ASHRAE LEVEL II ENERGY AUDIT

THE TOWNSHIP OF NORTH DUMFRIES

AYR COMMUNITY CENTRE
7 Church St, Ayr, Ontario

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 Community Centre located at 7 Church St in Ayr, Ontario.

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

Josh Gibbins, P.Eng.
Senior Energy Engineer
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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 Community Centre located at 7 Church St in Ayr, Ontario.

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 Community Centre. 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 Community Centre is a 2 storey arena facility built in 1945.

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

Table 1: Facility annual utility summary

Annual Electricity Consumption	[kWh]	381,446
Annual Electricity Cost	[$]	45,774
Facility Electricity EUI	[kWh/ft^2]	10.9
Median Electricity EUI	[kWh/ft^2]	15.4
Annual Natural Gas Consumption	[m^3]	36,422
Annual Natural Gas Cost	[$]	7,834
Facility Natural Gas EUI	[m^3/ft^2]	1.3
Median Natural Gas EUI	[m^3/ft^2]	1.3
Annual Water Consumption	[m^3]	2,355
Annual Water Cost	[$]	6,546

*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]
LED lighting retrofit	34,366	15.4	0	5,299	26,600	6,170	3.9
Electric baseboard programmable thermostat	972	0.0	0	117	500	0	4.3
Brine pump controls	8,897	0.0	0	1,068	7,500	890	6.2
Zamboni floodwater treatment	29,628	0.0	5,156	4,664	35,000	2,963	6.9
Floating head pressure controls	30,250	0.0	0	3,630	35,000	3,025	8.8

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 Community Centre facility at 7 Church St in Ayr, Ontario. 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 9, 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 Treasurer, Director of Corporate Services 519.632.8800 x123 sstedall@northdumfries.ca	Josh Gibbins, P.Eng. Senior Energy Engineer 519.576.2150 x480 jgibbins@walterfedy.com
The Township of North Dumfries 2958 Greenfield Road Ayr, ON N0B 1E0	WalterFedy 675 Queen Street South, Suite 111 Kitchener, ON N2M 1A1

2 HISTORICAL ENERGY USE ANALYSIS

2.1 General information

Electricity, natural gas, and water suppliers for Ayr Community Centre are summarized in Table 4.

Table 4: Facility utility information.

Facility Name:	Ayr Community Centre
Location:	7 Church St, Ayr, Ontario
Electrical LDC*:	Energy+
LDC Account No.:	00009266-00
Natural Gas Distributor:	Union Gas
NG Account No.:	190-3796 175-5418
Water Provider:	Region of Waterloo
Water Account No.:	210 10003 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 last 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	[$/kWh]	0.12
Electrical Demand	[$/kW]	12.7
Natural Gas Consumption	[$/m^3]	0.22
Water Consumption	[$/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 Community Centre for the baseline year of 2017.

Table 7: Facility annual electricity consumption

Annual Electricity Consumption	[kWh]	381,446
Annual Electricity Consumption Costs	[$]	45,774

As seen in Figure 1, electricity consumption varies with time of year. Summer electricity consumption reflects baseload use of lighting, appliances and other plug loads, the domestic hot water recirculating pump, and the supply and exhaust fans that are part of the ventilation system.

Electrical demand

Figure 2 shows monthly peak demand for the previous two years. The monthly peak demand is much higher in the winter season when the refrigeration system is operational.

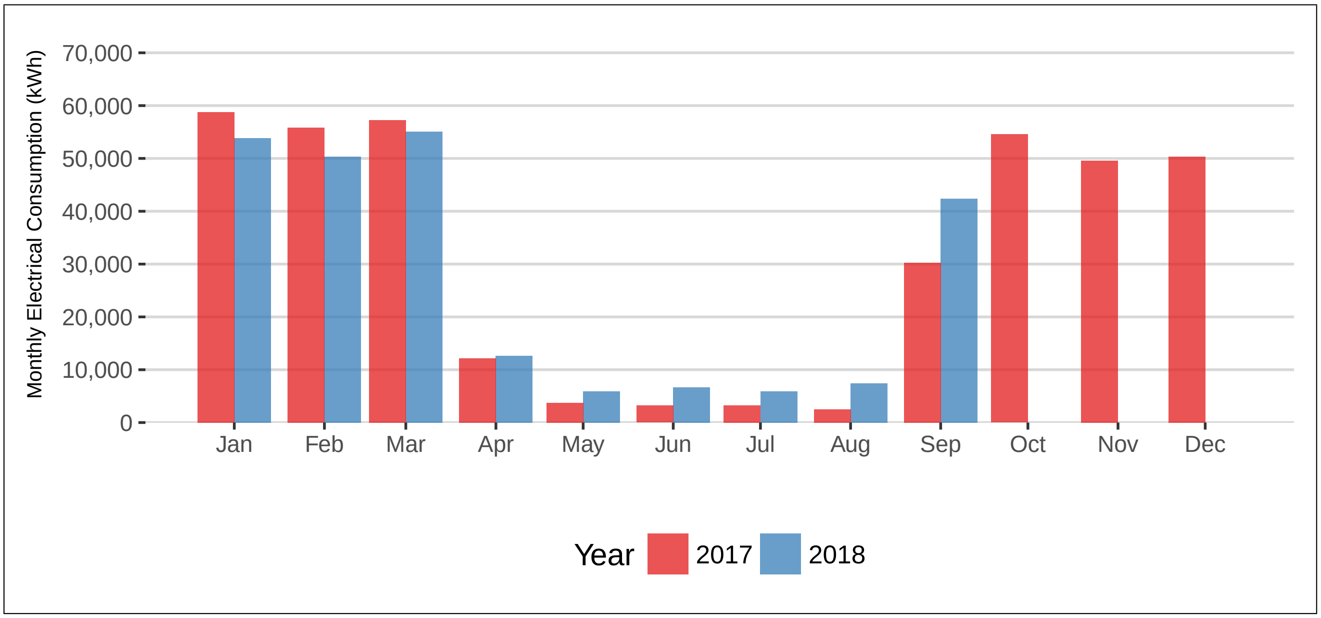


Figure 1: Monthly electricity consumption for the baseline period

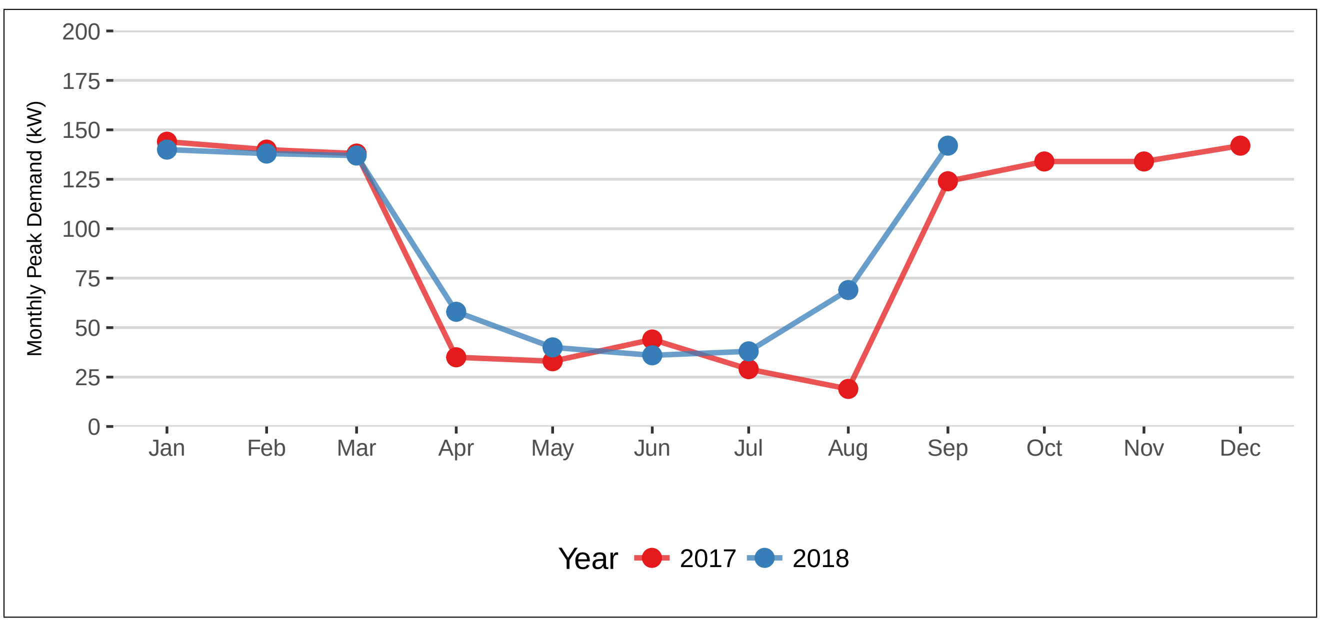


Figure 2: Monthly peak demand for the baseline period

Natural gas consumption

Table 8 summarizes the annual natural gas consumption of Ayr Community Centre for the baseline year of 2017.

Table 8: Facility annual natural gas consumption

Annual Natural Gas Consumption	[m^3]	36,422
Annual Natural Gas Consumption Costs	[$]	7,834

Natural gas is used for heating domestic hot water and for heating the ventilation air during the winter season. As seen in Figure 3, 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.

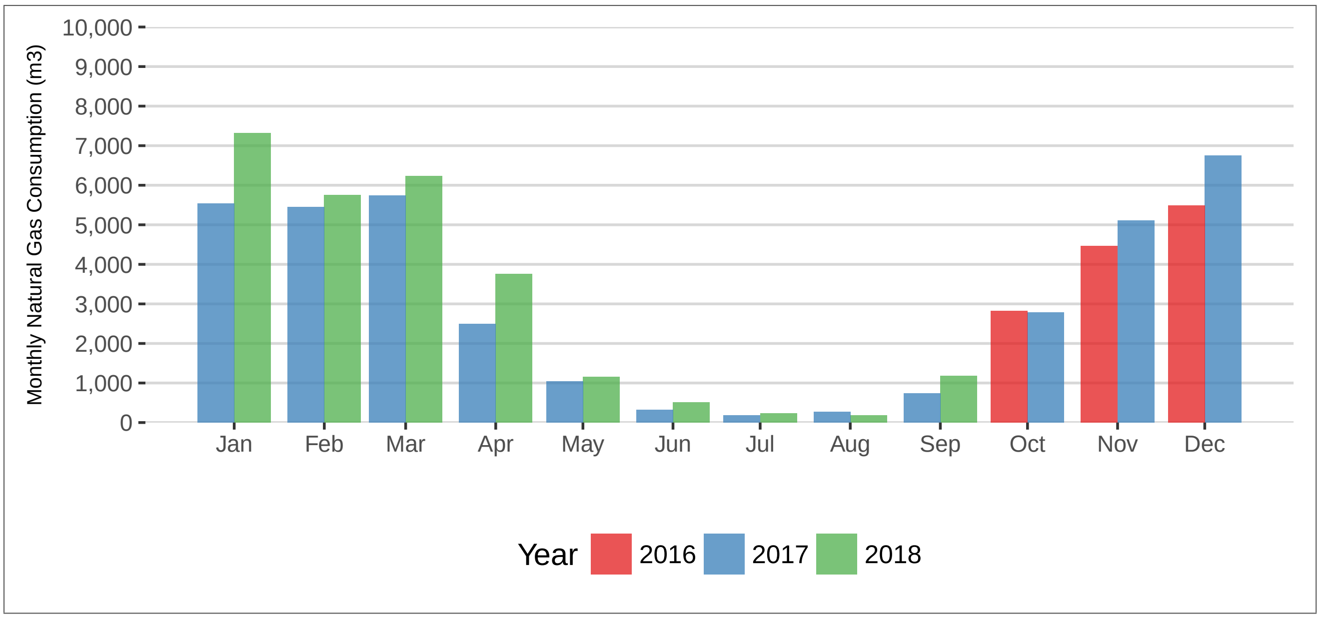


Figure 3: Monthly natural gas consumption for the baseline period

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 4.

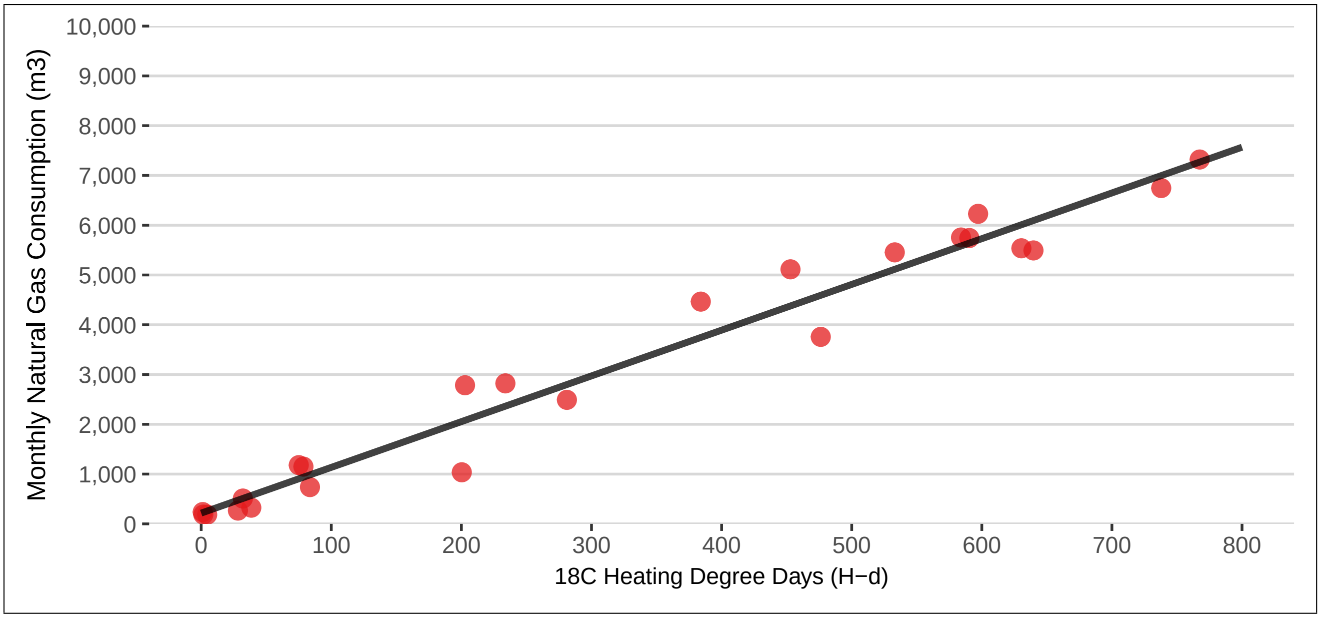


Figure 4: Linear regression of natural gas consumption vs. heating degree days

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

$$\text{Natural gas consumption } [m^3] = 216 + 9.2 \times 18°C \text{ HDD } (r^2 = 0.97)$$

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, 97% 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 Community Centre for the baseline year of 2017.

Table 9: Facility annual water consumption

Annual Water Consumption	[m^3]	2,355
Annual Water Consumption Costs	[$]	6,546

Figure 5 summarizes the monthly water consumption. Water consumption is slightly lower during the summer season. However, it is observed that there was an abnormally large increase in water consumption in March 2018 - April 2018 and September 2018 - October 2018.

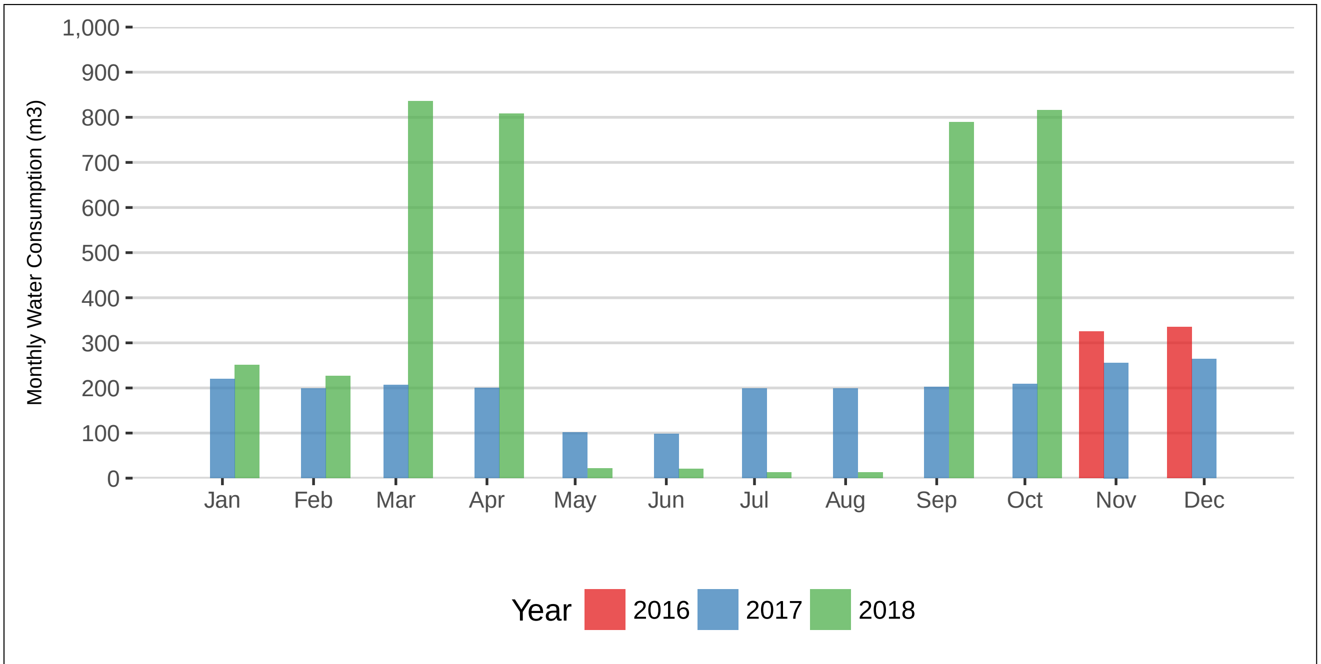


Figure 5: Monthly water consumption for the baseline period

2.6 Energy end uses

Table 10 summarizes the energy end uses for Ayr Community Centre.

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** [$]
Refrigeration	-	67,787	67,787	8.9	8,134
Space Heating	25,002	3,240	267,175	34.9	5,767
HVAC	-	199,557	199,557	26.1	23,947
Water Heating	11,420	-	120,557	15.7	2,456
Lighting	-	83,851	83,851	10.9	10,062
Appliances/Plug loads	-	27,011	27,011	3.5	3,241
Totals	36,422	381,446	765,937	100	53,608

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, circulation pumps, cooling tower, etc..
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 for the summer by regression analysis. An adjustment factor was applied to this to account for increased usage in the winter time.
- Domestic hot water heating natural gas consumption required to resurface the ice was also estimated assuming the ice is resurfaced eight times per day during the operating season.
- 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 refrigeration, space heating, HVAC, lighting, and plug loads.
- Refrigeration electricity consumption estimated based on arenas of similar type and size.
- Space heating electricity consumption estimated based on 12 W/ft^2 operating continuously during the operating season for areas with electric baseboard heating.
- Interior lighting electricity consumption estimated based on typical operating hours throughout the operating season.
- Exterior lighting electricity consumption estimated based on 12 hour/day operation throughout the year.
- Plug loads estimated at 0.25 W/ft^2 operating continuously throughout the operating season.
- HVAC electricity consumption estimated calculated as the difference between the total annual electricity consumption and the sum of the refrigeration, space heating, lighting, and plug loads 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 arena 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 Community Centre is 30% below the median electricity EUI and is 1.3% above the median natural gas EUI for similar arena facilities. The red bars in Figure 6 show the electricity and natural gas EUI of Ayr Community Centre in comparison to similar arena facilities in the database.

Table 11: Facility Electricity EUI comparison

Facility Electricity EUI	[kWh/ft^2]	10.9
Median Electricity EUI	[kWh/ft^2]	15.4
Facility Natural gas EUI	[m^3/ft^2]	1.3
Median Natural gas EUI	[m^3/ft^2]	1.3

Figure 7 compares the total annual electricity and natural gas consumption of all North Dumfries facilities.

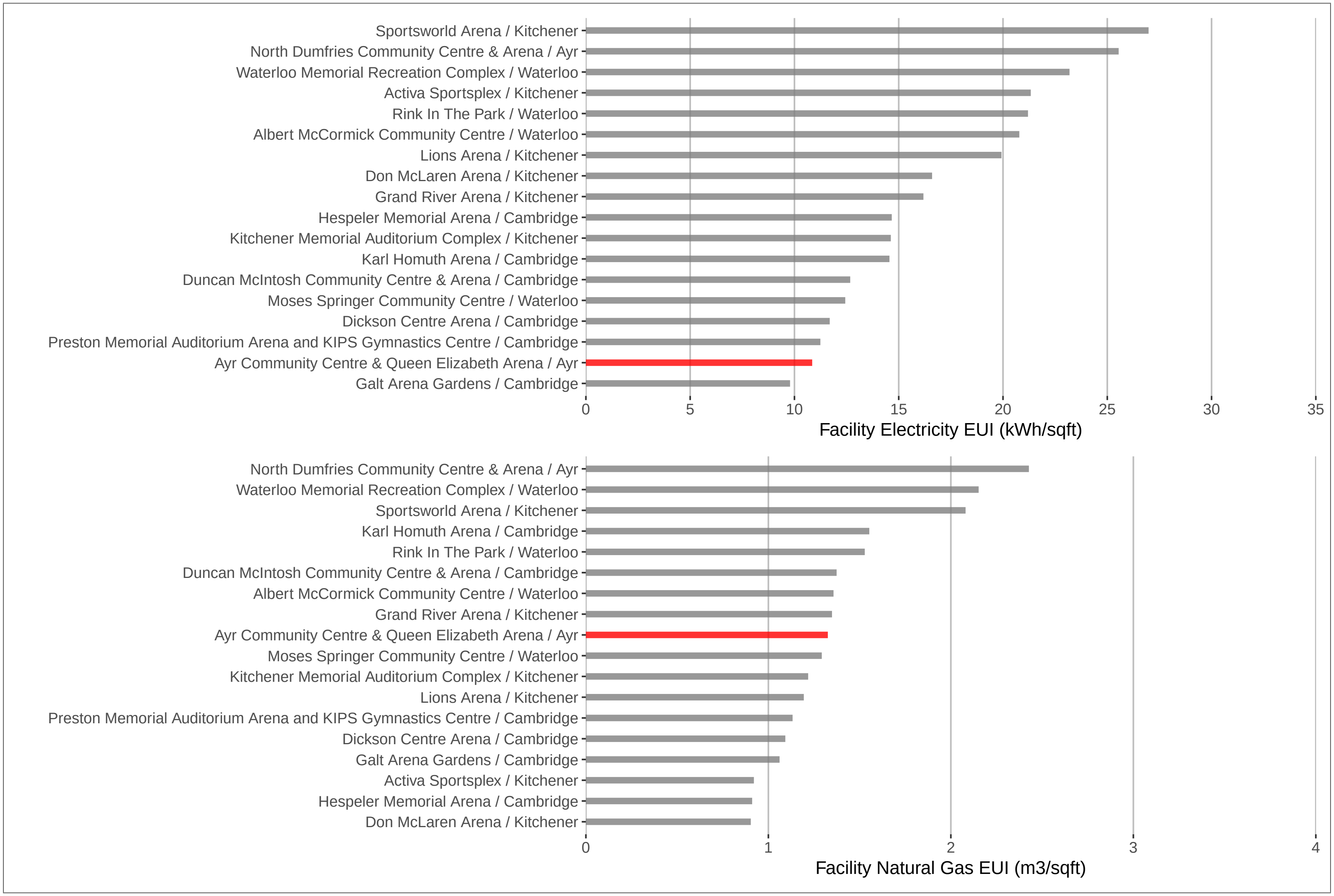


Figure 6: AElectricity and natural gas energy use intensity by building

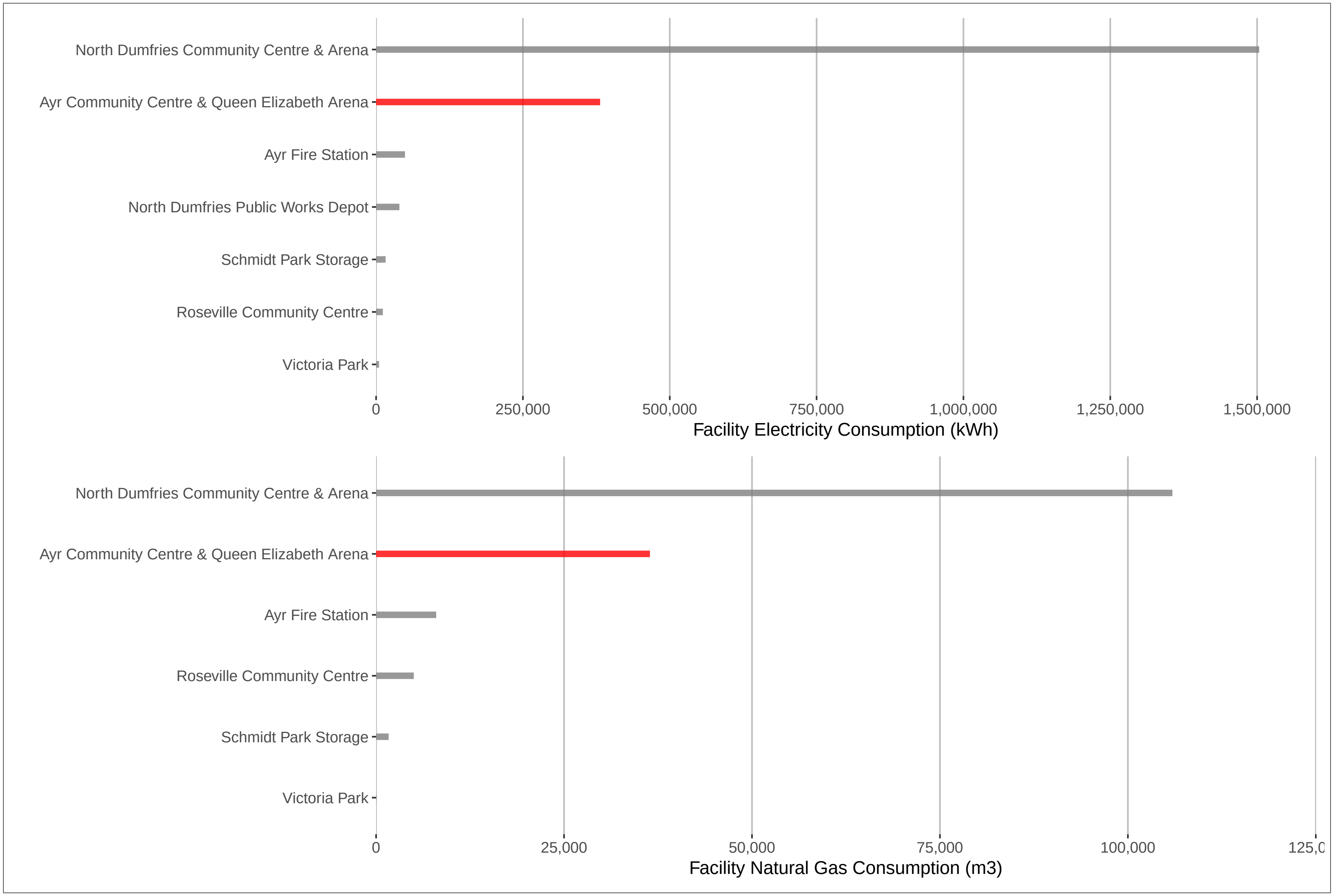


Figure 7: Annual electricity and natural gas energy use by building

3 EXISTING CONDITIONS

3.1 General facility information

Ayr Community Centre is a 2-storey arena facility constructed in 1945. It consists mainly of an ice rink, change rooms, concession areas, and spectator areas. Table 12 summarizes the general facility information for Ayr Community Centre.

Table 12: Facility background information

Facility name:	Ayr Community Centre
Location:	7 Church St, Ayr, Ontario
Number of floors:	2
Facility floor area:	30,012 ft^2
Year of construction:	1945
Building type:	Arena

3.2 Facility occupancy schedule

The facility operates from January to mid-March and mid-October to December. Table 13 shows the typical occupied hours during the operating season.

Table 13: Typical weekly hours

Monday - Friday	10:00 am - 12:00 am
Saturday - Sunday	7:00 am - 12:00 am

3.3 Building envelope

Table 14: Existing building envelope details

Component	Installed	Description
Pitched roof	1977	standing seam metal roof above rink
Low-slope roof	1977	corrugated steel decking with rigid insulation
Block masonry wall	1977	8" full face split architectural concrete block
Brick masonry wall	1977	bottom portion of northeast elevation next to main entrance
Metal siding	1977	Pre-finished metal vertical cladding
Vinyl framed windows	1977	double glazed windows on first and second floor
Aluminium framed windows	1977	double glazed windows on second floor
Overhead Doors	1977	
Aluminium framed glazed doors	2010	automatic sliding doors at main entrance
Exterior Doors	1977	hollow metal doors with metal frames
Arena Foundation	1977	concrete slab, rigid insulation
Floor Foundation	1977	4" poured reinforced concrete

Exterior roof

The pitched roof above the rink is comprised of a standing seam metal roof. The two low slope roofing levels are comprised of corrugated steel decking, with rigid insulation, built-up roofing assembly of triple ply asphalt membrane and a gravel ballast with parapet walls capped with metal flashing.

Exterior walls

The block exterior walls consist of 8" full face split architectural concrete block as the cladding surrounding a majority of the bottom portion of the elevations. A section of the bottom portion of the northeast elevation consists of brick masonry walls next to the main entrance. It appears the wall was once was finished with a concrete topping which is still apparent on a portion of the wall. Prefinished metal vertical cladding is installed along the upper portion of the elevations.

(a) Exterior block wall (b) Exterior wall with brick veneer

Figure 8: Building exterior walls

Exterior windows and doors

Double glazed, vinyl framed exterior windows are installed on the first and second floor. Double glazed, aluminum framed exterior windows are installed in the second floor hall. The main entrance vestibule has two aluminum framed glazed sliding doors complete with automatic door openers. Hollow metal doors in metal frames are positioned along the perimeter of the building. There are two installed overhead doors throughout the building.

(a) Exterior door (b) Exterior windows (c) Window details

Figure 9: Building exterior windows and doors

3.4 Mechanical systems

Table 15: Existing mechanical equipment

Description	Manufacturer	Model	Qty	Location	Installed	Size
DHW boiler	Rheem Ruud	G76-200-1	1	Service room	2002	199.9 MBH
DHW boiler	Bradford White	M265R8DS-INCWW	2	Water service room	1995	4.5 kW
DHW tank	AO Smith	T 120V 000	1	Service room	N/A	119 US GAL
DHW circulating pump	Armstrong	N/A	1	Service room	N/A	N/A
Condensing furnace	Luxaire	LP9C120D20MP12CB	5	Furnace closet	2013	120 MBH
Unit heater (electric)	Oulett	N/A	2	Various	1977	N/A
Baseboard heater	Stelpro	N/A	8	Dressing room	1977	N/A
Unit heater (gas)	Reznor	N/A	1	Ice resurfacing room	2013	N/A
Suspension heater	Federal Pioneer	UH27-581-1	3	Various	N/A	5 kW
Radiant tube heater	Brant Radiant	N/A	1	Bleachers	2017	N/A
Radiant tube heater	N/A	N/A	1	Bleachers	1977	N/A
Exhaust fan	N/A	N/A	6	Washrooms	N/A	N/A
Exhaust fan	N/A	N/A	2	Dressing room	1977	N/A
Circulation fan	N/A	N/A	1	Ice resurfacing room	1977	N/A
Kitchen exhaust	N/A	N/A	1	Party room	N/A	N/A
Exhaust fan	N/A	N/A	1	N/A	N/A	0.5 HP
Dehumidifier	Dry Solutions	DS-4000	1	Arena	2018	N/A
Packaged AHU	Engineered Air	N/A	1	Roof	1977	N/A

Space heating system

Space heating in areas such as washrooms, offices, and common areas are provided by a combination of natural gas furnaces, electric and gas unit heaters, and electric baseboard heaters. Space heating in change rooms is provided by a packaged AHU located on the roof. Radiant tube heaters provide space heating to the bleacher sections of the arena.

Domestic hot water is provided by several domestic hot water heaters. There are a number of exhaust fans located throughout the building.

(a) Furnace (b) Unit heater (c) Baseboard heater (d) Radiant tube heater

Figure 10: Space heating systems

Domestic hot water system

(a) DHW heater (b) DHW tank

Figure 11: Domestic hot water system

3.5 Lighting

Table 16: Existing lighting fixtures

Location	Fixture Type	Wattage	Quantity	Installed
Parking lot	LED Wall Packs	70	5	N/A
Throughout	T8/T12 Fluorescents	56	58	1977
Arena	Halogen Hi-Bay	756	44	1977
Party Room	CFL	15	29	N/A

Exterior lighting

Exterior lighting consists of wall pack units which have been replaced with LED fixtures.

(a) Wallpack (b) Exterior lighting

Figure 12: Exterior lighting

Interior lighting

Change rooms and common areas have a mixture of T8 and T12 fluorescent fixtures. The arena has halogen hi-bay fixtures.

(a) Fluorescent fixtures (b) Halogen fixtures (c) CFL fixtures

Figure 13: Interior lighting

3.6 Refrigeration

Table 17: Existing arena equipment

Description	Manufacturer	Model	Qty	Location	Installed	Size
Chiller	CIMCO	N/A	1	N/A	1977	N/A
Compressor	Mycom	N/A	1	Compressor room	1977	N/A
Chilled water pump	WEG	00158EP3H145JM	1	N/A	1977	1.5 HP
Chilled water pump	WEG	T0D1C0X0H0000301746		N/A	1977	2 HP
Cooling tower	CIMCO	N/A	1	Roof	2015	N/A
Condenser water pump	Bluffton Motor Works	1113017407	1	Compressor room	1977	0.5 HP

(a) Cooling tower

Figure 14: Arena cooling system

3.7 Plumbing fixtures

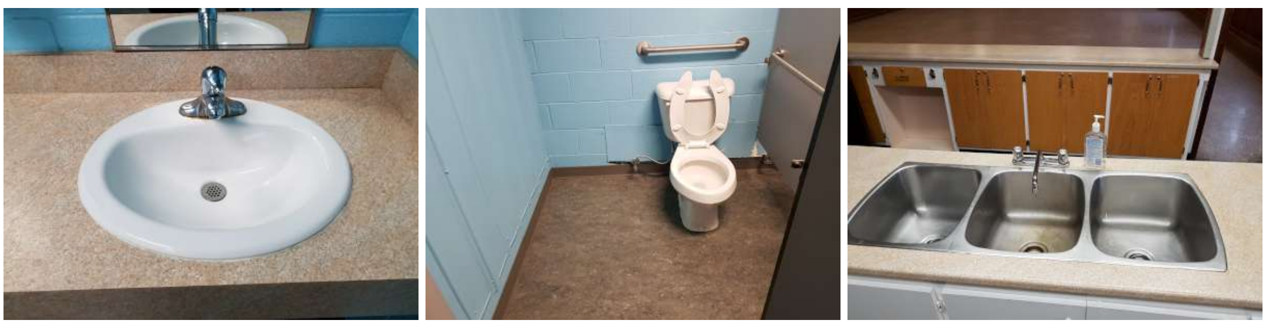
The men's and ladies public washrooms are equipped with floor mounted, toilets. They are manufactured by American Standard and Crane Plumbing. The men's washroom typically has two toilets, two urinals and two wall mounted lavatories. The women's washroom typically has three toilets and two wall mounted lavatories.

There are a total of six dressing rooms plus one referee dressing room. Each dressing room has one toilet, one lavatory and one shower with two heads.

There is one triple-basin stainless steel sink with two separate faucets, one double-basin stainless steel sink with one faucet and one single basin sink with one faucet in the kitchen within the party room.

Table 18: Existing plumbing fixtures

Description	**Manufacturer**	**Qty**	**Location**	**Installed**
Toilet	American Standard/Crane	7	Washrooms	1977
Toilet	American Standard/Crane	7	Change rooms	1977
Shower head	American Standard/Crane	14	Change rooms	1977
Faucet	American Standard/Crane	11	Bathroom	1977
Faucet	Moen	4	Party room	1977



(a) Washroom faucet (b) Lavatory (c) Kitchen faucet

Figure 15: 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 19.

Table 19: 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	Medium (Envelope is old, but low opportunity for utility cost savings)

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 2,228 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 20 provides a summary of the LED lighting retrofit analysis results.

Table 20: LED lighting retrofit

ECM	Electricity Savings [kWh]	Demand Savings [kW]	Nat. Gas Savings [m^3]	Cost Savings [$]	Capital Cost [$]	Utility Incentive [$]	Simple Payback [years]
LED lighting retrofit	34,366	15.4	0	5,299	26,600	6,170	3.9

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

4.3 Electric baseboard programmable thermostat

As stated previously, the office and the two adjacent washrooms have heating provided by electric baseboards which operate continuously to maintain the temperature of the spaces. Electricity consumption savings can be achieved by installing programmable thermostats on the baseboard heaters as setbacks can be implemented during unoccupied hours.

Assumptions

- Installing programmable thermostat will allow the operating hours of the electric baseboards to be reduced by 30%.

Calculations

- Electricity consumption savings calculated using the annual space heating electricity consumption and the assumed efficiency improvement from the programmable thermostat.

Table 21 provides a summary of the electric baseboard programmable thermostat analysis results.

Table 21: Electric baseboard programmable thermostat

ECM	Electricity Savings [kWh]	Demand Savings [kW]	Nat. Gas Savings [m^3]	Cost Savings [$]	Capital Cost [$]	Utility Incentive [$]	Simple Payback [years]
Electric baseboard programmable thermostat	972	0.0	0	117	500	0	4.3

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

4.4 Replace electric baseboard heating

The office and the two adjacent washrooms have heating provided by electric baseboards. The electric baseboards are assumed to operate continuously to maintain the temperature of the spaces and have no setbacks. Utility cost savings can be achieved by replacing the electric baseboards with a natural gas condensing furnace complete with programmable thermostat. Natural gas has a lower cost per unit of energy than electricity, and the programmable thermostat presents an opportunity to implement setbacks during unoccupied hours.

It is recommended to install condensing furnaces as they can reach efficiencies of up to 98%.

Assumptions

- Proposed condensing furnace will have an output of an efficiency of 90%.
- A programmable thermostat will be installed with the proposed condensing furnace.

Calculations

- All electricity consumption used for electric baseboard heating was converted to natural gas consumption at 90 efficiency.
- Cost savings calculated as the difference in electricity and natural gas consumption costs.
- Equipment costs estimated using RSMeans 2015.
- An incentive of $200 per condensing furnace is available from Union Gas.

Table 22 provides a summary of the electric baseboard replacement analysis results.

Table 22: Replace electric baseboard heating

ECM	**Electricity Savings** [kWh]	**Demand Savings** [kW]	**Nat. Gas Savings** [m^3]	**Cost Savings** [$]	**Capital Cost** [$]	**Utility Incentive** [$]	**Simple Payback** [years]
Replace electric baseboard heating	2,268	0.0	-239	221	10,100	200	44.8

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

4.5 Radiant tube heater upgrade

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 arena seating area 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 5% of annual space heating natural gas consumption.
- The old radiant tube heater will be replaced by a model of similar capacity and length.
- New models have an Infrared (IR) efficiency of 50% in comparison to 45% for the older models.
- 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 and the IR efficiency improvement.
- Natural gas consumption savings calculated as the annual radiant tube heater natural gas consumption multiplied by the system efficiency improvements described previously.
- Capital costs estimated using quotes obtained from suppliers.
- An incentive of $300 per radiant heater is available from Union Gas.

Table 23: Radiant tube heater upgrade

ECM	**Electricity Savings** [kWh]	**Demand Savings** [kW]	**Nat. Gas Savings** [m^3]	**Cost Savings** [$]	**Capital Cost** [$]	**Utility Incentive** [$]	**Simple Payback** [years]
Radiant tube heater upgrade	0	0.0	250	54	3,300	300	55.8

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

4.6 Zamboni floodwater treatment

REALice is a water treatment device for ice arenas to remove micro-air bubbles from water that is used when laying and resurfacing the ice. This high precision de-aeration makes it possible to flood the ice with unheated water to create hard and resilient ice and lower utility costs.

The financial saving mechanisms for the REALice system are as follows:

1. Reduction in thermal energy required to heat up the resurfacing water.
2. Reduction in electricity for the operation of the refrigeration plant as 1) low-temperature resurfacing water is applied to the ice surface and, 2) the ice rink slab temperature is raised to allow resurfacing water to freeze an an appropriate rate.

Assumptions

- The Ayr Community Centre is assumed to be comparable to other similar arena facilities.

Calculations

- Electricity and natural gas consumption savings are estimated based on the performance of the REALice system at comparable facilities.

Table 24 provides a summary of the Zamboni floodwater treatment analysis results.

Table 24: Zamboni floodwater treatment

ECM	**Electricity Savings** [kWh]	**Demand Savings** [kW]	**Nat. Gas Savings** [m^3]	**Cost Savings** [$]	**Capital Cost** [$]	**Utility Incentive** [$]	**Simple Payback** [years]
Zamboni floodwater treatment	29,628	0.0	5,156	4,664	35,000	2,963	6.9

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

4.7 Refrigeration system waste heat recovery

There are two primary methods to recover waste heat in an ammonia refrigeration plant:

1. Recovery of ammonia vapour superheat. The ammonia vapour at the outlet of the compressors is superheated, typical temperatures are approximately 200F. At this temperature the grade of the heat is high and can be used to preheat domestic hot water prior to the vapour fully condensing in the evaporative condensing unit (fluid cooler). This is a common practice in new refrigeration plant installations.
2. Recovery of ammonia condensation heat. The typical condensing temperature of ammonia is 95F. While a significant amount of heat is rejected to atmosphere in the evaporative condensing unit, the grade of the rejected heat is low and can not be used to fully heat domestic hot water. Typical uses are snow melt and heating coils (space heating) if additional heat pumps are utilized.

Assumptions

- The Ayr Community Centre is assumed to be comparable to other similar arena facilities.

Calculations

- The results of an investigation of the financial feasibility of an ammonia desuperheater in a **separate detailed study** of preheating domestic hot water using the desuperheater described. Based on the similarities in the facilities, the results of this separate study are a reasonable indicator of how a desuperheater would perform at Ayr Community Centre.

Table 25 provides a summary of the refrigeration system waste heat recovery analysis results.

Table 25: Refrigeration system waste heat recovery

ECM	**Electricity Savings** [kWh]	**Demand Savings** [kW]	**Nat. Gas Savings** [m^3]	**Cost Savings** [$]	**Capital Cost** [$]	**Utility Incentive** [$]	**Simple Payback** [years]
Refrigeration system waste heat recovery	0	0.0	2,958	636	20,000	0	31.4

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

4.8 Floating head pressure controls

Refrigeration systems are designed to move heat from the ice pad to the building exterior. Typically, the operation of the system requires that the ammonia vapour condense at 95F in the evaporative condensing unit. This fixed setpoint has been established such that the system can function in the hottest days of the summer and traditionally was operated in this manner throughout the entire year. However, for the majority of the year (when it is cooler outside) the temperature setpoint where the ammonia vapour condenses can be lowered increasing the efficiency of the refrigeration plant. The condensation temperature of the ammonia is controlled by the discharge (head) pressure of the compressors.

CIMCO, has developed a refrigeration system controller (Seasonal Plus Controller) that "floats" the head pressure of the compressors based on outside air conditions. The head pressure setpoint is dynamically changed by the controller in response to the outdoor wet bulb temperature to allow condensing at the lowest temperature possible. In using floating head pressure control, the condenser fan is constantly operating at a variable speed rather than cycling on and off. The process of floating head pressure improves the efficiency of the compressors, saving electricity.

In addition, the Seasonal Plus Controller includes a infra-red (IR) camera mounted over the ice rink to more accurately monitor the ice surface temperature, the current refrigeration system controller monitors the slab temperature to determine when additional cooling is required. Monitoring of the ice surface temperature (compared to slab temperature) allows for a faster response from the refrigeration plant.

A case study of an arena refrigeration plant in both fixed and floating head pressure control mode (50F wet bulb) was highlighted in an ASHRAE journal. This article provided a comparison of compressor COP in both modes clearly showing the benefit of a floating head pressure strategy.

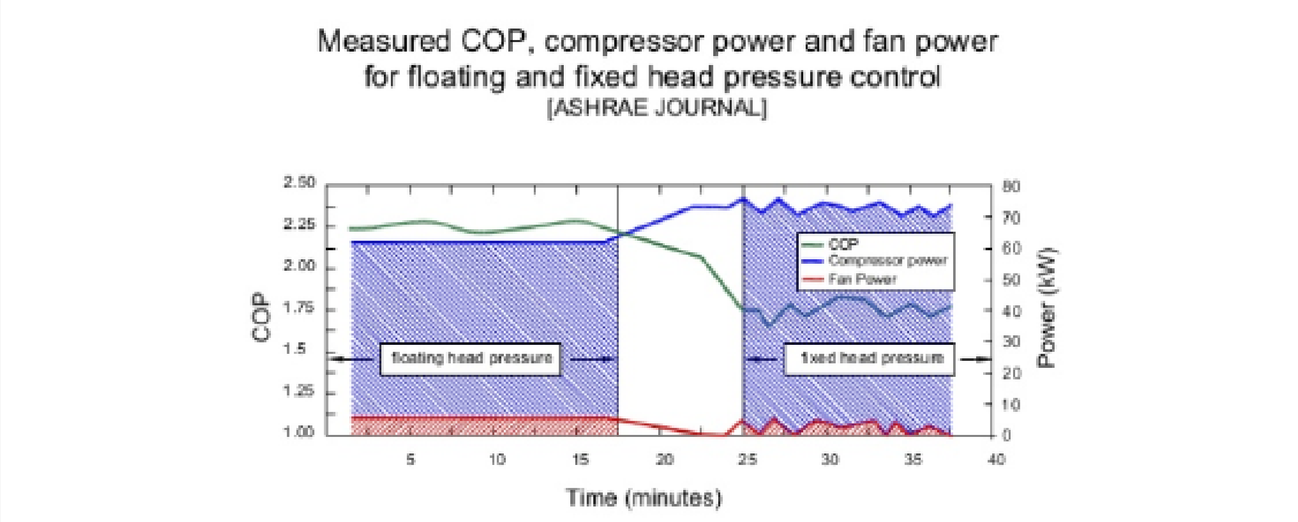


Figure 16: Measured compressor performance for both floating and fixed control mode (ASHRAE Journal - Feb 1999)

Assumptions

- The Ayr Community Centre is assumed to be comparable to other similar arena facilities.

Calculations

- CIMCO has completed numerous business cases for municipalities on the potential savings from the installation of the Seasonal Plus Controller at community arena's. This includes completing the saveONenergy incentive application on behalf of owners.
- Electricity consumption savings are based on the performance of the Seasonal Plus Controller at comparable facilities and the specifics of the Ayr Community Centre

Table 26 provides a summary of the refrigeration system waste heat recovery analysis results.

Table 26: Floating head pressure controls

ECM	Electricity Savings [kWh]	Demand Savings [kW]	Nat. Gas Savings [m^3]	Cost Savings [$]	Capital Cost [$]	Utility Incentive [$]	Simple Payback [years]
Floating head pressure controls	30,250	0.0	0	3,630	35,000	3,025	8.8

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

4.9 Brine pump controls

The existing brine pumps at Ayr Community Centre pump water underneath the arena to chill the concrete slab. Currently, these pumps operate continuously regardless of whether the compressor in the refrigeration plant is operating or not. Implementing on/off controls on these pumps so that they operate only when the compressors are running can result in significant electricity consumption savings.

Assumptions

- The existing compressor only operates approximately 65% of the time.

- The existing brine pump can be turned off approximately 35% of the time.
- The existing compressor consumes approximately 30 kW.
- The existing brine pump consumes approximately 25 hp (18 kW).

Calculations

- A ratio of the brine pump demand to the compressor demand was calculated.
- This ratio was used with the annual electricity consumption of the refrigeration plant to estimate the annual electricity consumption of the brine pumps alone.
- The annual electricity consumption of the brine pumps was reduced by the percentage of time they can be turned off to calculate the electricity consumption savings.

Table 27 provides a summary of the refrigeration system waste heat recovery analysis results.

Table 27: Brine pump controls

ECM	Electricity Savings [kWh]	Demand Savings [kW]	Nat. Gas Savings [m^3]	Cost Savings [$]	Capital Cost [$]	Utility Incentive [$]	Simple Payback [years]
Brine pump controls	8,897	0.0	0	1,068	7,500	890	6.2

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

4.10 Install rooftop solar PV system

A solar PV analysis was conducted for Ayr Community Centre 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.

A roof replacement is recommended prior to installing solar panels.

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 from 10 AM to 5 PM.

Calculations

- 353 x 320 W panels for total system size of 113 kW.
- Demand savings estimated at 20% of total system size.
- Electricity will be credited under a net metering scenario at the utility price of $0.120/kWh.
- Total system installed cost estimated at $3.00/W.

Table 28 provides a summary of the solar PV analysis results.

Table 28: Install solar PV system

ECM	Electricity Savings [kWh]	Demand Savings [kW]	Nat. Gas Savings [m^3]	Cost Savings [$]	Capital Cost [$]	Utility Incentive [$]	Simple Payback [years]
Install solar PV system	136,172	22.6	0	16,628	338,900	0	20.4

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

4.11 Replace plumbing fixtures

The existing plumbing fixtures are described in Section 3.7. 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 29 compares existing fixtures to new low flow fixtures.

Table 29: 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	285	5.7	171	114
Washroom faucet	0.25	6	18	4.5	14	4.5
Toilet	N/A	6	72	4.8	58	14

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 2 times per day by 20 occupants during the operating season.
- Washroom faucets were assumed to be used for 0.25 minutes per use and 2 times per day by 40 occupants during the operating season.
- Toilets were assumed to be used 2 times per day by 40 occupants during the operating season.
- 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:

  Consumption [m^3] = 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:

  Consumption [Btu] = Water use [lbs] x Temperature rise [°F] / Heater efficiency [%]]

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

Table 30 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 30: 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	356	114	394	4,200	0	10.7
Replace washroom faucets	14	4	16	4,500	0	289.7
Replace toilets	0	14	40	9,800	0	244.8

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

5 RECOMMENDATIONS

Table 31 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 31: Conservation measures summary table

ECM	Electricity Savings [kWh]	Demand Savings [kW]	Nat. Gas Savings [m^3]	Cost Savings [$]	Capital Cost [$]	Utility Incentive [$]	Simple Payback [years]
LED lighting retrofit	34,366	15.4	0	5,299	26,600	6,170	3.9
Electric baseboard programmable thermostat	972	0.0	0	117	500	0	4.3
Brine pump controls	8,897	0.0	0	1,068	7,500	890	6.2
Zamboni floodwater treatment	29,628	0.0	5,156	4,664	35,000	2,963	6.9
Floating head pressure controls	30,250	0.0	0	3,630	35,000	3,025	8.8
Replace shower heads	0	0.0	356	394	4,200	0	10.7
Install solar PV system	136,172	22.6	0	16,628	338,900	0	20.4
Refrigeration system waste heat recovery	0	0.0	2,958	636	20,000	0	31.4
Replace electric baseboard heating	2,268	0.0	-239	221	10,100	200	44.8
Radiant tube heater upgrade	0	0.0	250	54	3,300	300	55.8
Replace toilets	0	0.0	0	40	9,800	0	244.8
Replace washroom faucets	0	0.0	14	16	4,500	0	289.7

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

Table 32 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 32: Recommended conservation measures summary table

ECM	Electricity Savings [kWh]	Demand Savings [kW]	Nat. Gas Savings [m^3]	Cost Savings [$]	Capital Cost [$]	Utility Incentive [$]	Simple Payback [years]
LED lighting retrofit	34,366	15.4	0	5,299	26,600	6,170	3.9
Electric baseboard programmable thermostat	972	0.0	0	117	500	0	4.3
Brine pump controls	8,897	0.0	0	1,068	7,500	890	6.2
Zamboni floodwater treatment	29,628	0.0	5,156	4,664	35,000	2,963	6.9
Floating head pressure controls	30,250	0.0	0	3,630	35,000	3,025	8.8

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

Table 33 summarizes all ECMs which were analyzed qualitatively.

Table 33: Qualitative ECM summary table

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

APPENDICES