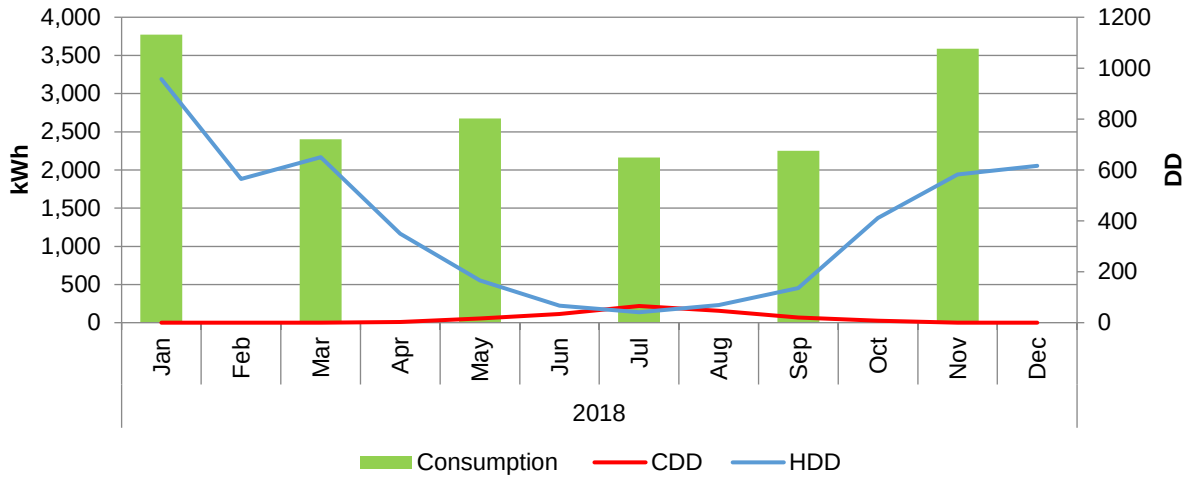

Figure 2: Electrical Consumption Trend for Moberly Lake Firehall

Based on the analysis, there is an increase in electricity consumption during the winter months (from October through March). The electricity consumption increase may be attributed to a number of factors including increased operational hours of the lighting, and the operation of the electric heating, furnace, and radiant tube fans.

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Year-round systems, which are building baseload electrical consumers, include the electric domestic hot water heater, building exhaust fans systems, the breathing air compressor, as well as building plug loads, such as computers and small appliances.

3.4 Fossil Fuels

As there is no means of metering the amount of propane consumed each month in the facility it has not been possible to analyse the correlation of fossil fuel use for heating with degree days.

3.5 Annual Energy Consumption Breakdown by Type

The combined electricity and propane energy consumption figures have been converted to common units of energy to be able to compare the total amount of energy from each source at this facility. Propane consumption has been estimated based on the results ofthe energy model.

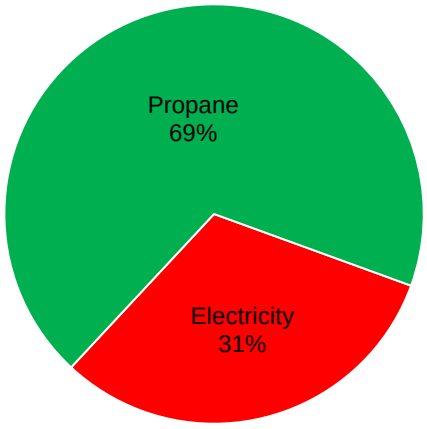


Figure 3: Annual Energy Consumption by Fuel Type

Based on the previous figure, propane accounts for 69% of all energy consumed while electricity accounts for the other 31% of energy consumed. If we look at the cost of energy and compare the two, we can see a different story in the figure below.

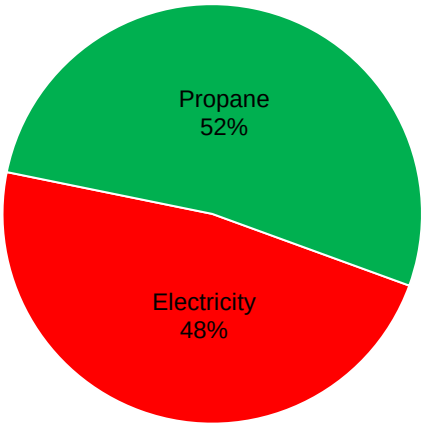


Figure 4: Annual Energy Cost by Fuel Type

Based on the figure above, propane accounts for 52% of all energy costs while electricity accounts for the other 48% of energy costs. Although Propane makes up 69% of the energy consumption it only accounts for only 53% of the energy cost.

Another way to look at the utility consumption is by greenhouse propane emissions breakdown.

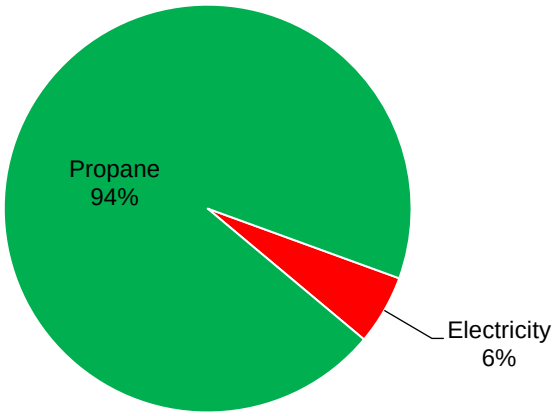


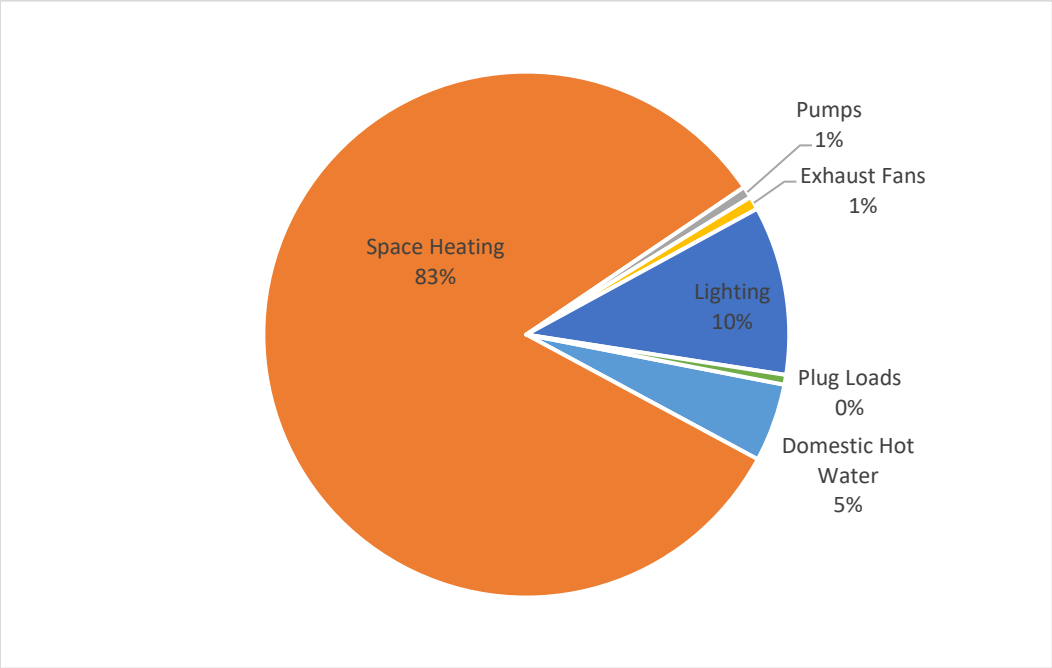
Figure 5: Annual Greenhouse Propane Emission by Fuel Type

Based on the figure above, greenhouse propane emissions from propane accounts for 94% of all greenhouse propane emissions while greenhouse propane emissions from electricity account for the other 6% of greenhouse propane emissions. This is the opposite of the energy costs. It indicates a reduction in propane consumption will have a large impact on greenhouse propane consumption and however only result in small cost savings.

3.6 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 (also refer to the table, below) in this analysis include:

- Domestic Hot Water
- Space Heating
- Pumps
- Exhaust Fans
- Lighting – All interior and exterior lighting.
- Other and Plug Loads



- Figure 6: Annual Energy Consumption by End-Use

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The following table summarizes that annual energy breakdown by major end-use in absolute energy consumption, as a percentage of the total energy consumed, and as an absolute cost.

Table 6: Annual Energy Consumption by Major End-Use

Energy Type	LPG (GJ)	Electricity (kWh)	Equivalent Energy (ekWh)	% Energy
Domestic Hot Water	0	2,628	2,628	5%
Space Heating	136	7,360	45,153	83%
Pumps	0	395	395	1%
Exhaust Fans	0	443	443	1%
Lighting	0	5,680	5,680	10%
Plug Loads	*0*	*101*	*101*	*1%*
Other Loads	0	224	224	0%
Total	**136**	**16,831**	**54,614**	**100%**

Another way of looking at the same information is to consider the cost breakdown in the figure below. This shows the space heating (including electric) and lighting are the largest contributors to the facilities energy costs.

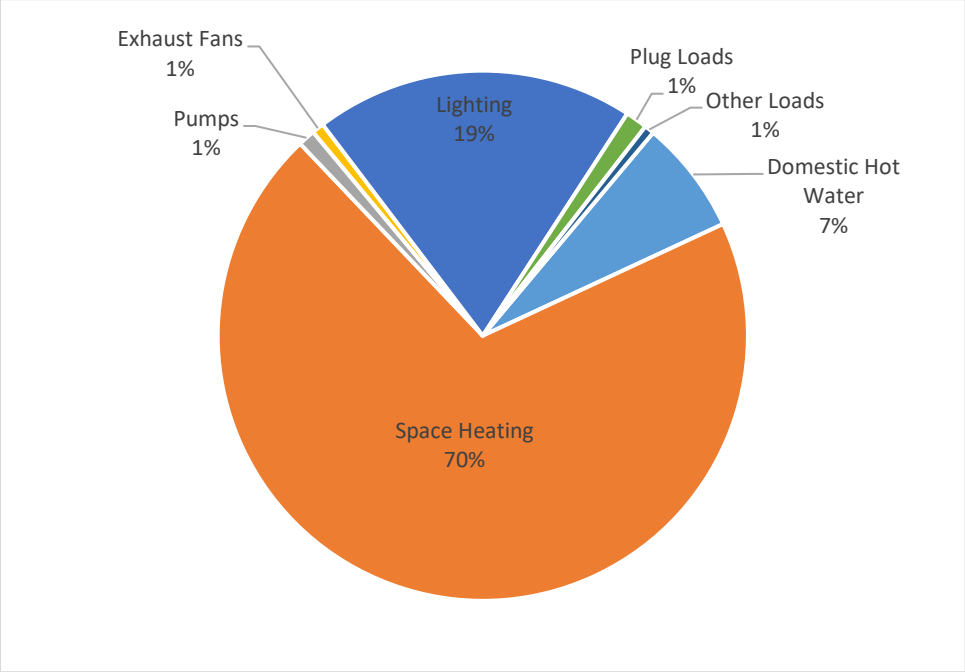

Figure 7: Annual Energy Cost by End-Use

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3.7 Energy Performance Benchmarking

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. The table below compares the EUI at this facility to the Office of Energy Efficiency (OEE) benchmarks to assess the facility's energy performance against similar buildings. Based on the limited categories the closest category was determined to be Commercial/Institutional Sector – British Columbia – Other Services.

Table 7: EUI Comparisons

Calculated in Utility Analysis *GJ/m²*	OEE *GJ/m²*
0.47	1.04

(Source: *Natural Resources Canada, Commercial and Institutional Consumption of Energy Survey 2018.*

Commercial/Institutional Sector British Columbia and Territories[1] Table 22: Other Services Secondary Energy Use and GHG Emissions by Energy Source | Natural Resources Canada (nrcan.gc.ca)

The data available from the OEE (NRCan) is for Energy intensity benchmarks for the commercial and institutional sector (Other Services in British Columbia). This data is an average and includes similar facilities as the Moberly Lake Firehall. The category chosen was the closest to the classification of the facility. The benchmark indicates that Moberly Lake Firehall Energy Use Intensity (EUI) is much lower than the benchmark for the similar facilities.

4 ASSESSMENT FINDINGS

This section provides an overview of the energy conservation measures (ECMs) analyzed in this report. A series of ECMs were reviewed. For each measure, estimates of the annual savings in each of the following were determined:

- Electricity consumption;
- Natural Gas consumption;
- Total energy cost; and
- GHG emissions.

The following ECMs were reviewed for the Firehall:

Table 8: Charlie Lake Firehall ECMs

ECM	Description
ECM-1	Replace electric DHW heater with tankless LPG (propane) heater
ECM-2	Replace LPG furnace with high efficiency furnace
ECM-3	Set back temperature of Administration offices
ECM-4	Replace radiant tube heaters with new high efficiency units

4.1 ECM-1: NEW LPG FIRED HIGH EFFICIENCY DHW HEATER

4.1.1 Existing Condition

The existing domestic hot water heater has surpassed its expected useful life and requires replacement. The heater uses electricity, which is significantly more expensive than LPG, and also there will be significant standing losses, despite the tank being insulated and it has very little use. The cost of LPG is $19.79/GJ and electricity when converted to GJ is $39.50/GJ.

4.1.2 Proposed Conditions

It is recommended that the domestic hot water heater is replaced with a high efficiency near condensing propane fired heater, with an expected efficiency of 88%. This will eliminate standing losses and will benefit from the less expensive fuel source.

4.1.3 Analysis

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

Table 9: ECM-1 –Energy Savings			
Natural Gas Savings (GJ)	Electricity Savings (kWh)	GHG Reduction (Tonnes CO_2e)	Total Cost Savings ($)
-4.7	1517	-0.22	$113

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

Table 10: ECM-1 –Financial Analysis					
Cost Savings ($)	Project Implementation Cost ($)	Simple Payback (Years)	Net Present Value ($)	Internal Rate of Return (%)	Discounted Payback (Years)
$113	$4,500	40	-$3,475	-10.32%	N/A

4.2 ECM-2: Install New High Efficiency Condensing Furnace

4.2.1 Existing Condition

The existing LPG fired furnace has surpassed its expected useful life and should be replaced. The furnace has a current rated efficiency of 80%, although based on age it is likely less efficient.

4.2.2 Proposed Condition

It is recommended that the furnace is replaced with a high efficiency condensing furnace with an expected efficiency of 98%. This will increase the overall efficiency by up to 23%.

4.2.3 Analysis

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

Table 11: ECM-2 Energy Savings			
Natural Gas (GJ)	Electricity Savings (kWh)	GHG Reduction (Tonnes CO_2e)	Total Cost Savings ($)
13	0	0.65	$287

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

Table 12: ECM-2 – Financial Analysis					
Cost Savings ($)	Project Implementation Cost ($)	Simple Payback (Years)	Net Present Value ($)	Internal Rate of Return (%)	Discounted Payback (Years)
$287	$7,500	26.1	-$4,159	-0.33%	N/A

4.3 ECM-3: Night Set Back of Heating

4.3.1 Existing Condition

The existing LPG fired furnace is controlled by an adjustable wall mounted thermostat that is currently set to maintain a space temperature of 20°C throughout the year.

4.3.2 Proposed Condition

It is recommended that the thermostat is replaced with a programmable thermostat and that the temperature is set back continuously to 16oC. As the fire hall is manned for only approximately 8 hours per month the thermostat should have an override switch that can be activated by the occupants to boost the heat to the desired level for a 2 hour period.

4.3.3 Analysis

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

Table 13: ECM-3 Energy Savings			
Natural Gas (GJ)	Electricity Savings (kWh)	GHG Reduction (Tonnes CO_2e)	Total Cost Savings ($)
11	0	0.55	$243

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

Table 14: ECM-3 – Financial Analysis					
Cost Savings ($)	Project Implementation Cost ($)	Simple Payback (Years)	Net Present Value ($)	Internal Rate of Return (%)	Discounted Payback (Years)
$243	$750	3.1	$2,084	32.40%	3.6

4.4 ECM-4: Replace Radiant Tube Heaters with High Efficiency Heaters

4.4.1 Existing Condition

The existing LPG fired radiant tube heaters in the vehicle bay has passes their expected useful life and should be replaced.

4.4.2 Proposed Condition

It is recommended that the radiant tube heaters are replaced with new high efficiency radiant tube heaters complete with back reflectors.

4.4.3 Analysis

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

Table 15: ECM-2 Energy Savings			
Propane (GJ)	Electricity Savings (kWh)	GHG Reduction (Tonnes CO_2e)	Total Cost Savings ($)
3	0	0.15	$66

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

Table 16: ECM-2 – Financial Analysis					
Cost Savings ($)	Project Implementation Cost ($)	Simple Payback (Years)	Net Present Value ($)	Internal Rate of Return (%)	Discounted Payback (Years)
$66	$8,000	121	-$7,227	-9.65%	NA

5 OTHER OPPORTUNITIES CONSIDERED

The following section discusses energy saving opportunities that were considered and recommended for further analysis and possible implementation.

5.1 SOLAR PHOTOVOLTAIC GENERATION SYSTEM

The proposed alternative energy initiative involves the possibility of installing a solar array power generation system at the Firehall to complement the current solar collectors for DHW heating.

The cost of installing solar PV systems has declined steadily over the last decade as a result of technology improvements and more efficient systems yielding a higher power output. In B.C., a 1 kW solar PV system, south facing and tilted with no shading, will generate about 1,000 kWh per year or about 25,000 kWh over its 25-year lifetime. This is taking into account an industry average solar panel efficiency degradation rate of 0.5% per year. At a turnkey installation cost of about $3,500, per panel, it would take over 25 years to recoup your investment at today's average electricity rates.

In addition to the long payback there are other considerations to take into account. Which include the current load bearing capacity of the selected roof, the orientation of the roof, and the age of the roof (once the PV panels are installed it becomes more costly to replace the roof). Taking into consideration the long payback for solar panels, and the complications introduced by the physical characteristics of the roof, it was considered not economic or practical to pursue this option.

5.2 IMPROVE BUILDING ENVELOPE CONDITIONS

Other than simple weatherstripping measures for doors, building envelope modifications such as improved insulation, become very expensive and would typically only be considered if there were any significant deficiencies in the envelop. This would be evident from a high heating load in the building and based on the findings of the building energy index, no such deficiencies appear to be prevalent. As such any building envelope upgrades were not considered for this study.

6 CONCLUSIONS AND RECOMMENDATIONS

Several ECMs were identified during the detailed energy assessment. Table 15 summarizes the combined recommended ECMs along with estimated costs, savings and simple payback. A more detailed summary is included in **Appendix B**.

Measure	Implementation Cost ($)	Table 15: Estimated Savings			Total Savings ($)	Simple Payback (Years)
		Electricity(kWh)	Natural Gas (GJ)	GHG Emissions (CO2 eq)		
ECM-1	$4,500	1,517	-4.7	-0.22	$113	40
ECM-2	$7,500	-	13	0.65	$287	26.1
ECM-3	$750	-	11	0.55	$243	3.1
ECM-4	$8,000	-	3	0.15	$66	120.6
Bundle	**$20,750**	**1,517**	**22**	**1.14**	**$710**	**29.2**

A more detailed summary is included in **Appendix B**.

Based on the fact that some of the equipment has reached the end of its useful life the energy efficiency and conservation measures were selected to replace the existing technology with high efficiency alternatives. Although the paybacks are fairly long, Roth IAMS recommends that the Firehall proceeds with all of the measures identified.

7 Implementation Plan and M&V

7.1 Implementation Plan

Implementation of the measures identified in this assessment will assist the Peace River Regional District – Moberly Lake Firehall to reduce risks associated with utility market volatility and unplanned capital maintenance expenditures. It is recommended that the measures which are the simplest and have the least interruption to the occupants be implemented first. The information below has been provided to assist with the planning for implementation.

Table 20: Chetwynd Recreation Centre

ECM/Scenario	Design Period	Construction Period	Seasonal Requirements	Disruption
ECM-1	0	2 Days	Install before winter sets in.	Minimal.
ECM-2	0	2 Days	Can install same time as DHW heater.	Minimal.
ECM-3	0	1 day	To be completed when new furnace installed.	None.
ECM-4	0	2 Days	Coordinate with replacement of furnace.	Will require fire trucks to be moved outside

7.2 Measure and Verification

Once the recommendations have been implemented it is recommended the facilities utility consumption be monitored to identify the actual savings that are a result of these changes.

This is relatively straight forward for electricity as it is billed on a monthly basis. However, for LPG (Propane) it would be very difficult to monitor as there are no consumption records, only deliveries.

8 EMISSIONS SAVING SUMMARY

8.1 EMISSION REDUCTION

The Canadian government is creating emission reduction targets that will determine the path of all business in Canada for the foreseeable future. An emissions reduction plan for Greenhouse Gas (GHG) emissions is the first step in achieving a reduced impact on the environment.

The Energy Savings measures proposed for the facility will have an immediate and positive effect on our local and global environment. The immediate impact on our local environment will follow as a reduction in demand offsets power generation from the local power stations and a reduction in natural gas consumption.

Greenhouse gases are primarily comprised of Carbon Dioxide (CO2), Methane (CH4), Nitrous Oxide (N2O), Sulphur Hexafluoride (SF6), Perfluorocarbons (PFCs), and Hydrofluorocarbons (HFCs). CO2 is the primary component and typically makes up about making up over 99% of the greenhouse gases produced. As a result, greenhouse gases are typically measured in terms of kilograms or tonnes of equivalent carbon dioxide (CO2e). Emission factors used for calculating the combustion of natural gas and power generation in British Columbia are 51 kg of CO2e/GJ and 12 kg of CO2e/kWh respectively.

The sites total current annual equivalent carbon dioxide emissions (CO2e) are 9.1 Tonnes CO2e/year. This results in a current greenhouse gas intensity of 0.016 Tonnes CO2e/m^2. Based on the proposed bundle of ECMs the greenhouse gas savings are estimated to be 1.14 Tonnes of CO2e/year which represents approximately 12.5 percent greenhouse gas emission reduction.

9 STUDY LIMITATIONS

This report was prepared by Roth IAMS for Peace River Regional District. The material in it reflects our professional judgment considering the following:

- Our interpretation of the objective and scope of works during the study period;
- Information available to us at the time of preparation;
- Third party use of this report, without written permission from Roth IAMS, is the responsibility of such third party;
- Measures identified in this report are subject to the professional engineering design process before being implemented.

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

Any third-party use of this report, or any reliance on decisions to be made, is subject to interpretation. Roth IAMS accepts no responsibility or damages, if any, suffered by any third party because of decisions made or actions based on this report.

10 CLOSURE

Based upon the information referenced herein, this report has been prepared exclusively for the Client – Peace River Regional District. It has been prepared in a manner consistent with good engineering judgement. Should new information come to light, RothIams Ltd. requests the opportunity to review this information, and our conclusions contained in this report. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, will be the responsibility of such third parties.

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APPENDIX A

DEFINITIONS AND ABBREVIATIONS

Project No. 21075

The following definitions and abbreviations should be considered during the review of this energy and water assessment report:

- **Average Person** – An average person can be defined as a typical person within our society. The average person was used in the reports to describe the behaviour or a typical person in society in the context of their consumption patterns for water.
- **Average Resident** – An average resident can be defined as a resident of the assessed facility as observed by the facility assessors and via an interview with the facility managers.
- **Building Automation System (BAS) –** a distributed control system that is a computerized, intelligent network of electronic devices designed to monitor and control the mechanical, electronics, and lighting systems in a building. BAS core functionality keeps the building climate within a specified range, provides lighting based on an occupancy schedule, and monitors system performance and device failures and provides email and/or text notifications to building engineering/maintenance staff. The BAS functionality reduces building energy and maintenance costs when compared to a non-controlled building. A building controlled by a BAS is often referred to as an intelligent building. *Alternate term:* ***Building Management System (BMS).***
- **Capital Cost** – Capital Costs identified in this report include costs including the following phases of work: design, equipment and materials, construction/installation, project management, construction administration and commissioning.
- **Cooling Degree Days (CDD)** – Cooling Degree Days is a measure of how hot a location was over a period, relative to a base temperature. The base temperature is 18.0°C and the period is one year. If the daily average temperature exceeds the base temperature, the number of cooling degree-days for that day is the difference between the two temperatures. However, if the daily average is equal to or less than the base temperature, the number of cooling degree-days for that day is zero.
- **Discounted Payback** – Discounted Payback is the time required to recover the present value of cash flows equal to the cost of investment. Simple payback period does not take into account the principles of time value of money.
- **Energy Conservation Measure (ECM)** – any type of project conducted, or technology implemented to reduce the consumption of energy in a building. These can come in a variety of forms: water, electricity and gas being the main three for industrial and commercial enterprises. The aim of an ECM should be to achieve a saving, reducing the amount of energy used by a particular process, technology or facility. Alternative terms: **Energy Efficiency Measure (EEM)**, **Energy Management Opportunity (EMO)**, or **Facility Improvement Measure (FIM)**.
- **Energy Utilization Index (EUI)** – Energy Utilization Index is a normalized comparison of the energy performance of facility where the normalizing factor is floor area. The units for the EUI are ekWh/m^2 or GJ/m^2.

- **Equivalent Kilowatt Hour (ekWh)** – An equivalent kilowatt-hour is the equivalent energy content of natural gas in terms of kilowatt hours for use in facility benchmarking (requiring common energy units).
- **Greenhouse Gas Carbon Dioxide Equivalence (CO_2e)** – Greenhouse gases (GHGs) are primarily comprised of Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O), Sulfur Hexafluoride (SF_6), Perfluorocarbons (PFCs), and Hydrofluorocarbons (HFCs). GHGs are typically measured in terms of kilograms or tonnes of carbon dioxide equivalent (CO_2e).
- **Heating Degree Days (HDD)** – Heating Degree Days is a measure of how cold a location was over a period, relative to a base temperature. The base temperature is 18.0°C and the period is one year. If the daily average temperature is below the base temperature, the number of heating degree-days for that day is the difference between the two temperatures. However, if the daily average temperature is equal to or higher than the base temperature, the number of heating degree-days for that day is zero.
- **Internal Rate of Return (IRR)** – The internal rate of return (IRR) is a capital budgeting metric used by firms to decide whether they should make investments. It is an indicator of the efficiency of an investment, as opposed to net present value (NPV), which indicates value or magnitude. The IRR is the annualized effective compounded return rate which can be earned on the invested capital, i.e., the yield on the investment. A project is a good investment proposition if its IRR is greater than the rate of return that could be earned by alternate investments (investing in other projects, buying bonds, even putting the money in a bank account). Thus, the IRR should be compared to any alternate costs of capital including an appropriate risk premium.
- **Low Cost/No Cost Measures** – Low cost/no cost measures are defined as measures that can be implemented within the Operations and Maintenance (O&M) budget. Low cost/no cost measures typically include such initiatives as schedule adjustment, set-point adjustment, and fluid flow-rate adjustment.
- **Net Present Value (NPV)** – Net present value (NPV) is a standard method for the financial appraisal of long-term projects. Used for capital budgeting, and widely throughout economics, it measures the excess or shortfall of cash flows, in present value (PV) terms, once financing charges are met. It is also called net present worth (NPW).
- **Simple Payback (SP)** – Simple payback is the ratio of capital investment cost to the energy cost savings. It indicates how long a capital investment pays back. SP = (Capital Cost) / (Energy Cost Savings).
- **Greenhouse Gas Carbon Dioxide Equivalence (CO_2e)** – Greenhouse gases (GHGs) are primarily comprised of Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O), Sulfur Hexafluoride (SF_6), Perfluorocarbons (PFCs), and Hydrofluorocarbons (HFCs). GHGs are typically measured in terms of kilograms or tonnes of carbon dioxide equivalent (CO_2e).

- **Water Conservation Measure (WCM)** – any type of project conducted, or technology implemented to reduce the consumption of water in a building. (See Energy Conservation Measure (ECM)). Alternative Term: **Water Efficiency Measure (WEM)**
- **Water Utilization Index (WUI)** – Water Utilization Index is a normalized comparison of the water performance of a facility where the normalizing factor is floor area. The units for the WUI are m^3/m^2.
- **Variable Frequency Drive (VFD)** – a type of adjustable-speed drive used in electro-mechanical drive systems to control AC motor speed and torque by varying motor input frequency and voltage.

APPENDIX B

ECM SUMMARY AND SAVINGS

Project No. 21075

FCAPX

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Table 1
Summary of Potential Energy Conservation Measures - Moberly Lake Fire Hall

Propane	$	19.850	per GJ
Fuel Oil	$	-	per L
Electricity	$	0.142	per kWh
Carbon Tax	$	45.00	per CO2 eq tonne

Province	British Columbia
Escalation Rate (Energy)	0%
Discount Rate	7%

		Utility Savings			Emissions Savings				Financial Analysis					
Measure Number	**Description**	**Natural Gas (GJ)**	**Electricity (kWh)**	**Total ($)**	**Electricity (CO_2 eq tonnes/yr)**	**Natural Gas (CO_2 eq tonnes/yr)**	**Total (CO_2 eq tonnes/yr)**	**Total Savings ($)**	**Total Project Cost ($)**	**SPB[1] (Years)**	**Effective Measure Life (Years)**	**Net Present Value ($)**	**Internal Rate of Return (%)**	**Discounted Payback DPB (Years)**
ECM-1	High Efficiency LPG (Propane) DHW Heater	- 5	1,517	$ 122	0.02	- 0.24	- 0.22	$ 113	$ 4,500	40.0	15	-$ 3,475	-10.32%	N/A
ECM-2	Replace furnace with high efficiency condensing Furnace	13		$ 258	-	0.65	0.65	$ 287	$ 7,500	26.1	25	-$ 4,150	-0.33%	N/A
ECM-3	Night set back for Administration offices	11		$ 218	-	0.55	0.55	$ 243	$ 750	3.1	25	$ 2,084	32.40%	3.6
ECM-4	Replace radiant tube heaters with high efficiency heaters	3		$ 60	-	0.15	0.15	$ 66	$ 8,000	120.6	25	-$ 7,227	-9.65%	N/A
	Recommended Measure Bundle	**22**	**1,517**	**$ 658**	**0.02**	**1.12**	**1.14**	**$ 710**	**$ 20,750.00**	**29.24**	**22.8**	-$ 12,900.95	**-2.35%**	N/A

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