Submission to

Peace River Regional District

Energy Audit Report for the Charlie Lake Fire Hall

Version: Draft

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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 Charlie Lake Firehall, which is located at 13065 Firehall Road, Charlie Lake, BC. 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 1977 and measuring approximately 292m^2, followed by a second-floor addition in 1987 measuring 332m^2. The total floor area of the facility is approximately 694 m^2 (6,815 ft^2). The current annual utility consumption for this facility is approximately 34,073 kWh of electricity and 545 GJ of natural gas. This equates to an annual greenhouse gas (GHG) emissions of 29.2 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 1.07 GJ/m^2 which is very close to 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 48 GJ of natural gas, and 5,114 kWh 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 2.47 Tonnes CO_2e/year, which is equivalent to an 8% 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 - Charlie Lake Firehall

Natural Gas	$ 8.610	per GJ
Fuel Oil	$ -	per L
Electricity	$ 0.123	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	Lighting Retrofit	- 3	5,114	$ 601	0.06	- 0.15	- 0.09	$ 597	$ 8,000	13.4	25	-$ 1,042	5.51%	41.1
ECM-2	High Efficiency DHW Heater	21		$ 181	-	1.06	1.06	$ 228	$ 3,500	15.3	15	-$ 1,421	-0.27%	N/A
ECM-3	Night set back of heating	30		$ 258	-	1.51	1.51	$ 326	$ 3,000	9.2	20	$ 455	8.89%	15.3
	Recommended Measure Bundle	**48.00**	**5,114**	**$ 1,040.26**	**0.06**	**2.41**	**2.47**	**$ 1,151**	**$ 14,500.00**	**12.59**	**17.4**	-$ 3,257.71	**3.56%**	**31.52**

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Table of Contents

1 Introduction 1
1.1 Purpose and Objective 1
1.2 Scope of Work 1
1.3 Background 1
1.4 Key Client Information Summary 2
1.5 Acknowledgements 2
1.6 Definitions and Abbreviations 2
1.7 Energy Assessment Team 2
1.8 Assessment Methodology 2
1.8.1 Utility Analysis 2
1.8.2 Documentation Review 3
1.8.3 Site Visits 3
1.8.4 Building Envelope System Assessment 3
1.8.5 Mechanical System Assessment 3
1.8.6 Electrical System Assessment 3
1.8.7 Energy Conservation Measure Identification and Analysis 3
1.8.8 Recommendations 4
2 Facility Description 5
2.1 Overview 5
2.2 Owner-Supplied Reference Material 6
2.3 Building Envelope 6
2.4 Mechanical Systems 7
2.4.1 Domestic Hot Water Systems 7
2.4.2 Heating Systems 8
2.4.3 Ventilation Systems 8
2.5 Electrical Systems 9
2.5.1 Lighting Systems 9
2.5.2 Other Systems 9

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3 Utility Analysis and Benchmarking 10
3.1 Current Utility Consumption 10
3.2 Utility Price Structure 10
3.3 Electricity 11
3.4 Fossil Fuels 12
3.5 Annual Energy Consumption Breakdown by Type 13
3.6 Annual Energy Consumption Breakdown by Major End-Use 15
3.7 Energy Performance Benchmarking 16
4 Assessment Findings 18
4.1 ECM-1: Lighting Retrofit 18
4.1.1 Existing Condition 18
4.1.2 Proposed Conditions 18
4.1.3 Analysis 18
4.2 ECM-2: New High Efficiency DHW Heater 19
4.2.1 Existing Condition 19
4.2.2 Proposed Condition 19
4.2.3 Analysis 19
4.3 ECM-3: Night Set Back of Heating 20
4.3.1 Existing Condition 20
4.3.2 Proposed Condition 20
4.3.3 Analysis 20
4.3.4 Other Opportunities Considered 21
4.4 Solar Photovoltaic Generation System 21
4.5 Improve Building Envelope Conditions 21
5 Conclusions and Recommendations 22
6 Implementation Plan and M&V 23
6.1 Implementation Plan 23
6.2 Measure and Verification 23
7 Emissions Saving Summary 24
7.1 Emission Reduction 24
8 Study Limitations 25
9 Closure 26

APPENDIX

Appendix A – Definitions and Abbreviations
Appendix B – ECM Summary and Savings

1 INTRODUCTION

1.1 PURPOSE AND OBJECTIVE

Peace River Regional District retained Roth IAMS Ltd to conduct an energy assessment of the Charlie Lake Firehall, located at 13065 Firehall Road, Charlie Lake, BC. 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 624m² (6,815ft²) 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;
  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 offices, workshops, and garage. The gross floor area of the facility is approximately 624m² (6,815ft²).

1.4 Key Client Information Summary

Table 2: Key Client Information Summary	
Customer Name	PRRD – Charlie Lake Firehall
Site Address	13065 Firehall Road, Charlie Lake, BC
Contact Person	Ron Schildroph, Deputy Chief, Charlie Lake Fire Department
Contact Information	250-785-1424
	Ron.schildroph@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.

- Ron Schildroph – Peace River Regional District – Charlie Lake Firehall

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

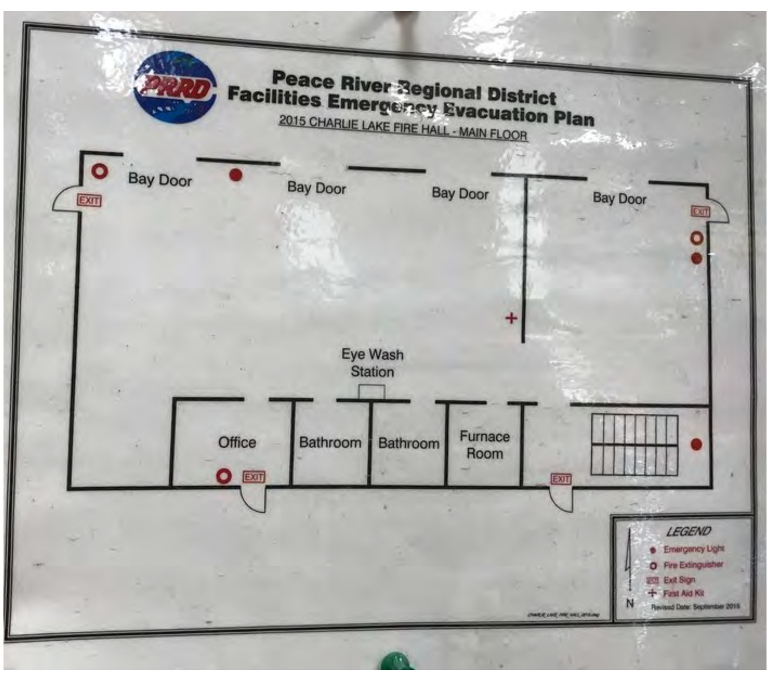
The following sections summarize observations made during the site investigation.

2.1 OVERVIEW

The Charlie Lake Firehall is located at 13065 Firehall Road, Charlie Lake, BC. 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 1977 and measuring approximately 292m^2, followed by a second-floor addition in 1987 measuring 332m^2. The facility includes administration office, apparatus hall, garage, kitchen, and washrooms.

Table 3: Charlie Lake Firehall Salient Features				
Asset Name	**Year Built**	**Floor Area (square meters)**	**Floor Area (square footage)**	**Building Usage**
Firehall	1977	292	3,145	Apparatus Bay.
Addition	1987	332	3,570	Offices, kitchen, washrooms
Total		**624**	**6,815**	

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



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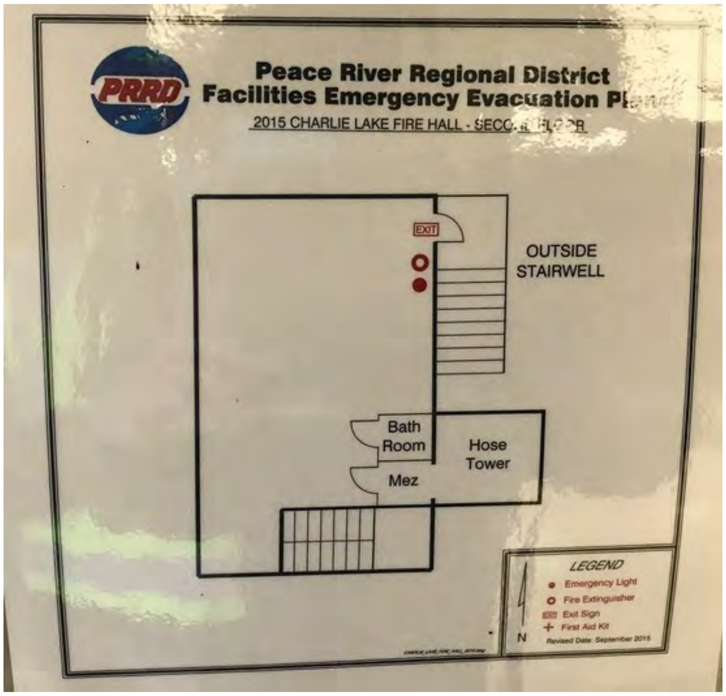


Figure 1: Peace River Regional District - Charlie Lake Firehall Layout showing main floor and upper level

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 2018 – Dec 2020) and Gas (Jan 2018 – Dec 2020).

2.3 Building Envelope

The building's foundations appear to be cast-in-place concrete foundation walls and strip footings with a concrete slab-on-grade floor structure. The building appears to be a wood-frame with a wood roof structure. The building is clad with vinyl siding. The flat roof appears to be covered with modified bitumen roofing assembly.

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 mostly located on building rooftops, electrical and mechanical rooms. An equipment list has been provided as part of the Building Condition Assessment which was conducted at the same time as the energy audit by Roth IAMS Ltd.

2.4.1 Domestic Hot Water Systems

A tank-type, natural gas-fired domestic water heater manufactured by Rheem is installed in the boiler room. The water heater has a volume and input heating capacity of 189 L (50 US Gal.), and 50 MBH, respectively.

Natural gas fired DHW heater

2.4.2 Heating Systems

There is a natural gas-fired hot water boiler installed in the boiler room. The boiler is manufactured by Super Hot (model SG-270-N_E), with a heating capacity of 270 MBH. The boiler provides heating water to the perimeter radiation on the second floor. The heating system appears to be controlled by simple adjustable room thermostats, one located on the second floor and one on the main. A third non-programmable thermostat is also installed on the main floor which presumably provides control of the heating for that zone.

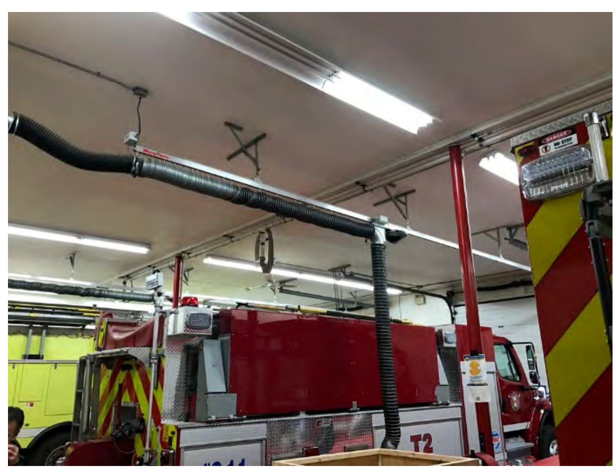
Main heating boiler

Non-Programmable thermostat for control of the heating

2.4.3 Ventilation Systems

Ceiling-mounted exhaust fans are installed in the main floor washrooms of the original building to serve as ventilation for these spaces. The fans are all residential style of fractional HP. The building includes a vehicle exhaust system with ducting, controls, hose reels and flexible hoses provided in the apparatus bay. The exhaust fan is located on the mezzanine.

View of ceiling mounted bathroom exhaust fan



View of the apparatus hall exhaust air system

2.5 Electrical Systems

2.5.1 Lighting Systems

The interior lighting system includes a combination of linear fluorescent tube light fixtures on the second floor and wall sconce light fixtures in main floor washrooms and offices. Linear fixtures have T8 lamps. The wall sconces are fitted with compact fluorescent lamps (CFLs). The interior lighting system includes in the apparatus bays are comprised of linear fixtures fitted with light emitting diodes (LEDs).

Exterior lighting is provided by LED wall pack fixtures around the perimeter of the building. Exterior lighting control is generally by photocell.

Fluorescent T8 Lighting in the facility

Newer LED lighting in the Apparatus Room

2.5.2 Other Systems

A breathing air generator, manufactured by Jordair is installed in the Apparatus Hall. The compressor is rated to provide 7.5cfm and is equipped with a 7.5HP motor and provides breathing air for the portable tanks. There are also 2 pumps which are used to fill the appliances with water. The ratings were unknown.

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

Charlie Lake Firehall electricity and gas consumption data used in the analysis was provided by PRRD. According to information provided, there is one main electricity and gas meter for the entire facility.

The following table summarizes the utility (electricity and natural gas) 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	34,073	$4,178	545	$4,689	1.07	$14.21

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)
$0.1226	-	$8.61

3.3 ELECTRICITY

Electricity data was reviewed for the most recent 36 months was reviewed. 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.

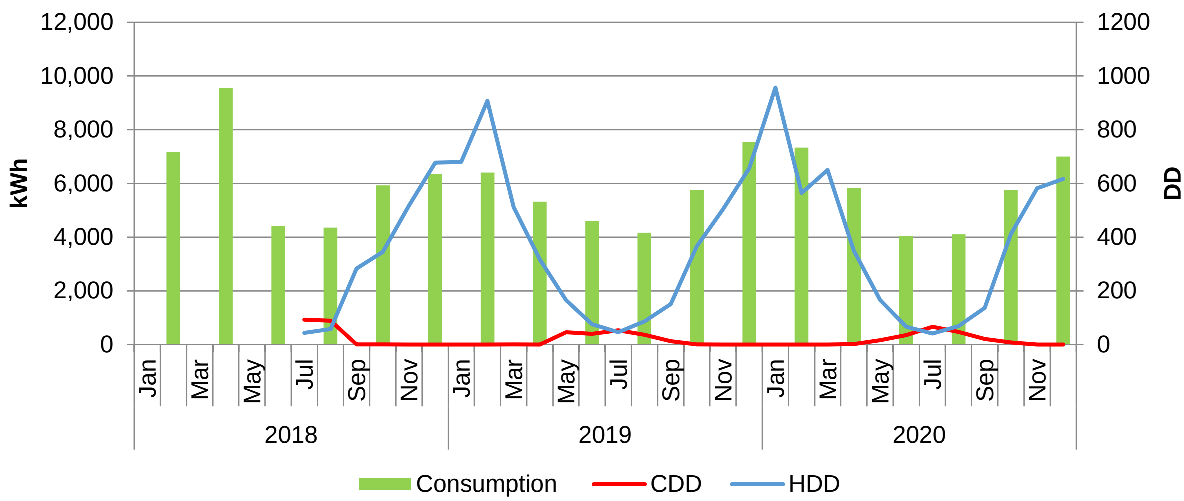


Figure 2: Electrical Consumption Trend for Charlie Lake Firehall

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

When looking at 2018 and 2019 electricity consumption essentially follows the same pattern.

Year-round systems, which are building baseload electrical consumers, include building exhaust fans systems, the breathing air compressor, fire appliance fill pumps, as well as building plug loads, such as computers and small appliances.

3.4 Fossil Fuels

The most recent 36 months of natural gas utility data were collected, analyzed and then plotted to illustrate trends and identify any irregularities. The figure below illustrates the natural gas consumption data for the facility. It should be noted that natural gas is billed bi-monthly, so it was not possible to split usage on a monthly basis.

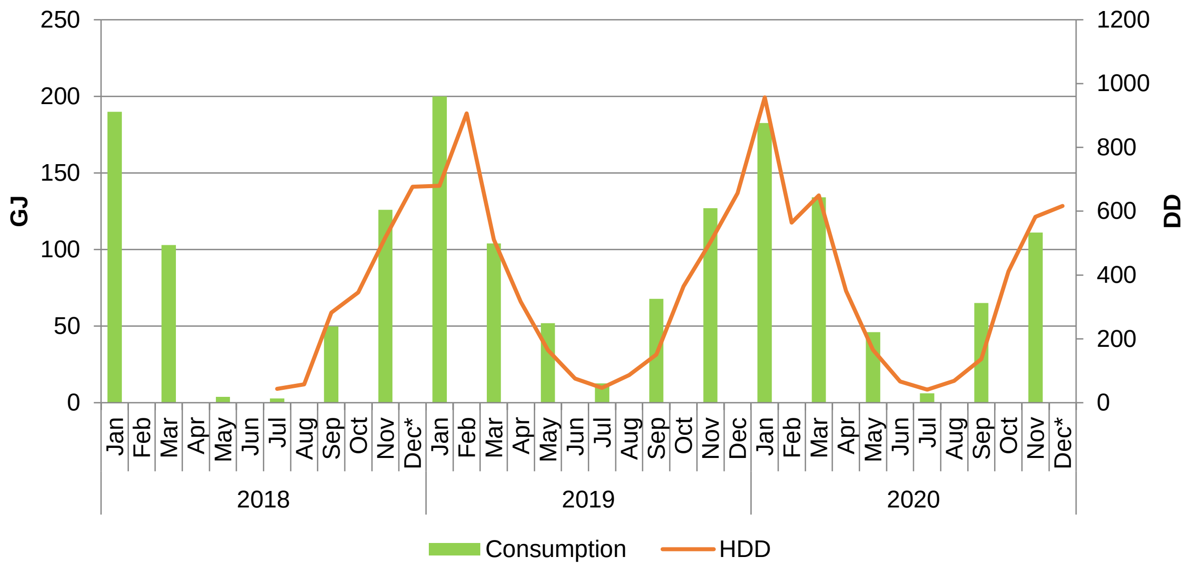


Figure 3: Fossil Fuel Consumption

At first glance, there appears to be some correlation between the heating degree days and consumption. The noticeable increase in natural gas usage, which starts in September and peaks in January or February, can be attributed to the heating cycle during the fall and winter months.

Building heating is provided by a single natural gas fired heating boiler serving the entire building. Occupancy also has an influence on usage as it also impacts the domestic hot water load provided by the gas-fired water heater. It was observed that the baseline amount of energy consumed during the summer months, which typically reflects non-heating loads, such as natural gas used for the generation of hot water, seems normal for this type of building.

A linear regression analysis was conducted on the building consumption data. The figure below shows the line of regression developed through the correlation of consumption and heating degree days that were used to develop the anticipated natural gas consumption during a baseline year.

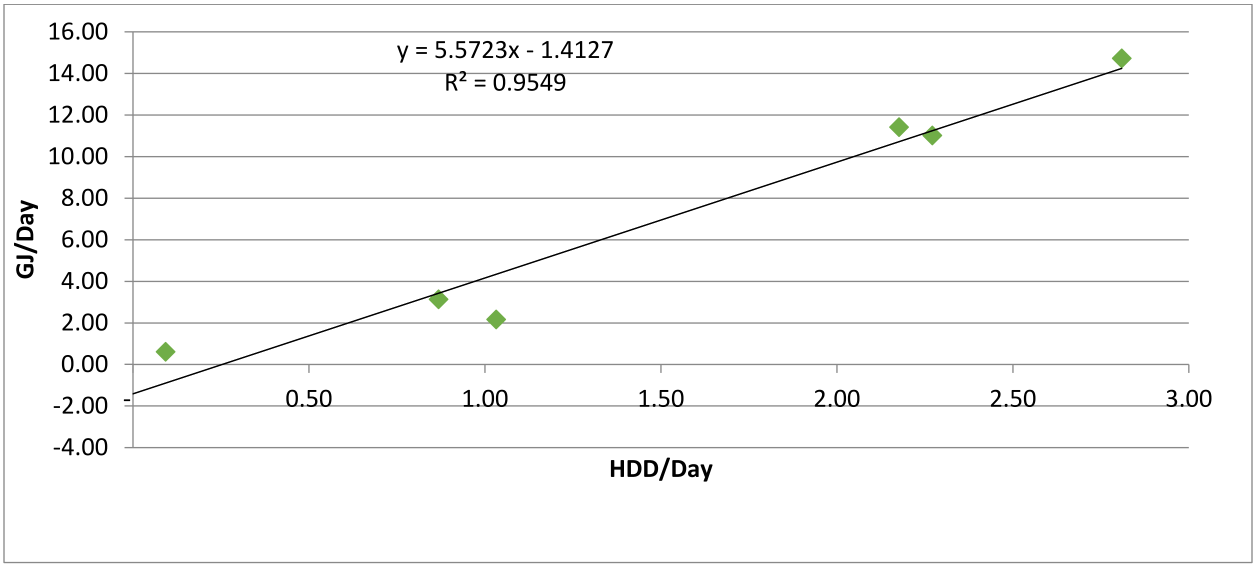


Figure 4: Results of Natural Gas Regression Analysis

Since the R-square (R2) value is a measure of the degree of correlated agreement between the natural gas consumed and the dependent variable chosen, in this case, HDD. The R2 value of 0.9549 shows a good correlation between natural gas consumption and HDD. The closer the value is to 1 the better the natural gas usage responds to changes in the weather. In In this case, it would appear that the buildings heating is well controlled in a manner that the consumption is dependent on changes in the weather. Despite this good correlation there is an opportunity to reduce the overall consumption of natural gas use.

3.5 Annual Energy Consumption Breakdown by Type

The combined electricity and natural gas 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. Natural gas consumption has been estimated based on the results of the energy analysis.

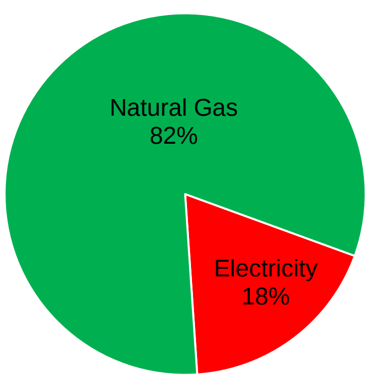


Figure 5: Annual Energy Consumption by Fuel Type

Based on the previous figure, natural gas accounts for 82% of all energy consumed while electricity accounts for the other 18% 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.

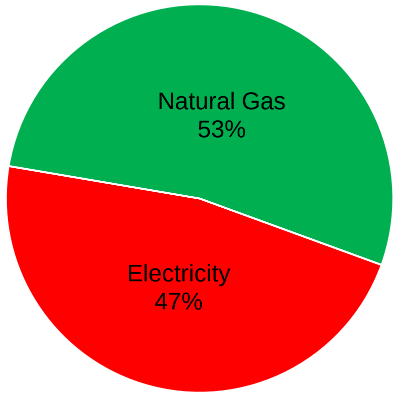


Figure 6: Annual Energy Cost by Fuel Type

Based on the figure above, natural gas accounts for 53% of all energy costs while electricity accounts for the other 47% of energy costs. Although Natural Gas makes up 82% 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 gas emissions breakdown.

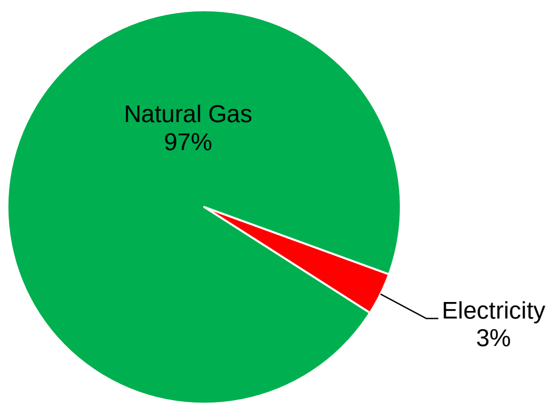


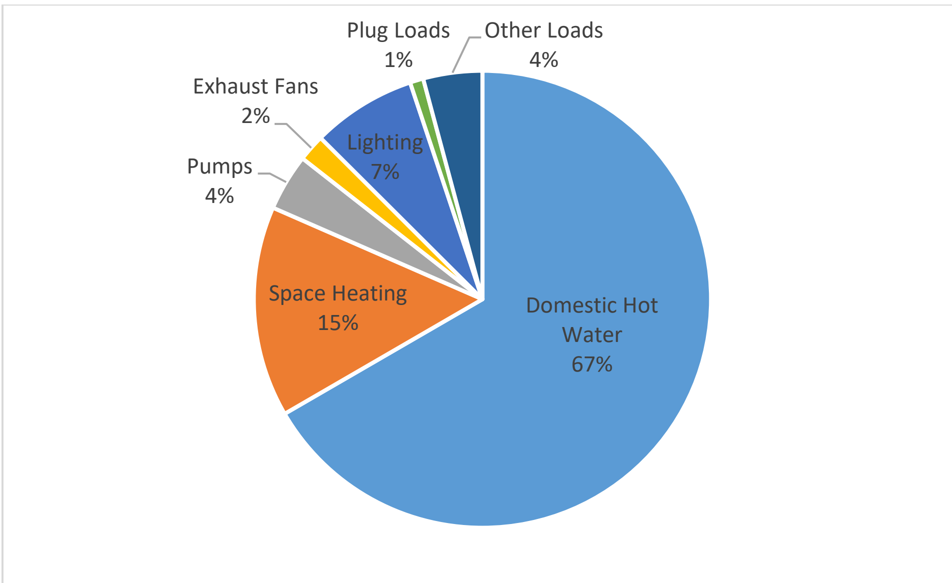
Figure 7: Annual Greenhouse Gas Emission by Fuel Type

Based on the figure above, greenhouse gas emissions from natural gas accounts for 97% of all greenhouse gas emissions while greenhouse gas emissions from electricity account for the other 3% of greenhouse gas emissions. This is the opposite of the energy costs. It indicates a reduction in natural gas consumption will have a large impact on greenhouse gas 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 8: Annual Energy Consumption by End-Use

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	**Natural Gas (GJ)**	**Electricity (kWh)**	**Equivalent Energy (ekWh)**	**% Energy**
Domestic Hot Water	443	0	123,079	67%
Space Heating	99	0	27,560	15%
Pumps	0	7,412	7,412	4%
Exhaust Fans	0	3,516	3,516	2%
Lighting	0	13,664	13,664	7%
Plug Loads	*0*	*1,750*	1,750	*1%*
Other Loads	0	7,712	7,712	4%
Total	**542**	**34,053**	**184,693**	**100%**

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Another way of looking at the same information is to consider the cost breakdown in the figure below. This shows the lighting; air handling and exhaust fans are the largest contributors to the facilities energy costs.

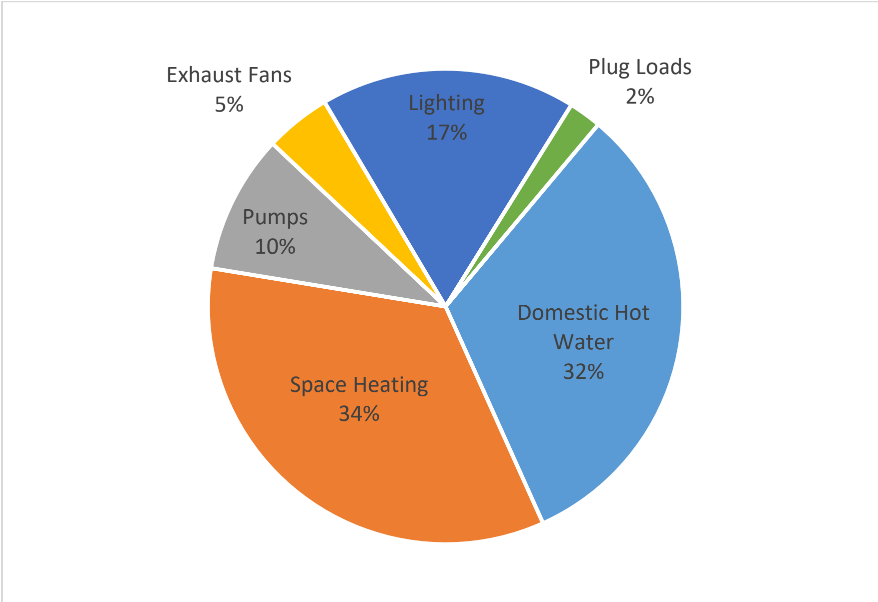

Figure 9: Annual Energy Cost by End-Use

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 Buildings.

Table 7: EUI Comparisons	
Calculated in Utility Analysis ***GJ/m²***	**OEE** ***GJ/m²***
1.07	1.04
(Source: *Natural Resources Canada, Commercial and Institutional Consumption of Energy Survey 2018.* Commercial/Institutional Sector British Columbia and Territories¹ 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 Buildings in British Columbia). This data is an average and includes similar facilities as the Charlie Lake Firehall. The category chosen was the closest to the classification of the facility. The benchmark indicates that Charlie Lake Firehall Energy Use Intensity (EUI) is very close to 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	Exterior Lighting Retrofit
ECM-2	Replace the DHW heating with high efficiency condensing unit
ECM-3	Night set back of heating

4.1 ECM-1: Lighting Retrofit

4.1.1 Existing Condition

The lighting in all areas of the firehall except the Apparatus Bay is comprised mainly of fluorescent T8 lamps and electronic ballasts, plus a few incandescent fixtures in bathrooms and utility spaces. The lighting is controlled by switches. The Apparatus Bays are illuminated by light emitting diode (LED) fixtures which were installed in the past 2 years.

Exterior lighting is predominantly by LED wall pack type fixtures mounted on the perimeter wall of the building, plus two incandescent pot lights mounted under the soffit.

4.1.2 Proposed Conditions

It is recommended the remainder of the interior fluorescent T8 light fixtures are replaced with new energy efficient LED lighting. The two incandescent pot lights on the exterior of the building should be fitted with LED lamps.

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 ($)
-3	5,114	0.09	$597

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)
$597	$8,000	13.4	-$1,042	5.51%	41.1

4.2 ECM-2: New High Efficiency DHW Heater

4.2.1 Existing Condition

The existing domestic hot water heater is in need of replacement. The heater is relatively inefficient owing to its age and the fact that there is no damper on the flue to prevent draw through (natural draft losses) and standing losses. The current efficiency is estimated to be approximately 65%. The condition assessment recently completed is recommending replacement of the domestic hot water heater.

4.2.2 Proposed Condition

It is recommended that the domestic hot water heater is replaced with a high efficiency condensing natural gas fired heater, with an expected efficiency of 88%.

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 ($)
21	0	1.06	$228

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)**
$228	$3,500	15.3	-$1,421	-0.27%	N/A

4.3 ECM-3: Night Set Back of Heating

4.3.1 Existing Condition

The existing perimeter radiation is controlled by three adjustable wall mounted thermostats that is currently set to maintain a space temperature of approximately 20ºC throughout the year.

4.3.2 Proposed Condition

It is recommended that the thermostats are replaced with programmable thermostats and that the temperature is set back to 16ºC outside of normal operating hours. To achieve this measure some additional modifications will be required for the new thermostats to provide the setback of the heating water.

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 ($)**
30	0	1.51	$326

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)
$326	$3,000	9.2	$455	8.89%	15.3

4.3.4 Other Opportunities Considered

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

4.4 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.

4.5 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.

5 CONCLUSIONS AND RECOMMENDATIONS

Several ECMs were identified during the detailed energy assessment. Table 13 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	$8,000	5,114	-3	0.09	$597	13.4
ECM-2	$3,500	-	21	1.06	$228	15.3
ECM-3	$3,000	-	30	1.51	$326	9.2
Bundle	**$14,500**	**5,114**	**48**	**2.47**	**$1,151**	**12.6**

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.

6 Implementation Plan and M&V

6.1 Implementation Plan

Implementation of the measures identified in this assessment will assist the Peace River Regional District – Charlie Lake Firehall to reduce risks associated with utility market volatility and unplanned capital maintenance expenditures. As mentioned above, is only recommended that both measures are implemented if the long term use of the building is secure.

Table 20: Chetwynd Recreation Centre				
ECM/Scenario	**Design Period**	**Construction Period**	**Seasonal Requirements**	**Disruption**
ECM 1	2 weeks	2 Weeks	None	Minimal
ECM 2	0	1 Day	None	Minimal
ECM 3	0	2 days	Complete prior to start of heating season.	Minimal

6.2 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.

A common general strategy is to compare historical energy use with post energy retrofit energy use. In short, this is establishing a baseline case and subtracting the post-installation energy use however you must include adjustments. Adjustments may account for changes in weather, occupancy, hours of operation or other factors that impact the baseline and performance periods.

Continue to monitor utility bills after the retrofits are implemented to determine the energy savings. Correct natural gas consumption for degree day data.

7 Emissions Saving Summary

7.1 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 29.2 Tonnes CO2e/year. This results in a current greenhouse gas intensity of 0.046 Tonnes CO2e/m^2. Based on the proposed bundle of ECMs the greenhouse gas savings are estimated to be 2.47 Tonnes of CO2e/year which represents approximately 8 percent greenhouse gas emission reduction.

8 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.

9 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

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

Table 1
Summary of Potential Energy Conservation Measures - Charlie Lake Firehall

Natural Gas	$	8.610	per GJ
Fuel Oil	$	-	per L
Electricity	$	0.123	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	Lighting Retrofit	- 3	5,114	$ 601	0.06	- 0.15	- 0.09	$ 597	$ 8,000	13.4	25	-$ 1,042	5.51%	41.1
ECM-2	High Efficiency DHW Heater	21		$ 181	-	1.06	1.06	$ 228	$ 3,500	15.3	15	-$ 1,421	-0.27%	N/A
ECM-3	Night set back of heating	30		$ 258	-	1.51	1.51	$ 326	$ 3,000	9.2	20	$ 455	8.89%	15.3
	Recommended Measure Bundle	**48.00**	**5,114**	**$ 1,040.26**	**0.06**	**2.41**	**2.47**	**$ 1,151**	**$ 14,500.00**	**12.59**	**17.4**	-$ 3,257.71	**3.56%**	**31.52**

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