ASHRAE LEVEL II ENERGY AUDIT

THE TOWNSHIP OF NORTH DUMFRIES

AYR FIRE STATION

501 Scott Street, Ayr, ON

Project No.: 2018-0527-11

May 8, 2019

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Project No.: 2018-0527-11

May 8, 2019

Shelley Stedall
The Township of North Dumfries
2958 Greenfield Road
Ayr, ON N0B 1E0

Dear Shelley Stedall,

RE: North Dumfries Energy Audits

WalterFedy is pleased to submit the attached ASHRAE Level II Energy Audit to The Township of North Dumfries. This report encompasses the originally agreed to scope, and has identified the potential for energy consumption and cost saving measures at Ayr Fire Station located at 501 Scott Street in Ayr, ON.

Based on the information provided by the The Township of North Dumfries, the report was completed with the data supplied and collected, as well as engineering judgement and various analysis tools to arrive at the final recommendations.

All of which is respectfully submitted,

WALTERFEDY

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Senior Energy Engineer
Energy Management Solutions

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EXECUTIVE SUMMARY

This report presents the results of a ASHRAE Level II Energy Audit completed by WalterFedy for The Township of North Dumfries at Ayr Fire Station located at 501 Scott Street in Ayr, ON.

The purpose of this ASHRAE Level II Energy Audit is to review how energy is currently being consumed within the facility, gain an understanding of how the facility is being operated, and provide recommendations for how energy can be saved through energy conservation measures (ECMs).

This ASHRAE Level II Energy Audit was prepared in conjunction with a Building Condition Assessment (BCA) of Ayr Fire Station. ECMs are based on replacement recommendations with energy savings potential in the BCA report as well as emerging and renewable energy technologies when applicable.

Ayr Fire Station is a 2 storey Fire Station facility built in 1990.

Table 1 summarizes the annual electricity, natural gas, and water consumption for Ayr Fire Station during the baseline year of 2017. The facility's energy use intensity was benchmarked against other similar Fire Station facilities.

Table 1: Facility annual utility summary

Annual Electricity Consumption	[kWh]	49,166
Annual Electricity Cost	[$]	5,482
Facility Electricity EUI	[kWh/ft^2]	3.1
Median Electricity EUI	[kWh/ft^2]	8.4
Annual Natural Gas Consumption	[m^3]	7,996
Annual Natural Gas Cost	[$]	1,958
Facility Natural Gas EUI	[m^3/ft^2]	0.51
Median Natural Gas EUI	[m^3/ft^2]	1.5
Annual Water Consumption	[m^3]	194
Annual Water Cost	[$]	540

*Utility costs calculated using utility rates described in Table 5.

Table 2 summarizes the annual utility savings and simple paybacks for the recommended conservation measures evaluated in this report. Conservation measures were evaluated independently and do not reflect interactive effects.

Table 2: Recommended ECM summary table

ECM	**Electricity Savings** [kWh]	**Demand Savings** [kW]	**Nat. Gas Savings** [m^3]	**Cost Savings** [$]	**Capital Cost** [$]	**Utility Incentive** [$]	**Simple Payback** [years]
Replace shower heads	0	0.0	217	246	600	0	2.4
LED lighting retrofit	19,903	2.3	0	2,219	10,800	995	4.4
Radiant tube advanced controls	0	0.0	579	142	1,000	0	7.1

Note: Cost savings calculated using utility rates from Table 5.

1 INTRODUCTION

1.1 Objectives

WalterFedy was hired by The Township of North Dumfries to complete an ASHRAE Level II Energy Audit at their Ayr Fire Station facility at 501 Scott Street in Ayr, ON. The purpose of this ASHRAE Level II Energy Audit is to review how energy and water is currently being consumed within the facility, gain an understanding of how the facility is being operated, and provide recommendations for how energy and water can be saved through conservation measures.

This report identifies and explains potential energy and water conservation measures and provides economic analyses in order to estimate utility savings, budget implementation costs, and simple payback periods. Energy savings are within an accuracy of +/-30% while implementation costs are within an accuracy of +/-50%.

The goal is to recognize ECMs with high savings and reasonable payback periods. An analysis of historical energy and water use provides insight into the consumption patterns of the facilities. The data and information pertaining to the property reflects conditions and operations at the time of the site survey on November 28, 2018.

1.2 Scope of work

The scope of work is as follows:

- Review and analyze the historical energy consumption of each building.
- Conduct an on-site survey of each building's energy consuming equipment and system areas.
- Review operating logs and interview site building operations personnel to obtain insight into operating issues and practices.
- Perform an opportunity assessment including but not limited to:
  - The estimated energy unit and cost savings identified for each Energy Conservation Measures (ECM);
  - The energy saving recommendations from current state for each new ECM identified, documenting proposed equipment or operational changes from current equipment;
  - An explanation of the methodology and calculations utilized to obtain the energy and cost saving estimates;
- and document such assessment.
- Determine the cost to implement the recommended measures, including equipment installation and significant changes to maintenance costs, and determine the simple payback period for each ECM using the estimated savings.
- Provide a ranking of ECM opportunities in order of payback period category (1 to 3 years, 3 to 5 years, and 6 to 10 years)
- Identify and include in the final Report all available grants or incentives per identified ECM available through the Independent Electricity System Operator (IESO), Local Utility or other Government programs and include identified grant.

1.3 Contact information

The contact information of the the Owner and Consultant (WalterFedy) can be found in Table 3.

Table 3: Contact Information

Client:	**Consultant:**
Shelley Stedall	Josh Gibbins, P.Eng.
Treasurer, Director of Corporate Services	Senior Energy Engineer
519.632.8800 x123	519.576.2150 x480
sstedall@northdumfries.ca	jgibbins@walterfedy.com
The Township of North Dumfries	WalterFedy
2958 Greenfield Road	675 Queen Street South, Suite 111
Ayr, ON N0B 1E0	Kitchener, ON N2M 1A1

2 HISTORICAL ENERGY USE ANALYSIS

2.1 General information

Electricity, natural gas, and water suppliers for Ayr Fire Station are summarized in Table 4.

Table 4: Facility utility information.

Facility Name:	Ayr Fire Station
Location:	501 Scott Street, Ayr, ON
Electrical LDC*:	Energy+
LDC Account No.:	00009220-00
Natural Gas Distributor:	Union Gas
NG Account No.:	195-6374 179-8757
Water Provider:	Region of Waterloo
Water Account No.:	210 10030 000

*Electrical Local Distribution Company

2.2 Utility rates

The utility rates shown in Table 5 are used throughout this report to evaluate the energy conservation measures identified in this ASHRAE Level II Energy Audit.

The electricity and natural gas rates are averages determined using the previous 24 months of utility bills. The water rate is taken from the Region of Waterloo website and current as of November 1, 2018.

Table 5: Facility utility rates

Electricity Consumption	[$/kWh]	0.11
Natural Gas Consumption	[$/m^3]	0.24
Water Consumption	[$/m^3]	2.78

2.3 Incentive summary

Electricity incentives

Electricity savings incentives have been calculated based on the IESO saveONenergy Retrofit Program as summarized in Table 6.

Table 6: Electricity savings incentives

Project Type	Demand Incentive	Consumption Incentive
Lighting	$400 / kW	$0.05 / kWh
Non-lighting	$800 / kW	$0.10 / kWh

1. The greater of the kW or kWh incentive will apply
2. Incentive capped at 50% of project cost

Natural gas incentives

Union Gas offers prescriptive and custom incentives for high efficiency natural gas consuming equipment. The incentives vary depending on the type of equipment. Information on all the incentives available can be found on the following webpage: *https://www.uniongas.com/business/save-money-and-energy/equipment-incentive-program*.

2.4 Data sources

The following data sources were used in this historical energy use analysis:

- 24 months of Energy+ monthly electricity bills.
- 24 months of Union Gas monthly natural gas bills.
- 24 months of Region of Waterloo bi-monthly water bills.
- Daily weather data for Kitchener/Waterloo.

2.5 Facility utility use

Due to different billing periods among the utilities, monthly consumption was determined by calculating an average daily consumption over a billing period and summing the average daily consumption for each month of the year.

Electricity consumption

Table 7 summarizes the annual electricity consumption of Ayr Fire Station for the baseline year of 2017.

Table 7: Facility annual electricity consumption

Annual Electricity Consumption	[kWh]	49,166
Annual Electricity Consumption Costs	[$]	5,482

As seen in Figure 1, electricity consumption remains relatively constant throughout the year. In general, there is a slight increase in electricity consumption in 2018 from 2017.

Natural gas consumption

Table 8 summarizes the annual natural gas consumption of Ayr Fire Station for the baseline year of 2017.

Table 8: Facility annual natural gas consumption

Annual Natural Gas Consumption	[m^3]	7,996
Annual Natural Gas Consumption Costs	[$]	1,958

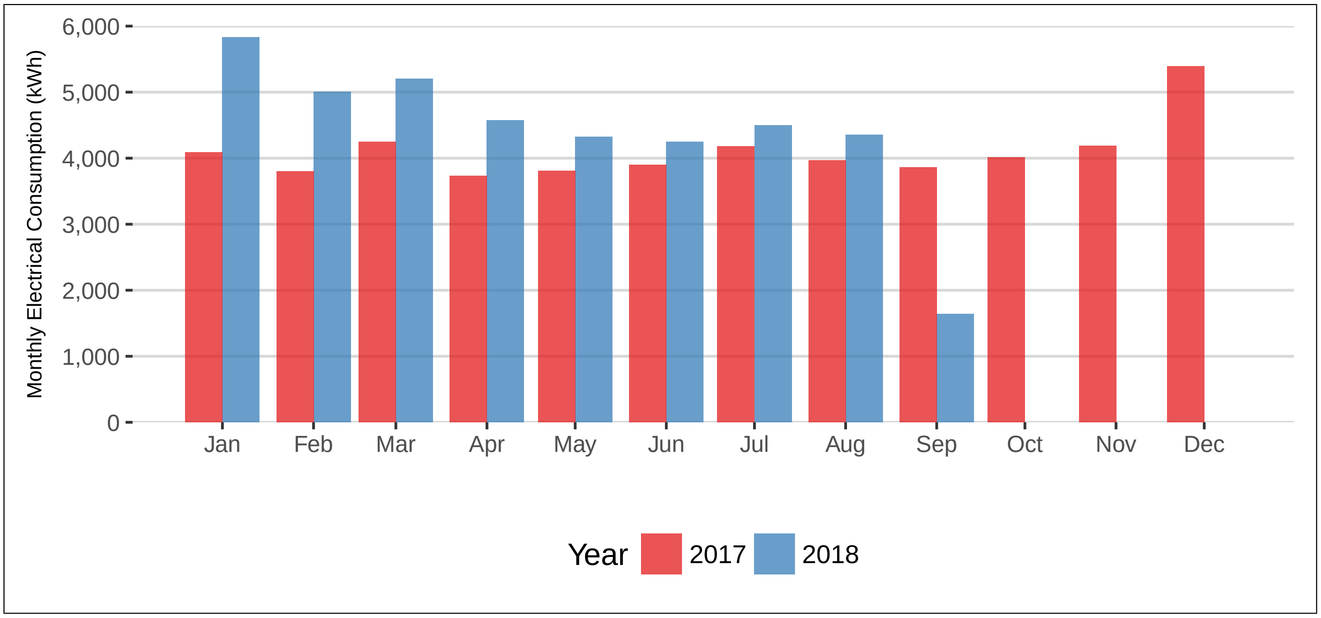


Figure 1: Monthly electricity consumption for the baseline period

Natural gas is used for heating domestic hot water and for heating the ventilation air during the winter season. As seen in Figure 2, the summer natural gas consumption reflects the baseload natural gas consumption for domestic hot water while the ventilation air natural gas consumption increases as outdoor temperature decreases.

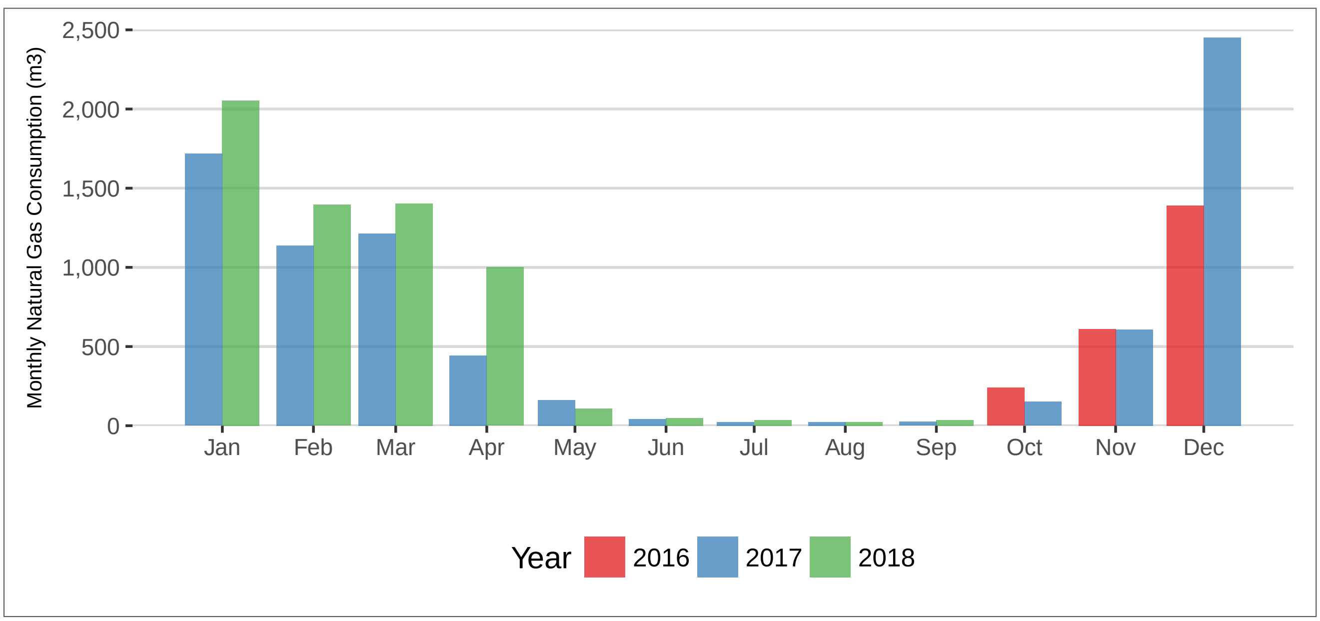


Figure 2: Monthly natural gas consumption for the baseline period

Natural gas regression analysis

As natural gas is used to heat outdoor ventilation air during the heating season, a linear regression analysis was completed comparing monthly natural gas consumption to heating degree days as seen in Figure 3.

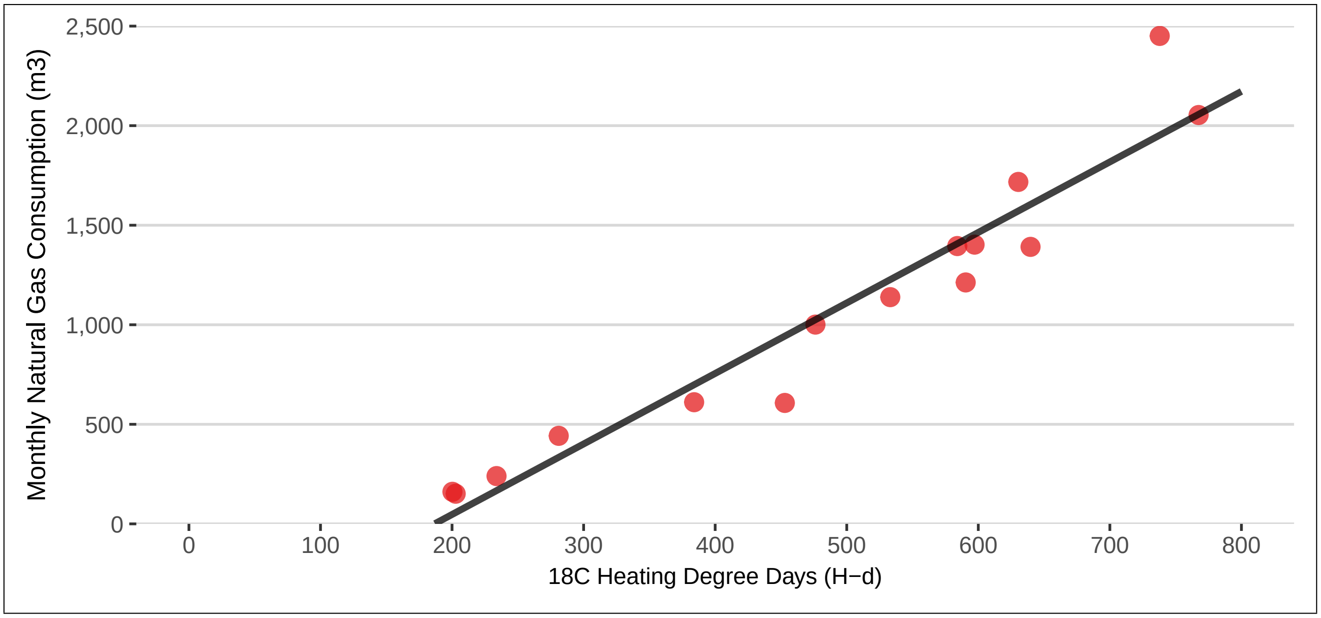


Figure 3: Linear regression of natural gas consumption vs. heating degree days

Linear regression resulted in the following model for natural gas consumption based on heating degree days (HDD):

$$\text{Natural gas consumption [m}^3\text{]} = -661 + 3.5 \times 18°\text{C HDD } (r^2 = 0.92)$$

The r^2 value, also called the coefficient of determination, is a measure of how well the model predicts the actual consumption data. An r^2 value of 1 indicates that the linear regression model correctly predicts every data point. In this case, 92% of the variability in the natural gas consumption data can be explained by correlating consumption to heating degree days.

Water consumption

Table 9 summarizes the annual water consumption of Ayr Fire Station for the baseline year of 2017.

Table 9: Facility annual water consumption

Annual Water Consumption	[m^3]	194
Annual Water Consumption Costs	[$]	540

Figure 4 summarizes the monthly water consumption. It is observed that there was an abnormally large increase in water consumption in September 2018 - October 2018.

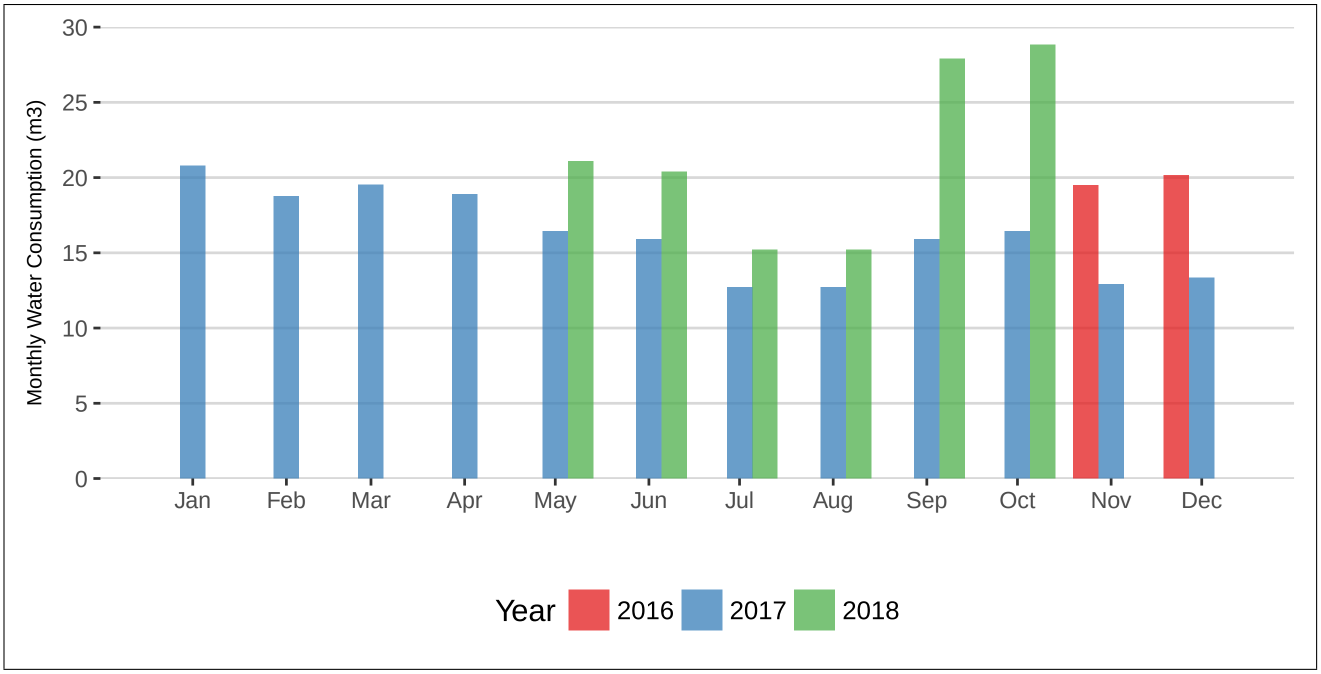


Figure 4: Monthly water consumption for the baseline period

2.6 Energy end uses

Table 10 summarizes the energy end uses for Ayr Fire Station.

Table 10: Annual energy end uses

End Use	**Natural Gas Consumption** [m^3]	**Electricity Consumption** [kWh]	**Total Energy Consumption** [ekWh]	**Total Energy Percentage** [%]	**Energy Costs** [$]
Space Heating	7,714	900	82,337	61.6	1,990
Space Cooling	-	1,066	1,066	0.8	119
HVAC	-	2,721	2,721	2.0	303
Domestic Hot Water	281	-	2,969	2.2	69
Lighting	-	41,864	41,864	31.3	4,668
Appliances/Plug loads	-	2,615	2,615	2.0	292
Totals	7,996	49,166	133,572	100	7,441

1. Refer to Table 5 for the utility rates used.
2. Natural gas converted to ekWh using factor of 11 ekWh/m^3
3. HVAC includes equipment such as ventilation fans and motors.
4. Total end use energy consumption matches the total baseline year energy consumption.

Calculations

- Natural gas consumption was divided into space heating and domestic water heating.
- Domestic water heating natural gas consumption was estimated as the base natural gas consumption in the summer.
- Space heating natural gas consumption was calculated as the difference between the total annual natural gas consumption and domestic water heating natural gas consumption.
- Electricity consumption was divided into space heating, space cooling, lighting, and miscellaneous loads.

- Space heating electricity consumption estimated based on 10 Wh/ft^2 operating continuously during the year for areas with electric heating.
- Space cooling electricity consumption estimated as the difference between the total summer electricity consumption and the base electricity consumption in the winter.
- Interior lighting electricity consumption estimated based on typical operating hours throughout the year.
- Exterior lighting electricity consumption estimated based on 12 hour/day operation throughout the year.
- Miscellaneous loads (fans, motors, appliances, plug loads, etc.) estimated as the remainder of the total annual electricity consumption.

2.7 Energy use intensity (EUI)

The intent of this section is to compare annual energy consumption of the facility under investigation to a database of similar Fire Station facilities. Data was obtained from the Ontario government which collects energy consumption and other building data from Broader Public Sector (BPS) organizations such as municipalities, school boards, universities, and hospitals. Annual consumption was normalized against the building's floor area to determine each facility's EUI.

As seen in Table 11, Ayr Fire Station is 63% below the median electricity EUI and is 67% below the median natural gas EUI for similar Fire Station facilities. The red bars in Figure 5 show the electricity and natural gas EUI of Ayr Fire Station in comparison to similar Fire Station facilities (10,000 - 20,000 sqft.) in the database.

Table 11: Facility Electricity EUI comparison

Facility Electricity EUI	[kWh/ft^2]	3.1
Median Electricity EUI	[kWh/ft^2]	8.4
Facility Natural gas EUI	[m^3/ft^2]	0.51
Median Natural gas EUI	[m^3/ft^2]	1.5

Figure 6 compares the total annual electricity and natural gas consumption of all North Dumfries facilities.

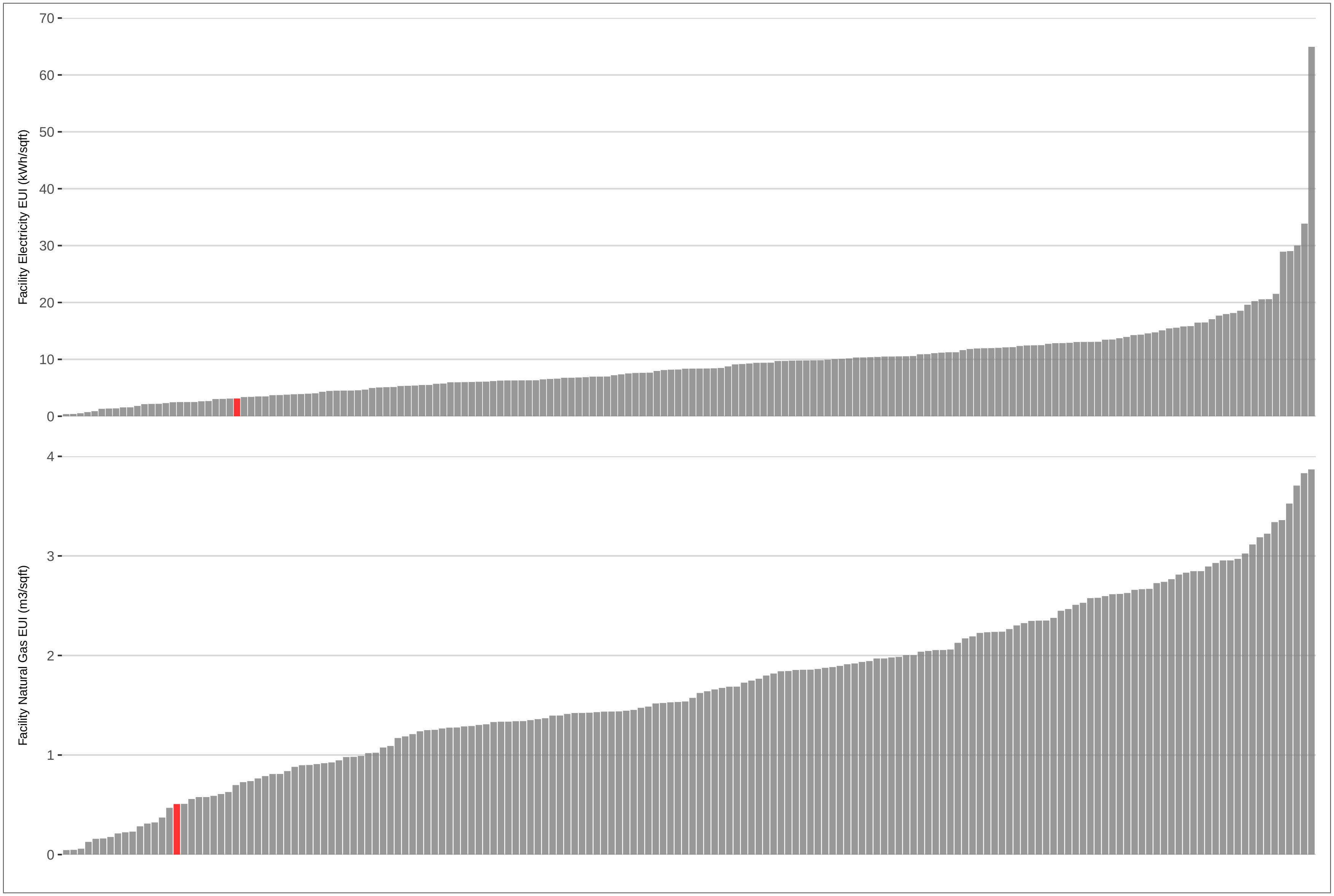


Figure 5: Electricity and natural gas energy use intensity by building

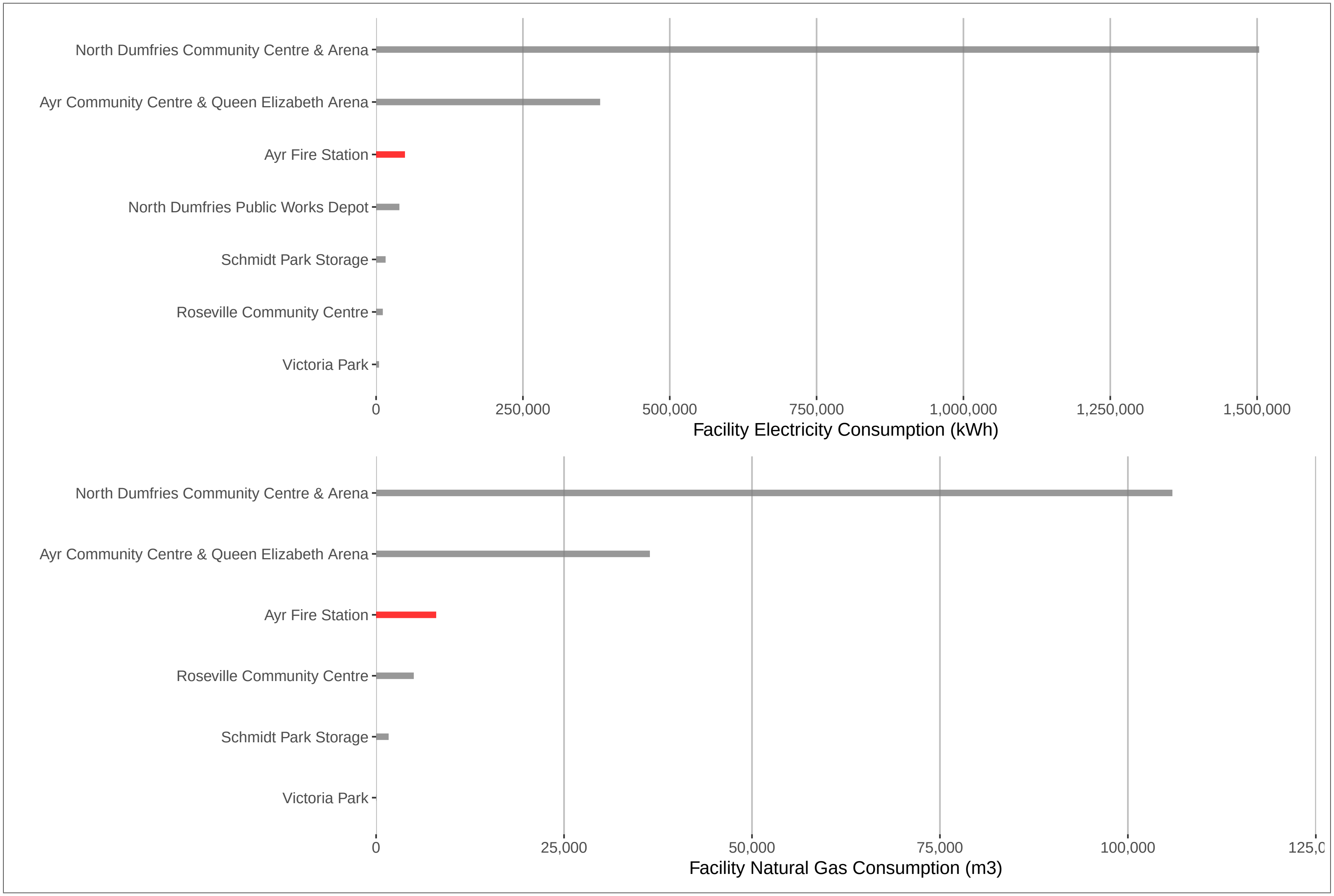


Figure 6: Annual electricity and natural gas energy use by building

3 EXISTING CONDITIONS

3.1 General facility information

Ayr Fire Station is a 2-storey Fire Station facility constructed in 1990. It consists mainly of a kitchen, training room, garage, cafeteria, and washrooms. Table 12 summarizes the general facility information for Ayr Fire Station.

Table 12: Facility background information

Facility name:	Ayr Fire Station
Location:	501 Scott Street, Ayr, ON
Number of floors:	2
Facility floor area:	15,572 ft^2
Year of construction:	1990
Building type:	Fire Station

3.2 Facility occupancy schedule

The facility operates throughout the year. Table 13 shows the typical weekly occupied hours for the facility.

Table 13: Typical weekly hours

Monday - Friday	24 hours
Saturday - Sunday	24 hours

3.3 Building envelope

Table 14: Existing building envelope details

Component	**Installed**	**Description**
Concrete unit masonry wall system	1990	concrete block foundation walls with steel frame construction
Concrete unit masonry wall system	1990	4” split architectural concrete block
Metal clad exterior walls	1990	prefinished metal vertical cladding
Exterior windows	1990	double glazed with metal frame
Exterior doors	1990	hollow metal doors with glazing
Overhead doors	1990	garage area doors
Sloped roofing structure	1990	standing seam metal roof
Gutters and downspouts	1990	eaves troughs for rain water drainage
Foundations	1990	concrete slab-on-grade
Basement construction	1990	concrete block basement walls

Exterior roof

The pitched roof above the building is comprised of a standing seam metal roof. The roofing is presumed to be original to the building.

Exterior walls

Concrete block foundation walls along with steel frame construction are viewed extending above grade as the primary foundational support for the building structure.

The block exterior walls consist of 4" split architectural concrete block as the cladding surrounding a majority of the bottom portion of the elevations. Prefinished metal vertical cladding is installed along the upper portion of the elevations.

(a) Exterior wall
Figure 7: Building exterior walls

Exterior windows and doors

Two double glazed windows fixed within metal frames are situated throughout the perimeter of the building and dates to manufacturing in 1990.

Two exterior hollow metal doors as well as one main entrance and one side entrance door with glazing provide the primary means of entry and egress for the building. The main entrance door leads into a vestibule. One exterior hollow metal door is provided for the parade truck shed.

Three overhead doors are installed as entry and egress points for the fire trucks into the garage. One overhead door is installed as a entry and egress point for the parade truck garage.

(a) Exterior door (b) Exterior door (c) Overhead door
Figure 8: Building exterior windows and doors

3.4 Mechanical systems

Table 15: Existing mechanical equipment

Description	Manufacturer	Model	Qty	Location	Installed	Size
Furnace	Carrier	58SCX060-GG	1	Mechanical room	2017	66000 BTHU
Electric wall heater	N/A	N/A	1	Front entrance	1990	N/A
Unit heater	N/A	N/A	1	Parade truck shed	1990	N/A
Radiant heater (gas)	Re-Verbeir-Ray	N/A	2	Garage	1990	N/A
DX split AHU (cool)	N/A	N/A	1	Site	2015	N/A
DX split AHU (cool)	N/A	N/A	1	Site	1990	N/A
Diesel generator	Stamford	UC1224E14	1	Generator room	1990	620 L
DHW heater	John Woods	JW 6058NA-FV-02	1	Mechanical room	2001	58000 BTHU
Water softener	Greenway	N/A	1	Generator room	2015	N/A

Space heating system

Space heating in areas such as washrooms, offices, cafeteria, and training rooms are provided by a natural gas furnace. The garage has heating provided by radiant tube heaters.

(a) Furnace (b) Radiant tube heater

Figure 9: Space heating systems

Space cooling system

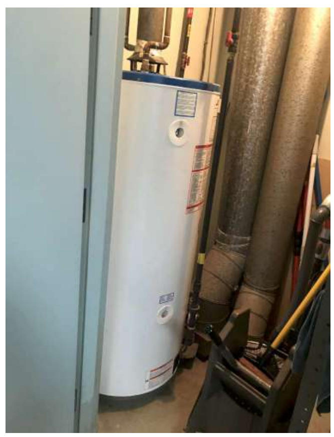
There are two air conditioning units which provide space cooling to the main and lower floors. The unit serving the lower floor is currently not operational. A small PTAC unit provides space cooling to the cafeteria on the main floor.

(a) Air conditioning unit (b) PTAC unit

Figure 10: Space cooling system

Domestic hot water system

Domestic hot water is provided by a natural gas domestic hot water boiler.



(a) DHW heater

Figure 11: Domestic hot water system

3.5 Lighting

Table 16: Existing lighting fixtures

Location	Fixture Type	Wattage	Quantity	Installed
Parking Lot	Wallpack	50	3	1990
Throughout	T8 Fluorescent	56	52	1990
Garage	T8 Fluorescent	112	16	1990

Exterior lighting

Exterior lighting consists of wall pack units on side elevations.

(a) Wallpack
Figure 12: Exterior lighting

Interior lighting

The interior spaces and garage areas have lighting provided by fluorescent T8 fixtures.

(a) Interior fluorescent fixtures (b) Interior fluorescent fixtures (c) Garage fluorescent fixtures
Figure 13: Interior lighting fixtures

3.6 Plumbing fixtures

Multiple plumbing fixtures were found throughout the building during inspection including: onesink, two shower stalls and one toilet in the basement men's washroom, one sink, one shower stall and one toilet in the basement men's washroom, one urinal, one toilet and one sink in the main floor men's washroom, two toilets and one sink in the main floor women's washroom, one toilet, one sink in the unisex washroom off the main fire hall, one slop sink in the janitor/mechanical room, one laundry basin sink in the laundry area and two stainless steel sinks in the kitchen.

Table 17: Existing plumbing fixtures

Description	Manufacturer	Qty	Location	Installed
Faucet	Moen	2	Basement washrooms	1990
Faucet	Moen	2	Main floor washrooms	1990
Faucet	Moen	1	Main fire hall washroom	1990
Faucet	Moen	1	Mechanical room	1990
Faucet	Moen	1	Laundry area	1990
Faucet	Moen	2	Kitchen	1990
Shower head	Moen	3	Basement washrooms	1990
Toilet	Moen	2	Basement washrooms	1990
Toilet	Moen	3	Main floor washrooms	1990
Toilet	Moen	1	Main fire hall washroom	1990
Urinal	Moen	1	Main floor washrooms	1990

(a) Washroom faucet (b) Toilet (c) Urinal

Figure 14: Typical plumbing fixtures

4 ENERGY CONSERVATION MEASURES

4.1 Building envelope upgrades

Building envelope upgrades typically include the following components:

- Roof: Increasing insulation to reduce heat losses through the roof.
- Exterior walls: Increase insulation to reduce heat losses through the exterior walls.
- Windows: Replacing old windows with new high efficiency windows to reduce heat losses through the windows.

Building envelope upgrades are not recommended to be considered until the envelope components are due for replacement due to the high cost of implementation, and low opportunity for utility savings. A qualitative analysis of the building envelope upgrades are presented in Table 18.

Table 18: Building envelope upgrades

Category	Description
Building component	Building envelope (roof, exterior walls, windows)
Recommended change	Increase insulation in roof and exterior walls, and replace windows
Impact on occupant comfort	Improved thermal comfort due to reduced heat loss, and increased air tightness
Estimated cost	High (> $100,000)
Estimated level of annual savings	Low (> 100 year payback)
Priority	Low

4.2 LED lighting retrofit

LED lighting technology continues to rapidly advance, resulting in increased energy efficiency, improved product reliability, increased selection, and reduced costs. Applications where lighting retrofits are typically the most feasible include facilities with dated light fixtures (prior to T8 fluorescent lamps), contain high light fixture densities (resulting in a high W/ft^2 ratio), and have extended daily use (24/7 operation). Replacing existing fixtures with LED fixtures can decrease overall lighting costs significantly, while providing improved lighting levels for occupants.

This report analyzes a LED fixture replacement with no fixture reduction. LED fixture replacement has the following benefits:

- Allows for the highest level of flexibility for enhanced lighting controls, whether it is tied to occupancy and daylight sensors, zonal controls, wireless, addressable sensors, or network solutions to be integrated on each luminaire.
- Maximized performance when the fixture body is designed with the proper heat dissipation for LED light sources.
- Optimized visual comfort with lenses designed to reduce LED glare and improve the light distribution.

Assumptions

- The existing light fixtures were retrofitted on a one-for-one basis.
- LED fixture replacement costs on a per fixture basis were held constant. No economies of scale were assumed.
- Costs include both fixture and installation costs.
- No maintenance cost savings were taken into account.
- Operating hours for the majority of fixtures are 8,760 hours per year.

Calculations

- The existing lighting electrical demand [kW] was determined by summing the electrical demand for all lights in the building.
- The existing lighting electrical demand [kW] was multiplied by the annual operating hours to determine the annual electricity consumption [kWh] for the existing lighting.
- A review of each existing light fixture type was completed to determine a suitable LED fixture replacement (per unit basis).
- An approximate cost and electrical power [W] for each LED fixture replacement was determined.
- The annual electricity consumption and monthly demand for the LED retrofit scenario was calculated and compared to the existing conditions.

Table 19 provides a summary of the LED lighting retrofit analysis results.

Table 19: LED lighting retrofit

ECM	Electricity Savings [kWh]	Nat. Gas Savings [m^3]	Cost Savings [$]	Capital Cost [$]	Utility Incentive [$]	Simple Payback [years]
LED lighting retrofit	19,902.7	0	2,219	10,800	995	4.4

Note: Cost savings calculated using utility rates from Table 5.

4.3 Radiant tube heater advanced sensors

Radiant tube heaters remain an energy efficient option, especially for large areas such as garages. This is because they can heat personnel directly rather than large volumes of air that would be distributed to the space.

There are a total of two radiant tube heaters in the fire truck garage which are controlled by and on/off switch. Advanced sensors can measure both ambient and radiant temperatures for more accurate temperature readings. They also sense when lights are turned off and automatically switch to unoccupied mode which has temperature setbacks. Installing these sensors can result in system efficiency improvements of up to 15%. A single sensor can be used to control a single radiant tube heater unit or multiple units in a single HVAC zone.

Assumptions

- Existing radiant tube heaters assumed to make up 50% of annual space heating natural gas consumption.
- Installing advanced temperature sensors will result in a 15% system efficiency improvement.
- A total of two sensors will be installed: one sensor each for the two units.

Calculations

- Natural gas consumption savings include savings from installation of advanced temperature sensors.
- Capital costs estimated using quotes obtained from suppliers.

Table 20 summarizes the results of the radiant tube heater advanced sensors analysis.

Table 20: Radiant tube heater upgrade

ECM	Electricity Savings [kWh]	Nat. Gas Savings [m^3]	Cost Savings [$]	Capital Cost [$]	Utility Incentive [$]	Simple Payback [years]
Radiant tube advanced controls	0.0	579	142	1,000	0	7.1

Note: Cost savings calculated using utility rates from Table 5.

4.4 Install rooftop solar PV system

A solar PV analysis was conducted for Ayr Fire Station using the HelioScope online modeling tool. A detailed report of the analysis and results can be found in the Appendices. This section provides a summary of the report's analysis and recommendations.

Assumptions

- The roof can structurally support the solar panels.
- Solar panels were placed with setbacks from roof edge and accounting for existing rooftop structures and shading.
- Solar panels were arranged in a configuration to maximize power production.

Calculations

- 119 x 320 W panels for total system size of 38 kW.
- Demand savings estimated at 20% of total system size.
- Electricity will be credited under a net metering scenario at the utility price of $0.112/kWh.
- Total system installed cost estimated at $3.00/W.

Table 21 summarizes the results of the solar PV analysis.

Table 21: Install solar PV system

ECM	**Electricity Savings** [kWh]	**Nat. Gas Savings** [m^3]	**Cost Savings** [$]	**Capital Cost** [$]	**Utility Incentive** [$]	**Simple Payback** [years]
Install solar PV system	42,060.0	0	4,690	114,200	0	24.3

Note: Cost savings calculated using utility rates from Table 5.

4.5 Replace plumbing fixtures

The existing plumbing fixtures are described in Section 3.6. Replacing the existing fixtures with new low flow fixtures presents an opportunity to reduce water consumption and natural gas consumption through reduced domestic hot water consumption

Table 22 compares existing fixtures to new low flow fixtures.

Table 22: Proposed plumbing fixtures

Fixture	**Duration** [min]	**Current Flow** [lpm]	**Current Use** [m^3]	**New Flow** [lpm]	**New Use** [m^3]	**Savings** [m^3]
Shower head	5	9.5	173	5.7	104	69
Washroom faucet	0.25	6	22	4.5	16	5.5
Toilet	N/A	6	88	4.8	70	18

Assumptions

- Current water consumption for plumbing fixtures was estimated based on age and type of fixture.
- Showers were assumed to be used for 5 minutes per use and 1 times per day by 10 occupants during the year.
- Washroom faucets were assumed to be used for 0.25 minutes per use and 4 times per day by 10 occupants during the year.
- Toilets were assumed to be used 4 times per day by 10 occupants during the year.
- DHW heaters assumed to be 80% efficient.
- Hot water required to be heated from 50°F to 80°F.

- Assumed hot and cold water use to be split evenly.

Calculations

- Current and retrofit water consumption was calculated using the following formula:

$$\text{Consumption } [m^3] = \text{Number of Occupants x Daily use x Duration [min] x Flow [lpm] x Days of Operation} / 1000\ [L/m^3]$$

- Current and retrofit hot water heating energy was calculated using the following formula and converted to m^3 of natural gas:

$$\text{Consumption [Btu]} = \text{Water use [lbs] x Temperature rise [°F]} / \text{Heater efficiency [\%]]}$$

- Capital costs are $300/fixture for faucets and shower heads and $700 per toilet.

Table 23 provides a summary of the water use savings by replacing all shower heads, toilets, and washroom faucets. Replacement is only recommended when the fixtures have reached the end of their useful life.

Table 23: Replace plumbing fixtures

ECM	Nat. Gas Savings [m^3]	Water Savings [m^3]	Cost Savings [$]	Capital Cost [$]	Utility Incentive [$]	Simple Payback [years]
Replace shower heads	217	69	246	600	0	2.4
Replace washroom faucets	17	5	19	1,200	0	61.8
Replace toilets	0	18	49	3,500	0	71.9

Note: Cost savings calculated using utility rates from Table 5.

5 RECOMMENDATIONS

Table 24 summarizes the annual energy savings and simple paybacks for the conservation measures evaluated in this report. Conservation have been sorted based on their payback period.

Table 24: Conservation measures summary table

ECM	Electricity Savings [kWh]	Nat. Gas Savings [m^3]	Cost Savings [$]	Capital Cost [$]	Utility Incentive [$]	Simple Payback [years]
Replace shower heads	0.0	217	246	600	0	2.4
LED lighting retrofit	19,902.7	0	2,219	10,800	995	4.4
Radiant tube advanced controls	0.0	579	142	1,000	0	7.1
Install solar PV system	42,060.0	0	4,690	114,200	0	24.3
Replace washroom faucets	0.0	17	19	1,200	0	61.8
Replace toilets	0.0	0	49	3,500	0	71.9

Note: Cost savings calculated using utility rates from Table 5.

Table 25 summarizes the conservation measures recommended for implementation or further investigation. These were selected as they had a payback period of less than 10 years.

Table 25: Recommended conservation measures summary table

ECM	**Electricity Savings** [kWh]	**Nat. Gas Savings** [m^3]	**Cost Savings** [$]	**Capital Cost** [$]	**Utility Incentive** [$]	**Simple Payback** [years]
Replace shower heads	0.0	217	246	600	0	2.4
LED lighting retrofit	19,902.7	0	2,219	10,800	995	4.4
Radiant tube advanced controls	0.0	579	142	1,000	0	7.1

Note: Cost savings calculated using utility rates from Table 5.

Table 26 summarizes all ECMs which were analyzed qualitatively.

Table 26: Qualitative ECM summary table

ECM	**Estimated Cost**	**Estimated Annual Savings**	**Priority**
Building envelope upgrades	High	Low	Low

APPENDICES