County of Frontenac Energy Assessment

As Per: O. Reg. 507/18 Energy Conservation and Demand Management Plan

June 2019

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Disclaimer

The observations, analysis, and recommendations listed in this report are based upon the utility information provided and observations made by Red Squirrel Conservation Services while on location at the County of Frontenac facilities described in this report.

The findings of this assessment are estimates, and energy savings have been calculated using averaged historical weather data and may vary per year. The impact of building changes, building use changes, new equipment, additional hardware and future weather data needs to be considered when evaluating savings.

The dollar savings calculations are also estimates and not guaranteed. The costs of energy conservation measures were derived from supplier websites and/or RSMeans and will require verification with local contractors, since prices are subject to change and vary by region.

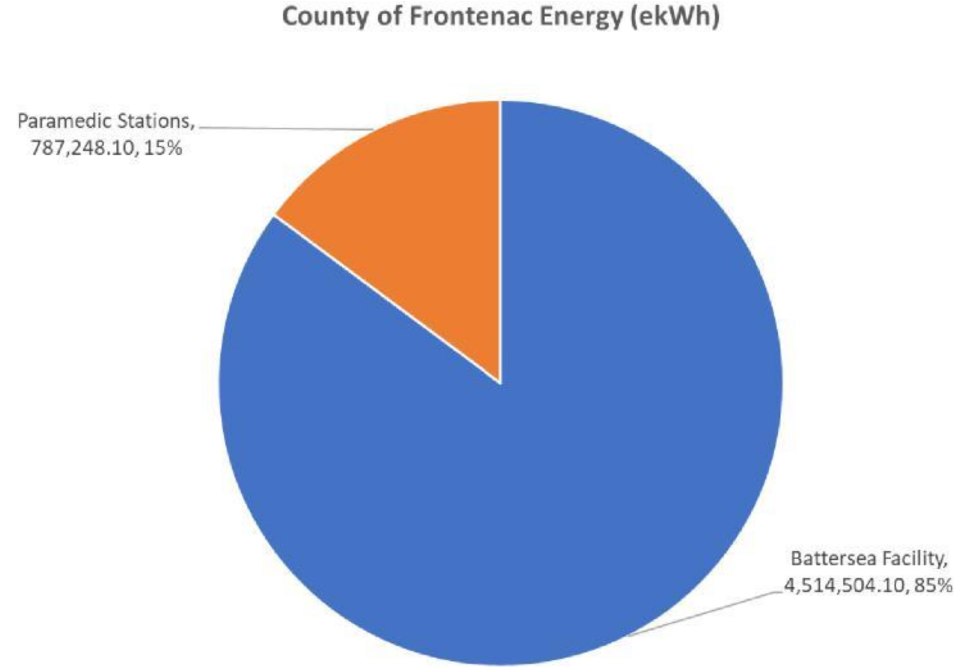
Therefore, the information, analyses, and recommendations listed in this report are to be regarded as suggestions. Red Squirrel Conservation assumes no liability with respect to the use of, or for damages resulting from the use of, any information, apparatus, method or process disclosed in this report.

The following is a list of acronyms (in order of appearance) used in the report:

- FPS (Frontenac Paramedic Service)
- ekWh (equivalent kilowatt hour)
- GHG (greenhouse gas)
- VFD (variable frequency drive)
- ECM (electronically commutated motor)
- LED (light emitting diode)
- BAS (building automation system)
- ASHP (air sources heat pump)
- CFL (compact fluorescent lamp)
- DHW (domestic hot water)
- ECDM (energy conservation and demand management)
- kWh (kilowatt hour)
- kW (kilowatt)
- DOE-2 (department of energy)
- R-value (resistance to heat flow – value)
- HVAC (Heating Ventilation and Air Conditioning)
- EUI (energy use intensity)
- GJ (gigajoule)
- GJ/m^2 (gigajoules per metre squared)
- RTU (roof top unit)
- CO_2 (carbon dioxide)
- Btu (British thermal units)
- kVA (kilo-volt-ampere)
- CFM (cubic feet per minute)
- PPM (parts per million)
- L/s (litres per second)
- ERV (energy recovery ventilator)
- HRV (heat recovery ventilator)
- DCKV (Demand-controlled kitchen ventilation)
- PVC (Polyvinyl chloride)
- HP (horsepower)
- Δ T (delta temperature)
- Δ P (delta pressure)
- PSI (pounds per square inch)
- COP (coefficient of performance)
- Btu/h (British thermal units per hour)
- CO (carbon monoxide)
- EMS (emergency medical services)
- IESO (Independent Electricity System Operator)

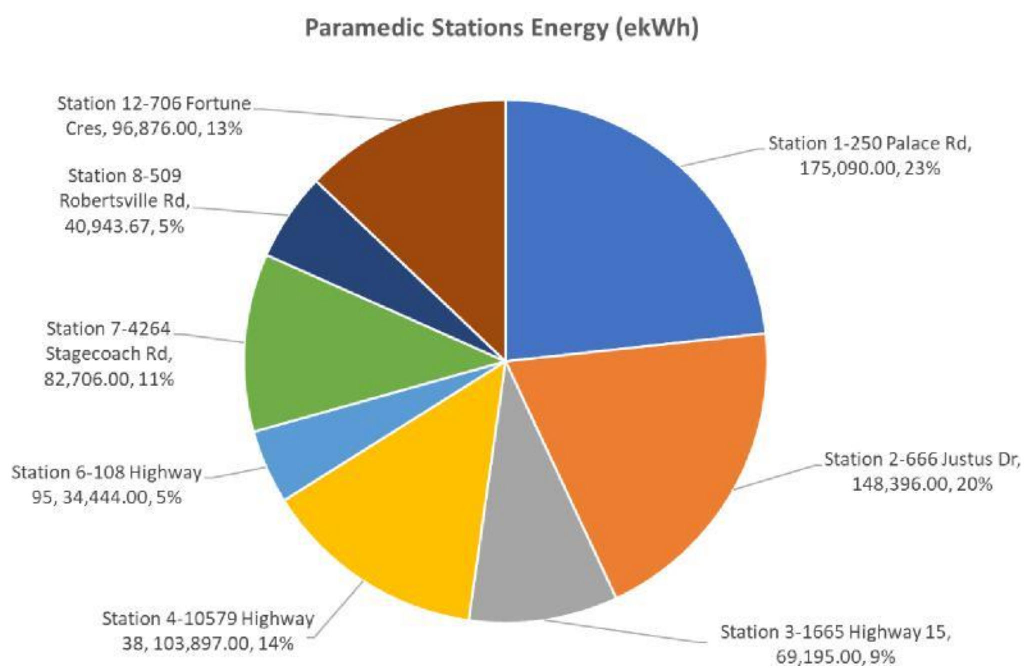
Executive Summary

This report summarizes an energy analysis of the County of Frontenac's facilities and prescribes measures to conserve energy and reduce greenhouse gas emissions. The facility at 2069 Battersea Rd. – comprising the County's administrative offices, training space for Frontenac Paramedic Service (FPS), and the Fairmount long-term care home – is the largest energy consumer in the Frontenac County asset mix. The charts following include electricity and all other fuels,



expressed as equivalent kilowatt hours (ekWh).

The following chart presents the energy use of the Paramedic Stations in more detail:



Recommendations have been made for upgrades, as shown in the following tables. Some have a big impact on greenhouse gas emissions (GHG), while others are more desirable from a financially point of view. A few offer benefits in both areas. Recommendations are meant to be signals for areas where more investigation is warranted. Bear in mind that the capital costs cited here are not based on real on-site quotes, and savings estimates should be refined using more detailed information input before committing funds.

Battersea Road Upgrade Recommendations:

Upgrade	Annual Savings Potential	Capital Cost Estimate	Simple Payback (in years)
Control mixed air dampers*	$3000	$3000	1.0
Reduce fan speed with VFD in air handlers	$12,000	$10,000	0.8
Remove possible exhaust air heating	Unknown	Low to moderate	Immediate
Change Kitchen Range Hood Fan to variable speed demand control	$800	$2400	3.0
Install strip curtains on walk-in coolers and freezer	$1000	$1500	1.5
Install ECM motors on cooler & freezer evaporator coils	$550	$2400	4.4
Upgrade Lighting in Coolers and Freezer to LED	$460	$1500	3.3
Install variable-speed drives on boiler circulation pumps	$5200	$7500	1.4
Insulate ceiling of Old House	$425	$5000	11.8
Night set back of temperature in Municipal office areas using BAS	$3200	$3000	0.9
Switch laundry to Ozone Cold Water System	$11,200	$15,000	1.3
Convert Old House at Battersea to ASHP	$1800	$60,000	33
Continue replacement of T8 and CFL lighting with LED. Prioritize lights that are on 24/7	$1860 (for 124 cabinet lights as an example)	$2356	1.3

Paramedic Stations Recommendations:

Upgrade	Annual Savings Potential	Capital Cost Estimate	Simple Payback (in years)
Convert Heating in Parham to Air Source Heat Pump	$2700	$16,000	5.9
Insulate foundation wall - Parham	$850	$2500	2.9
Palace Road – reduce excessive gas heat *	$1500	$500	0.3
Robertsville - reduce water temperature in radiant floor	$240	$800	3.3

GHG Recommendations

Frontenac County has a stated goal of reducing municipal GHG emissions at a rate of 1% per year. Strategies to achieve this fall into two broad categories:

- Reduce fossil fuel use through equipment upgrades and better controls
- Switch from fossil fuel to lower-carbon energy sources, primarily electricity

The opportunities to reduce GHG can also be divided into three categories:

- Changes that also have a good business case, with a quick financial return on investment
- Changes will have long-term economic paybacks, but still positive
- Changes that will result reduced GHG but increased overall cost

When replacing fossil fuels with electricity, the most expensive fuels should be replaced first. The energy content of oil and propane costs much more than it does for natural gas. This naturally leads to changing heating systems at the rural FPS stations that are not fuelled by gas.

The table on the following page summarizes the opportunities for GHG reduction. Some of the upgrades also appear in the previous tables.

GHG Reduction Recommendations

Upgrade Measure	Annual GHG Reduction (tonnes)	% of Current GHG Total
Ozone cold water laundry at Fairmount	66	9.9%
Convert Old House at Battersea Road to air source heat pump (ASHP) heating	57	8.6%
Switch Parham station to ASHP for space heating and electric resistance for domestic hot water (DHW).	18	2.7%
Switch FPS bases with propane heat to ASHP (Robertsville, Sydenham, Wolfe Island)	Robertsville 5.8 Sydenham 11.3 Wolfe Island 1.9	2.8%
Control ventilation air at Battersea Road	3.2 per 1000 CFM air reduction	unknown
Set back temperature setpoint at Municipal Offices, Battersea Road, when unoccupied	13	2%
Reduce fan speed in air handlers with VFD	8.23	1.2%
Reduce apparent overheating at Palace Road	6.3	1%

Introduction

This report was commissioned by the County of Frontenac for several purposes:

- To fulfil the Ontario government's requirement to implement an Energy Conservation and Demand Management (ECDM) plan for the period 2019-2024
- To identify ways to help Frontenac County meet its objective to reduce its greenhouse gas emissions (GHG) by 1% per year
- To identify ways to save money by implementing cost-effective upgrades to energy-consuming equipment and modifying procedures and behaviours that affect energy use.

According to Ontario Regulation 507/18:

(1) A public agency shall prepare, publish, make available to the public and implement energy conservation and demand management plans or joint plans in accordance with section 25.35.2 of the Act and with this Regulation.

(2) An energy conservation and demand management plan is composed of two parts as follows:

1. A summary of the public agency's annual energy consumption and greenhouse gas emissions for its operations.
2. A description of previous, current and proposed measures for conserving and otherwise reducing the amount of energy consumed by the public agency's operations and for managing the public agency's demand for energy, including a forecast of the expected results of current and proposed measures.

Reference: *www.ontario.ca/laws/regulation/r18507*

The County of Frontenac is a public agency and legally required to record its buildings' annual energy consumption. To create an energy conservation and demand management plan (ECDM) and establish energy-use baselines, the County of Frontenac enlisted Red Squirrel Conservation Services to assess how energy is used in County-operated facilities.

The facilities assessed for potential energy conservation and greenhouse gas emission reduction include:

- Fairmount Home and Municipal Offices, 2069 Battersea Rd, Glenburnie
- Six Frontenac Paramedic Services sites:
  - Station 1-250 Palace Rd, Kingston
  - Station 3-1665 Highway 15, Kingston (rented)
  - Station 4-10579 Highway 38, Parham
  - Station 6-108 Highway 95, Wolfe Island
  - Station 7-4264 Stagecoach Rd, Sydenham
  - Station 8-509 Robertsville Rd, Robertsville
  - Station 12-706 Fortune Cres, Kingston (rented)

The ambulance station at 666 Justus Dr. in Kingston was not assessed because it is rented and, as of June 2019, the lease is not expected to be renewed. The Howe Island ferry facility was also not assessed because it was determined that the Ministry of Transportation, not the County, pays the utility bills there. The other two rented facilities in Kingston – the ambulance stations at Fortune Crescent and Highway 15 – were assessed for overall energy use but not for capital upgrades, because the buildings and assets such as heating systems are not owned by the County.

The Battersea Road facility consists of Fairmount Long Term Care Home, the County administrative offices, and offices and training space for the Frontenac Paramedic Service (FPS). These facilities are served by a common heating system and a single electrical meter account, so for the purposes of this report they have been treated as a single facility.

Methodology and Scope of Work

Overall Audit Process

Utility, propane, and oil bills were obtained for all buildings included in the audit. The bills were analysed to compare the buildings' energy use to the energy-use averages of similar buildings nationally – a process called "benchmarking" – and to other County-owned and/or operated buildings.

Building plans, where available, were collected to enable software modelling of the buildings and to identify levels of insulation in the building envelopes.

Hourly data electrical data for one year was obtained for the Fairmount facility, and the billing tariff was analysed to determine the actual savings that can be obtained from kWh energy reductions as well as demand (kW) reductions.

The Red Squirrel audit team visited all County properties in person to photograph lighting and all other significant energy-consuming equipment, record key equipment specifications, and ask staff questions about how the building was normally used (e.g., operating schedules).

The field data and building plans were used to build energy models of each facility in software. The models were adjusted until the predicted utility consumption matched the consumption from actual bills to an accuracy of +/- 5%.

Using the software models, possible upgrades to the buildings or systems were modelled and energy savings predicted.

Software Used

The audit team used eQUEST energy management software to build a working model of the County of Frontenac facilities. eQUEST is based on the DOE-2 engine developed by James J. Hirsch and the US Department of Energy.

Utility Analysis

Electricity, natural gas, propane and fuel oil utility billing data from 2018 were used to determine a suitable energy consumption target and create accurate harmonized fuel rate estimates.

Building Envelope Analysis

The building envelopes for all facilities were studied in detail to achieve an accurate breakdown of the building materials, R-values of the insulative layers, and the types of windows and doors. The building envelope was assessed and modelled in eQUEST based on the review of architectural and as-built drawings and measurements taken on site.

Mechanical Systems Analysis

The Heating Ventilation and Air Conditioning (HVAC) systems were analysed and modelled to represent the function of the air handling units, gas fired burners, boilers, DX coils, heat recovery ventilators, pumps and exhaust fans. This information was obtained through an on-site review of equipment and examination of drawings and documentation provided by operational staff.

Electrical and Lighting Analysis

The electrical and lighting loads were calculated through billing analysis and site visits. During the site visits, all the lamps and fixture types were counted. A spreadsheet, including light wattage and daily run time for all major light sources, was developed for each facility. The values from this spreadsheet were then compiled and entered, zone by zone, into each eQUEST building model. The electrical loads from pumps, compressors, miscellaneous equipment (e.g., fridges, computers, monitors), vending machines, laundry facilities, and other plug loads were also included in the energy model.

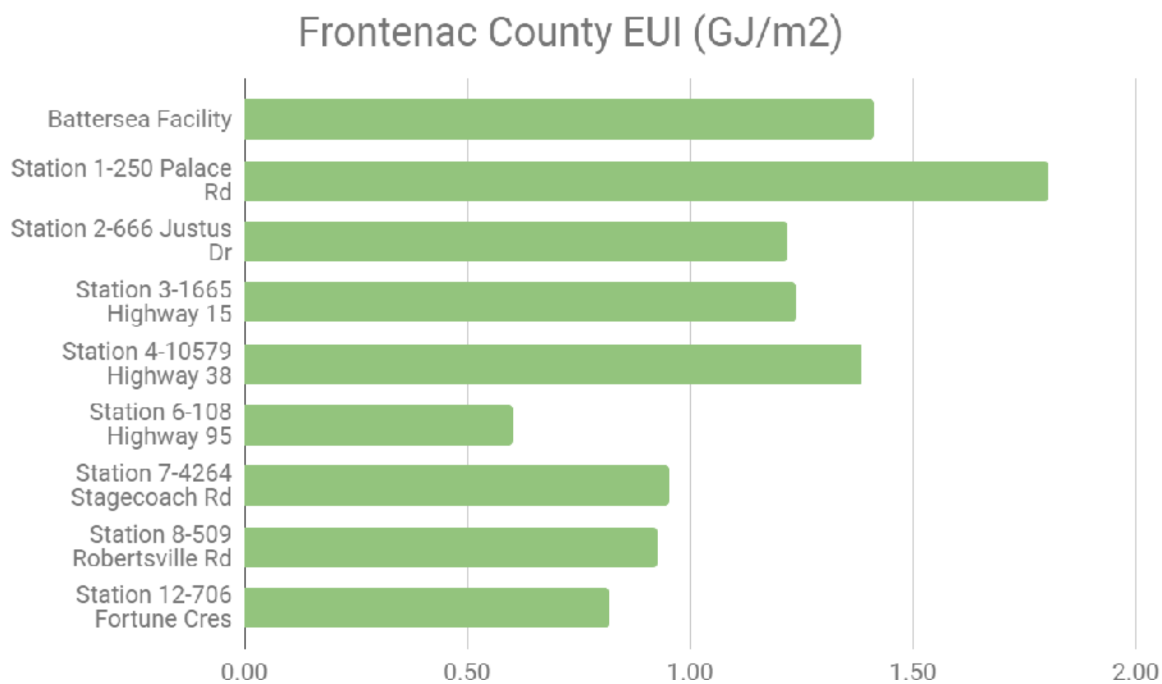
Reconciliation with Utility Bills

After the initial data entry, all eQUEST models were adjusted until they matched the actual consumption of all utilities according to the billing data.

Energy Use Intensity

EUI refers to the amount of energy used in a facility per square metre, irrespective of the source(s) of that energy. This enables the energy use performance of large facilities to be compared to that of smaller ones. (Put another way, it allows for apples-to-apples comparisons.)

An energy use intensity (EUI) calculation was completed for all facilities. To do this, the energy value of electricity, natural gas, oil, and propane used at each site was converted to Gigajoules (GJ) and then divided by the site's size in square metres, resulting in a ratio of GJ/m^2.



The chart below compares the EUI score (GJ/m^2) of the different Frontenac facilities:

Frontenac Paramedic Station 1 on Palace Road is clearly an outlier, with an energy use intensity higher than the other stations. Please see the 'Recommended Energy Conservation Measures' section for further analysis.

Energy Benchmarking Analysis

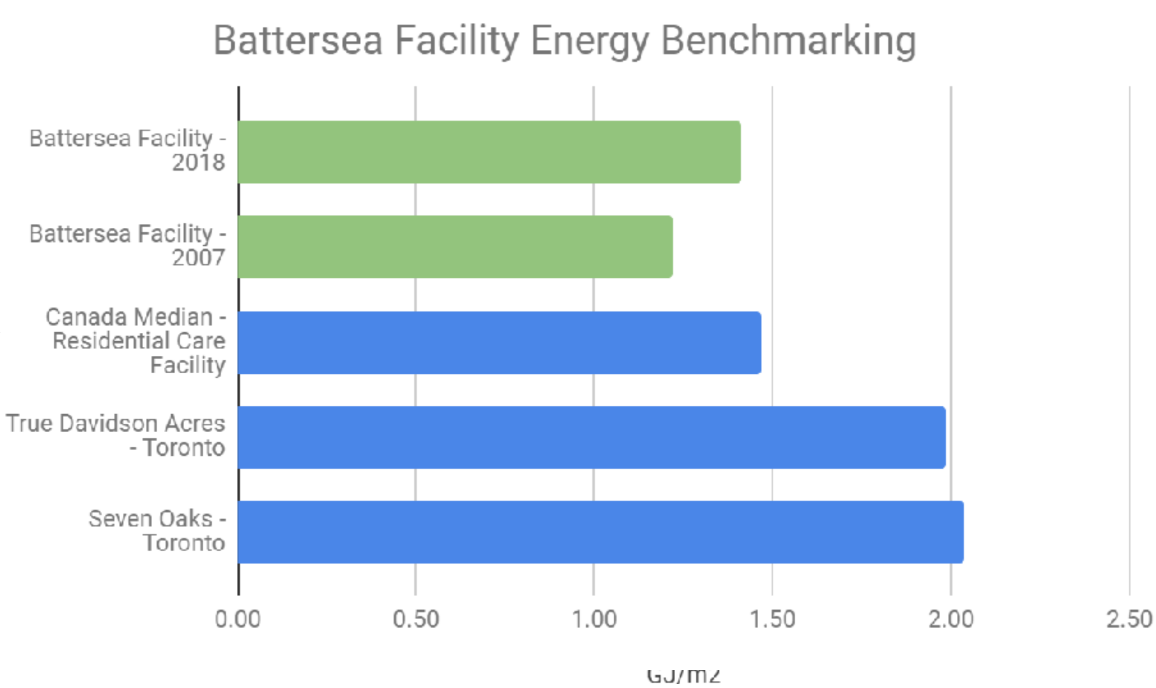
A benchmark is a standard or point of reference against which energy use can be compared and assessed. Energy benchmarking can be used to compare a building to an overall average for that type of building, or to compare the building to itself at different points in time.

The following section compares the EUI scores presented above to those of similar buildings elsewhere and to national averages.

2069 Battersea Road

This facility includes substantial office space, but also the Fairmount Long Term Care Home. This mixed use makes it somewhat challenging to find a close benchmark for comparison purposes. The external references used are long-term care facilities in Toronto that have a similar floor area and are used singularly for extended care.

The Battersea Road facility was also compared to a similar building using a software tool called 'Energy Star Portfolio Manager'. The classification selected for the benchmark was 'Health Care - Residential Care Facility'.



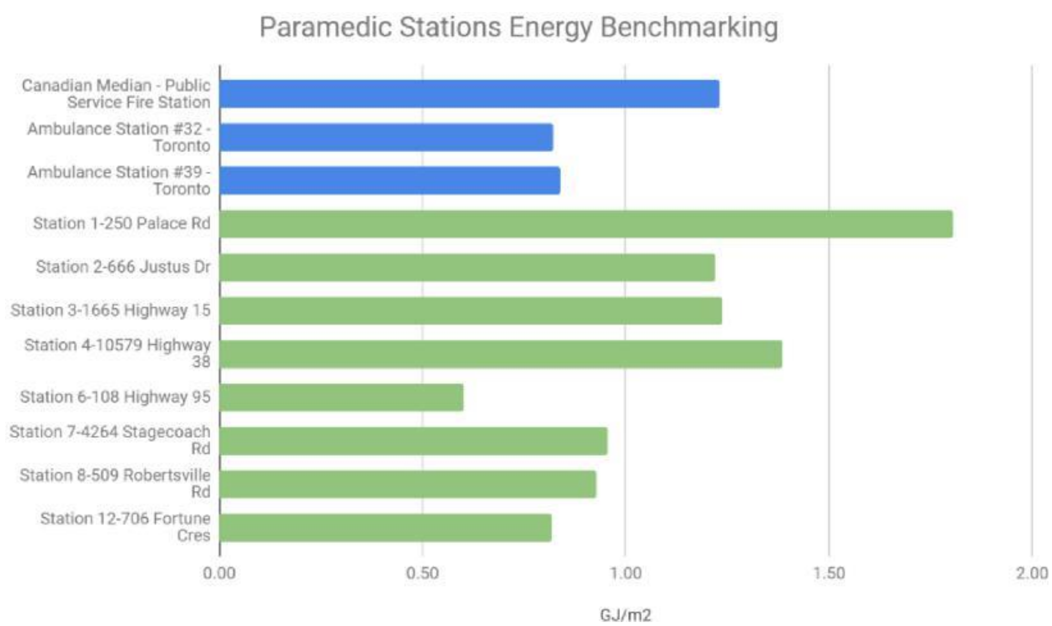
Battersea Road scores very favourably against the external comparison properties in Toronto and is very similar to the Canadian median value. Energy use since the last audit in 2007 has risen 8.5% for gas and 9% for electricity due to the addition of the Auditorium and air conditioning in several parts of the building. Without the recent and ongoing improvements to lighting efficiency, the increase would have been even greater.

Frontenac Paramedic Service Stations

A benchmark analysis was completed for the eight Frontenac Paramedic Service Stations using external reference metrics.

Two of the external reference facilities used are ambulance stations in Toronto that have a floor area similar to that of the Frontenac Paramedic Service Stations. They are both gas heated and have a similar external appearance.

The Frontenac stations were also compared to an average similar building using 'Energy Star Portfolio Manager'. The classification selected for the benchmark was 'Public Service - Fire Station'.



The data show, once again, that Palace Road is an outlier. Most of the other bases moderately exceed the Toronto comparable for ambulance stations but average a little less than the Canadian average for a fire hall.

Further analysis has shown that the main cause of the high EUI at Palace Road is heating, not electrical. Palace Road has a heating-fuel EUI (in ekWh/m2) approximately 40% higher than the average heating EUI of the stations. Further work is required to determine why this is the case.

Possible causes are:

- Air Handlers are introducing outside air. There are already and HRV and garage exhaust fans, so no additional outside air should be needed. The other stations have none.
- The bay doors are open much more often or for longer than other stations.
- The heating setpoint is too high.
- The gas burner in the RTU is malfunctioning and running very inefficiently.

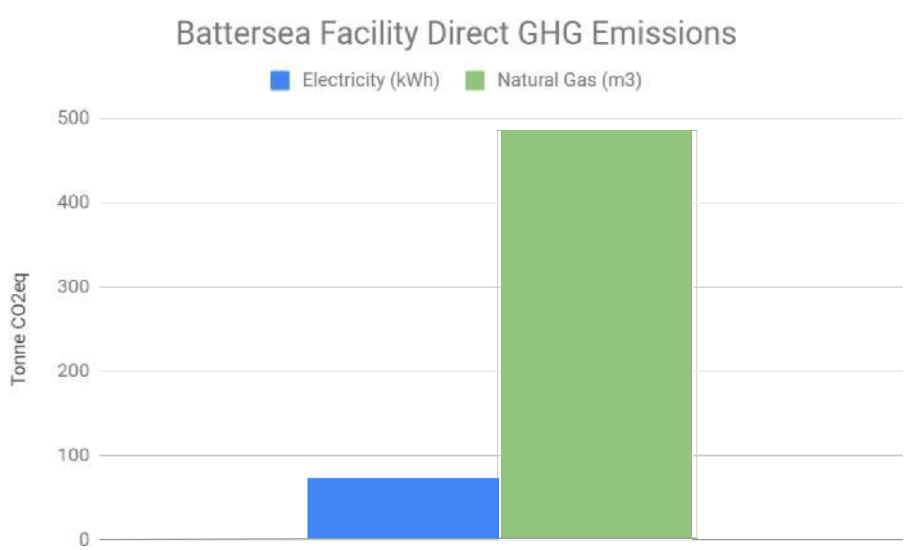
GHG Emissions

An analysis of GHG emissions was completed as per the Energy Star Portfolio Manager technical reference for greenhouse gas emissions. Emissions were calculated by multiplying facility energy values by emissions factors. For emissions analysis of on-site fuels, the standard method is one emissions factor per fuel type. These factors incorporate the emissions of carbon dioxide, methane, and nitrous oxide, to provide a single carbon dioxide equivalent number.

Portfolio Manager uses custom factors for Canada, which are further regionalized to account for differences within each province. For example, natural gas factors in Canada are computed by province to account for differences in gas content and supply across the country. The analysis of GHG emissions in this report comprises total direct emissions, which are fuel sources directly consumed at the facility.

Battersea Road Facility

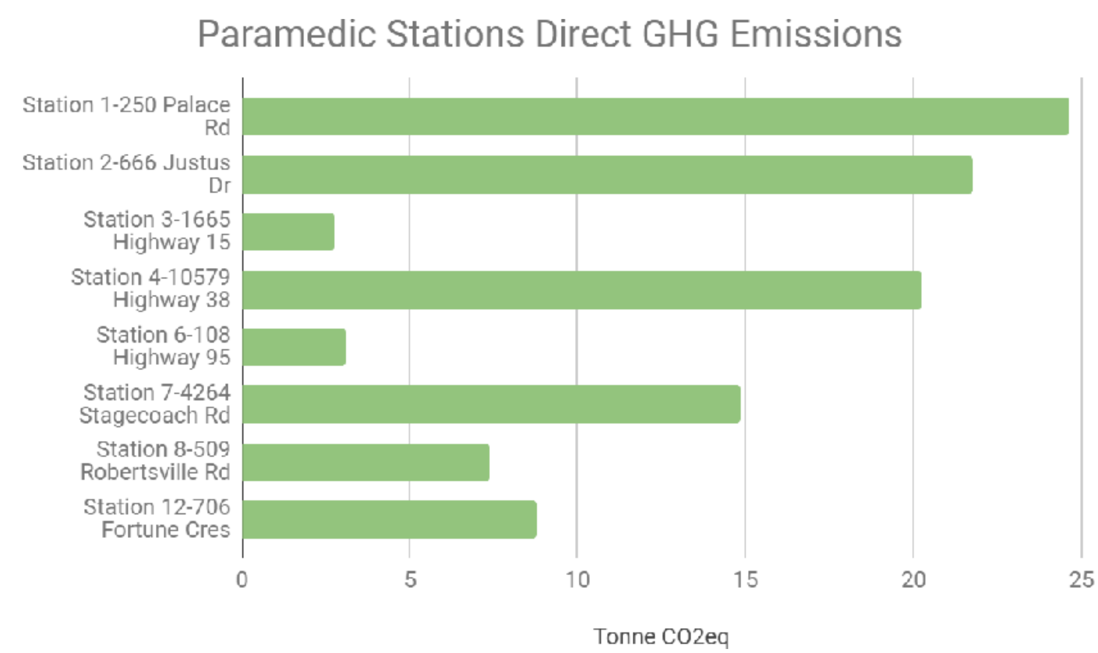
A GHG emissions analysis was completed for Fairmount Home and the associated offices on Battersea Road. The facility produced a total of 561 tonnes of CO2-equivalent emissions in 2018. The following chart breaks down the Battersea Road GHG emissions by fuel type:



Because Ontario has a relatively clean electrical grid, the emissions from electrical consumption are negligible in comparison to natural gas. However, on an energy production basis, electricity is far more expensive than other fuels (because there are more hidden costs in its production and delivery).

Frontenac Paramedic Service Stations

A GHG emissions analysis was completed for the eight Frontenac Paramedic Service Stations displayed in the chart below:

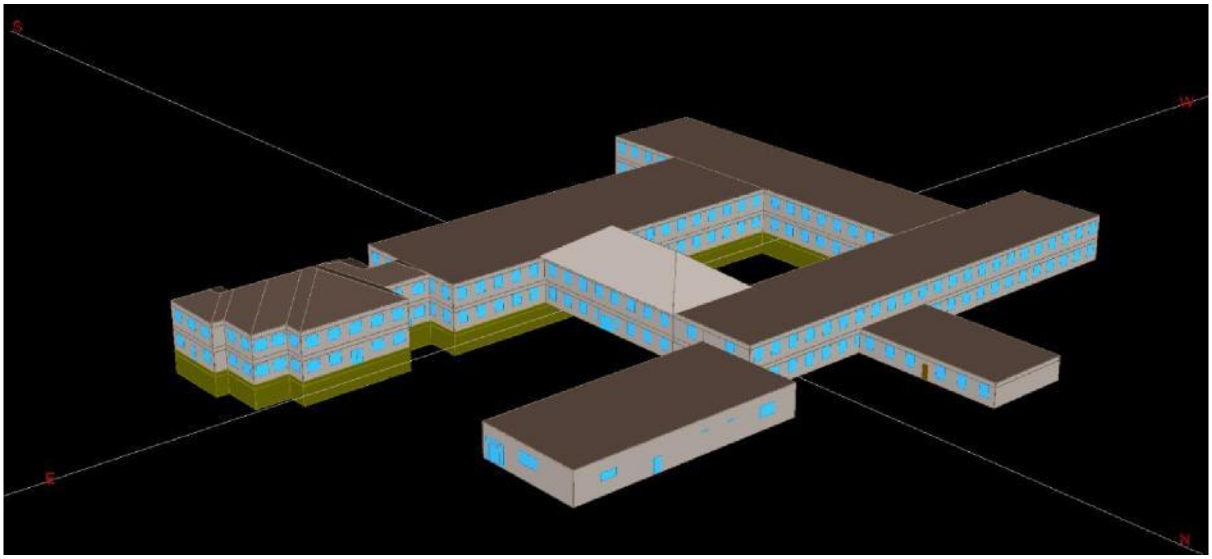


Note that the highest station with the highest emissions (nearly 25 tonnes), is a very small emitter compared to Battersea Road (560 tonnes). Station 3 has the lowest GHG emissions, as it is a fully electric facility. Generally, electricity in Ontario has a small GHG emissions factor, since the carbon generation from hydro and nuclear sources is relatively low.

Station 6 (on Wolfe Island) also has low GHG emissions. It is a small building with only crew facilities and no County-owned garages. (The garage building is owned by the Township of Frontenac Islands, not the County of Frontenac.)

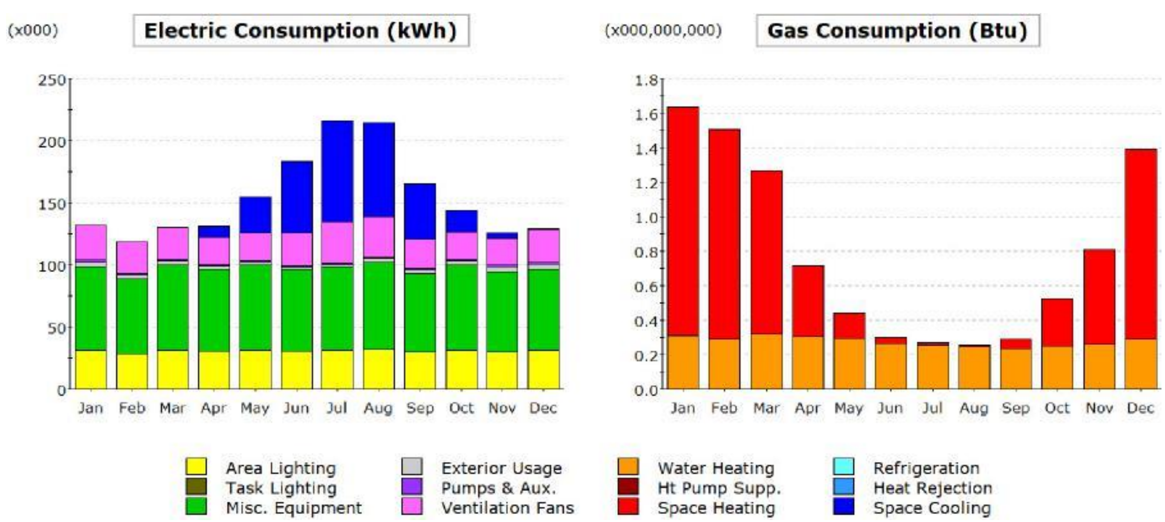
Energy Analysis by Building (2018 Data)

Battersea Road Facility



The graphic above shows the building as modelled in eQUEST energy software.

Energy by End-Use

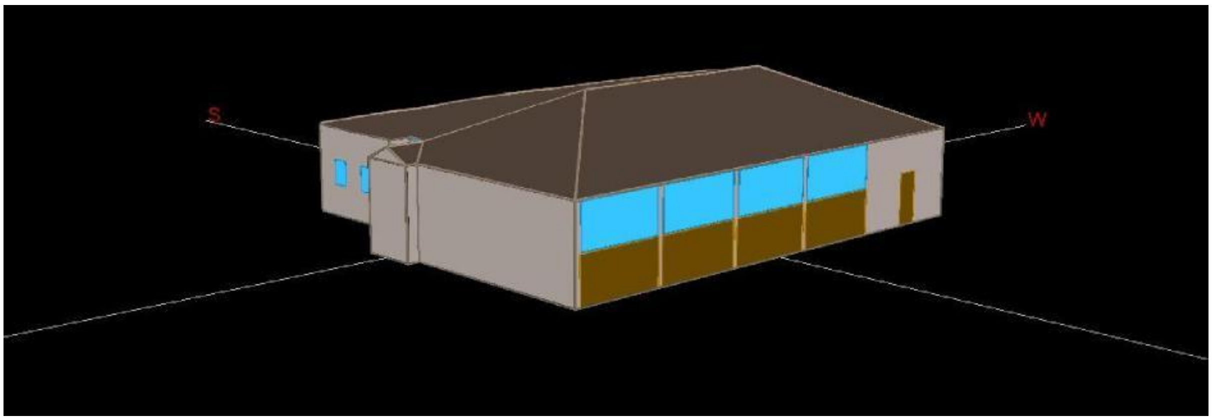


The graphic above displays the energy by end-use summary produced by the eQUEST energy model.

Paramedic Services Bases

Energy by End-Use

EMS Station (1) - 250 Palace Rd, Kingston



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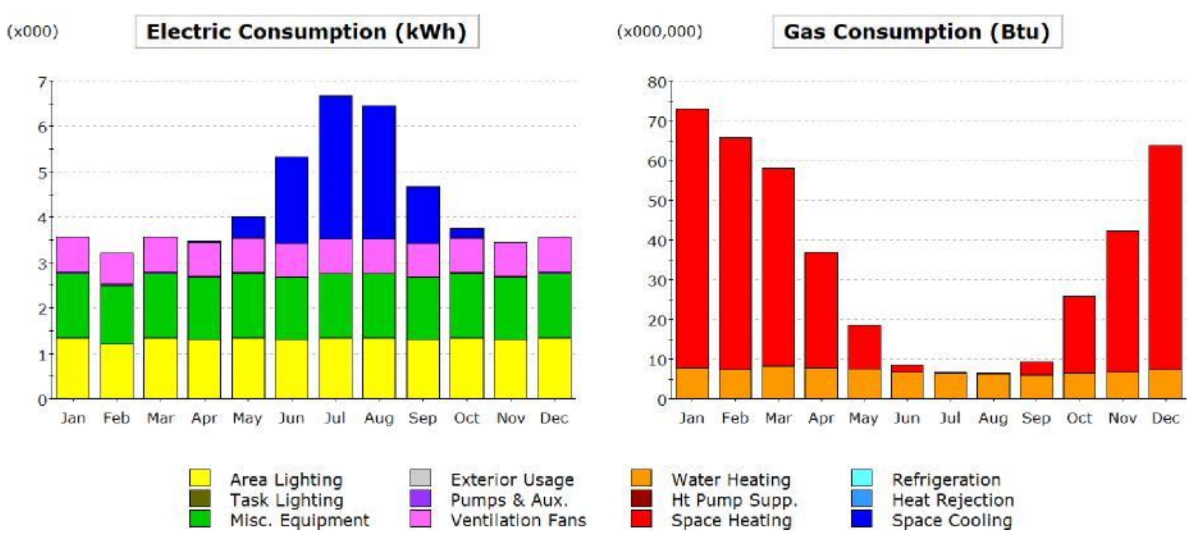
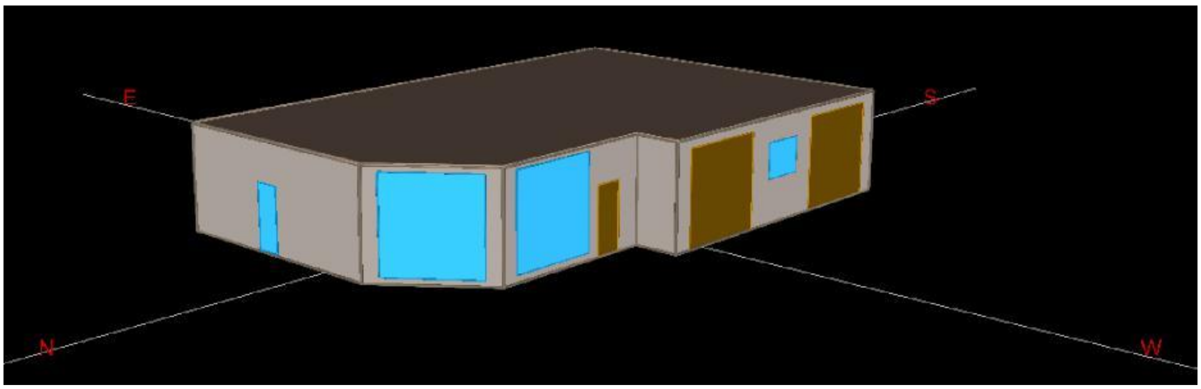


The graphic above displays the energy by end-use summary produced by the eQUEST energy model.

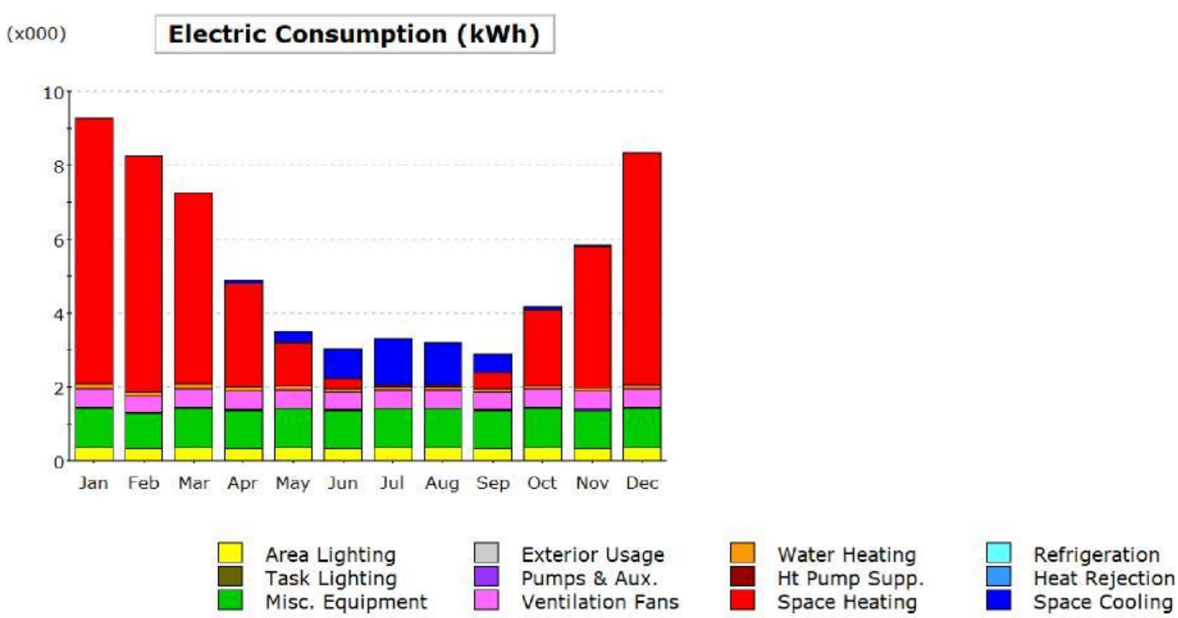
EMS Station (2) - 666 Justus Dr, Kingston (rented building)

As per direction from County officials, this building was not visited by the audit team, as it is rented, and services are likely to be relocated in the near future.

EMS Station (3) - 1665 Highway 15, Kingston (rented building)



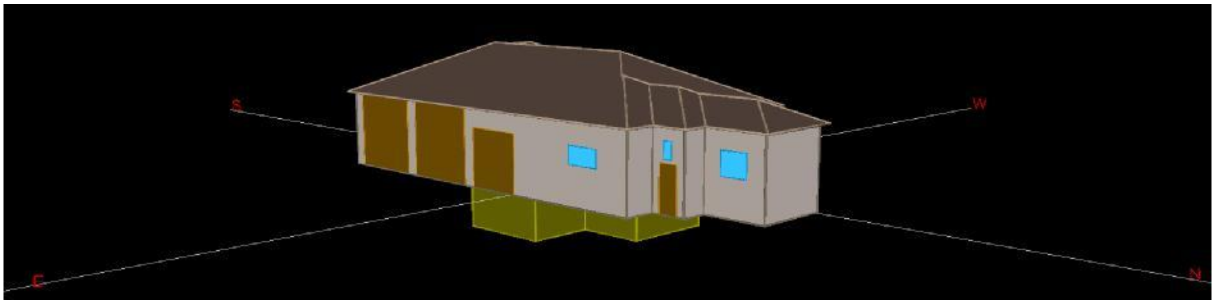
The graphic above shows the building as modelled in eQUEST energy software.



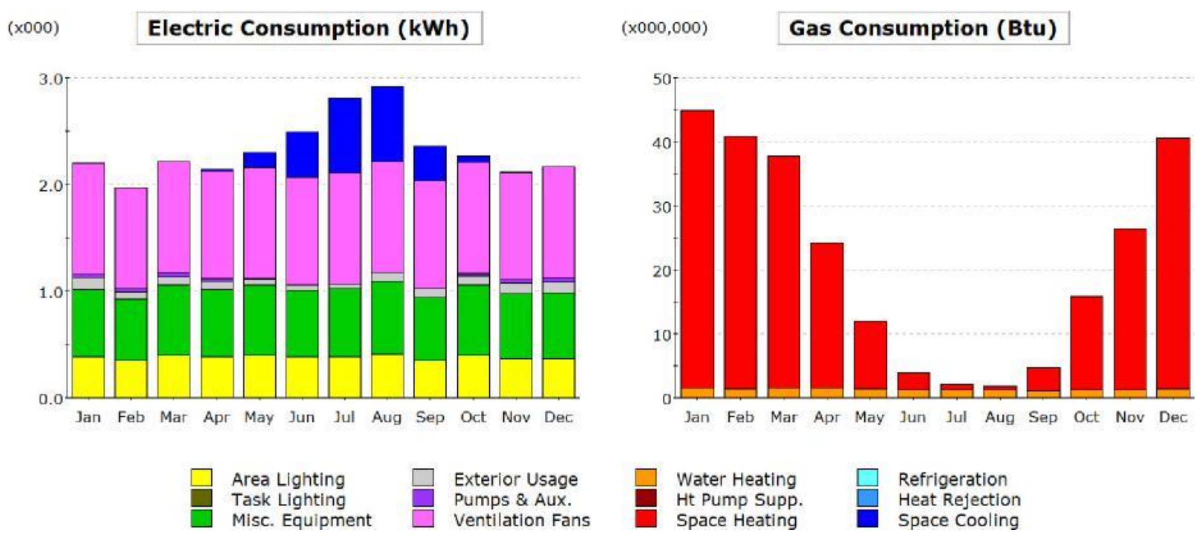
The graphic above displays the energy by end-use summary produced by the eQUEST energy model.

****Note about Hwy 15: this building has a heat pump for space heating and no gas or propane consumption.***

EMS Station (4) - 10579 Highway 38, Parham



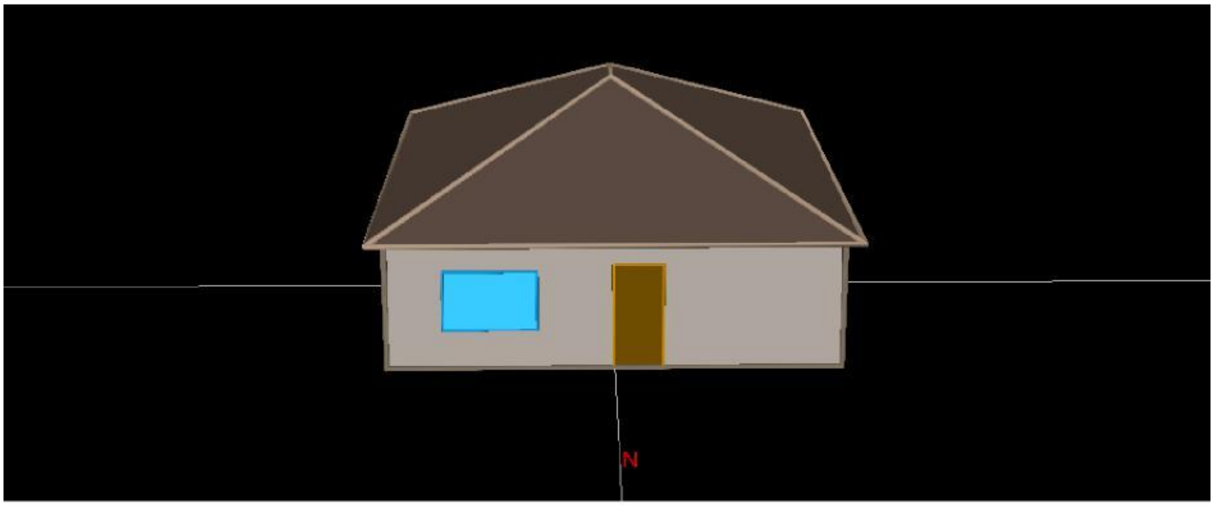
The graphic above shows the building as modelled in eQUEST energy software.



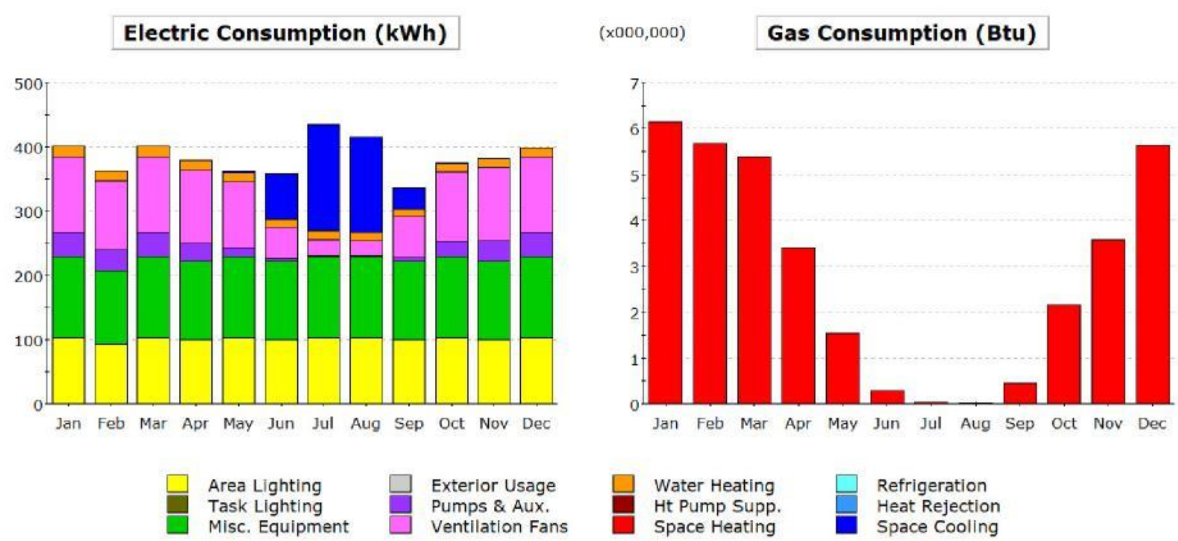
The graphic above displays the energy by end-use summary produced by the eQUEST energy model.

**Note about Parham energy model: eQUEST simulates energy consumption for fuels in BTU (British thermal units) which is then converted through a calculated multiplier to the fuel source of each site, in this case heating oil.*

EMS Station (6) - 108 Highway 95, Wolfe Island

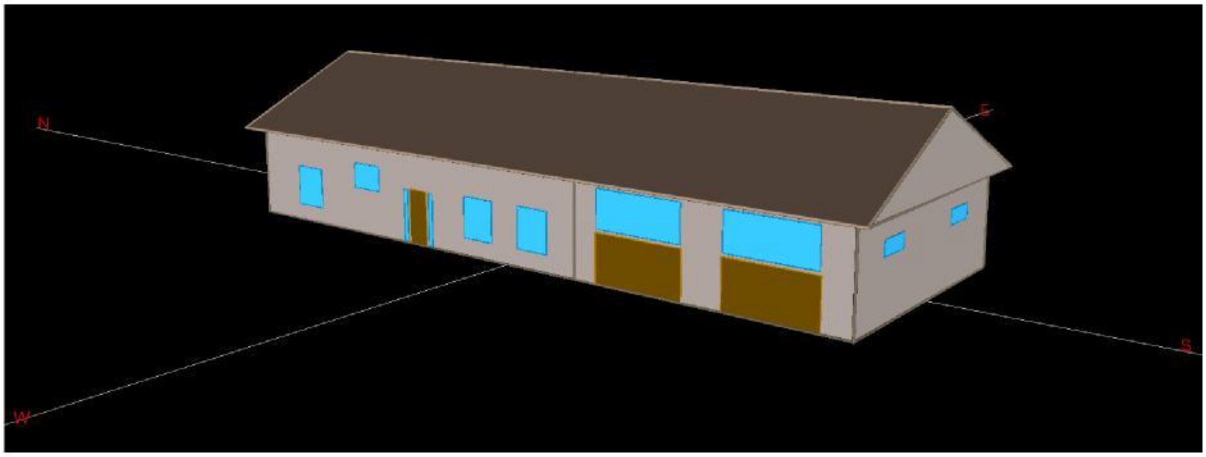


The graphic above shows the building as modelled in eQUEST energy software.



The graphic above displays the energy by end-use summary produced by the eQUEST energy model.

**Note about Wolfe Island: The propane bills provided align only with the consumption of the paramedic crew quarters behind the main fire/ambulance hall, so only this building was modelled. eQUEST simulates energy consumption for fuels in BTU (British thermal units), which is then converted through a calculated multiplier to the fuel source of each site (in this case, propane).*



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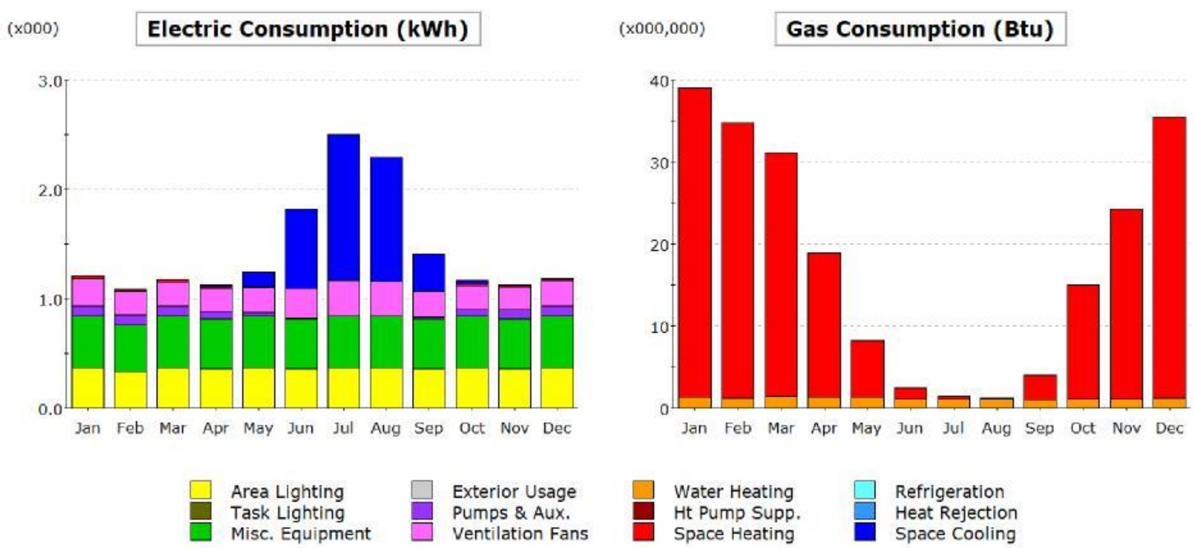
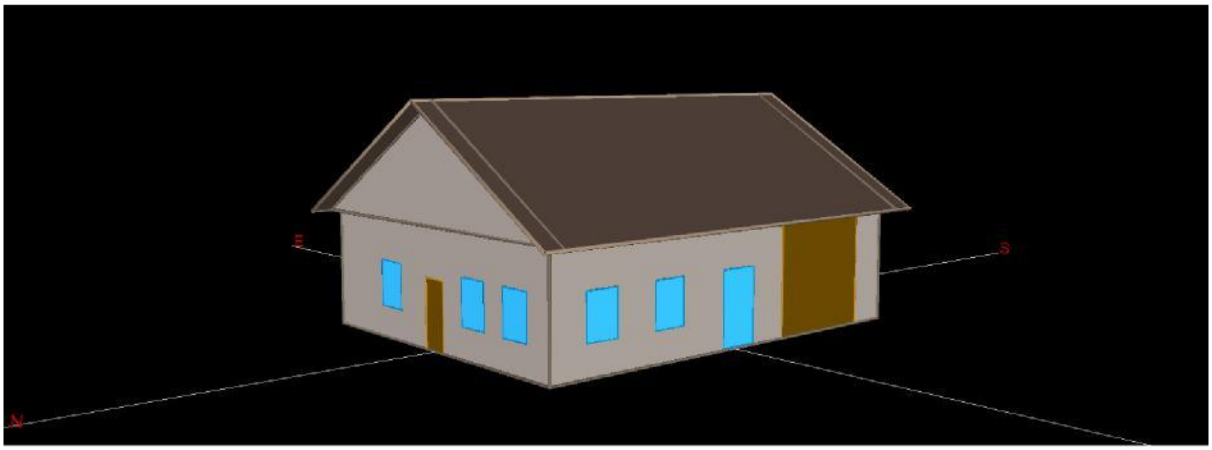
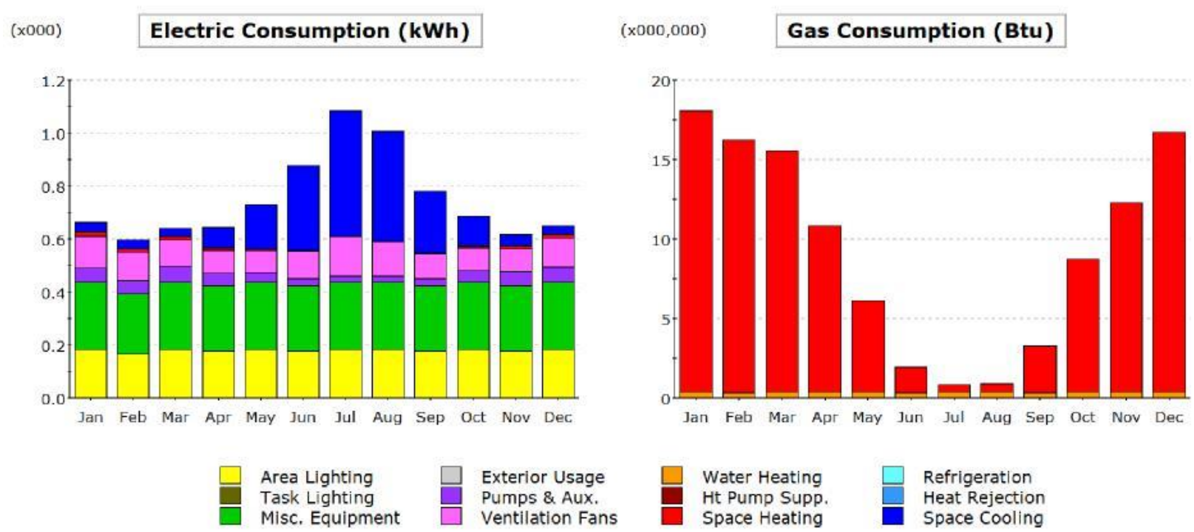


The graphic above displays the energy by end-use summary produced by the eQUEST energy model.

**Note about Sydenham: eQUEST simulates energy consumption for fuels in BTU (British thermal units), which is then converted through a calculated multiplier to the fuel source of each site (in this case, propane).*



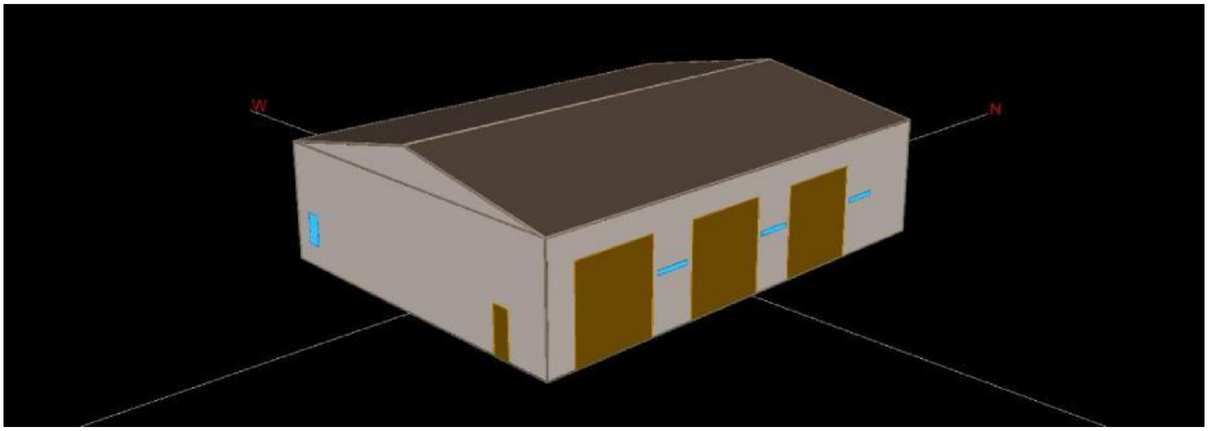
The graphic above shows the building as modelled in eQUEST energy software.



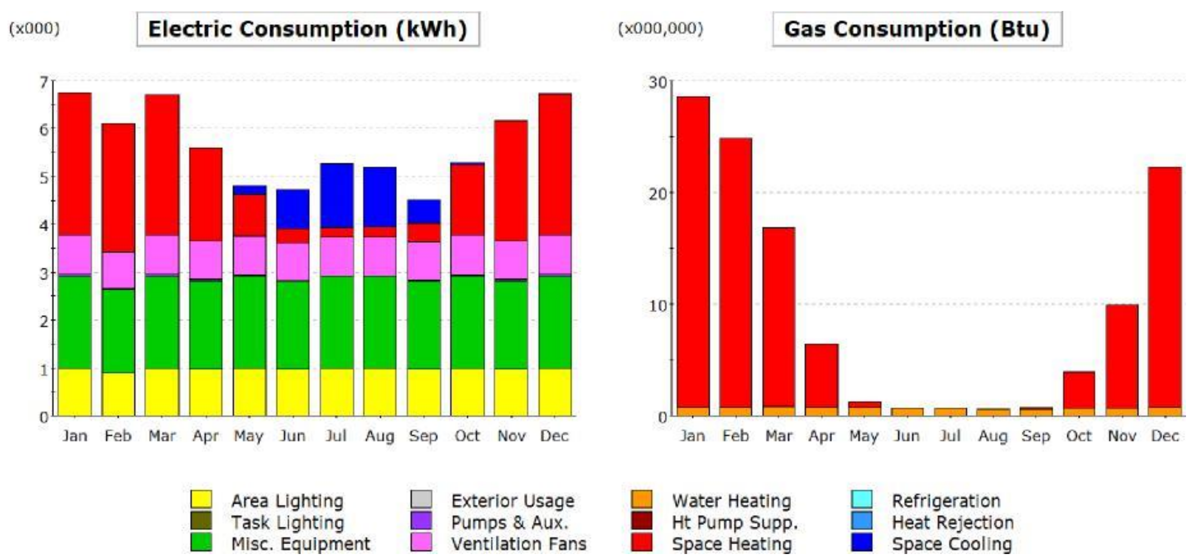
The graphic above displays the energy by end-use summary produced by the eQUEST energy model.

*Note about Robertsville: eQUEST simulates energy consumption for fuels in BTU (*British *thermal units), which is then converted through a calculated multiplier to the fuel source of each site (in this case, propane).*

EMS Station (12) - 706 Fortune Cres, Kingston



The graphic above shows the building as modelled in eQUEST energy software.



The graphic above displays the energy by end-use summary produced by the eQUEST energy model.

Understanding Demand Charges and the Battersea Road Electrical Bill

The graphic below is a portion of the June 2019 electricity bill for Battersea Road:

How we calculated your charges

Balance forward

Amount of your last bill	$16,050.60
Amount we received on May 22, 2019 - thank you	$16,050.60 CR
Balance forward	**$0.00**

Your electricity charges

Your service type is General Service - Demand

Electricity - kWh
Meter J3691531 for billing period April 17, 2019 to May 17, 2019
Metered usage in kilowatt-hours = 129,566.0880 kWh
Adjusted usage in kilowatt-hours (129,566.0880 x 1.0610*) = 137,469.6194 kWh

Demand - kW
Demand used in kilowatts = 232 kW
Total demand in kilowatts = **232 kW**

Demand - kVA
Demand used in kVA = 277 kVA
277 x 90% = 249 kVA
Total demand in kVA = **249 kVA**

Your demand charges are based on 249 kVA this month as it is the higher of the two measures.

Your power factor is 232 kW ÷ 277 kVA, which equals 83%.

Electricity: 99,922.0000 kWh @ 7.700000 ¢	$7,693.99
37,547.6194 kWh @ 8.900000 ¢	$3,341.74
Delivery	$4,755.78
Regulatory Charges	$536.38
HST (87086-5821-RT0001)	$2,122.63
8% Provincial Rebate	$1,306.23 CR
Total of your electricity charges	**$17,144.29**

The charges fall into three categories:

- Fixed charges that are the same every month, regardless of consumption
- Charge based on energy or kWh used that month
- Charge based on the peak demand (highest 15 minutes) for the month

All charges have 13% HST added and the 8% rebate removed.

The fixed charge is buried in 'delivery' and not shown but can be found on the Hydro One website. It is $89.73, before tax. All other parts of the bill are variable and based on consumption.
The kWh charges are charged at two rates – 7.7 and 8.9 cents per kWh – regardless of time of use. Note that if you save a kWh, you save from the second-rate block, unless you save so much that this block disappears.

The demand charge forms most of the charge called ‘delivery’ at the bottom of the bill. Demand is based on the highest wattage that the building requires for any 15-minute period in the month. On this bill, the value is 232 kW. There is, however, a penalty on this value if the power factor of the load is worse than 90%. This is applied by using kVA instead of kW as the demand, if it is greater. On this bill, the kVA was 277 (90% of 277 = 249). Since 249 is higher than the kW (232), the higher number is used.

A rigorous estimation of electrical savings at Battersea Road must include kWh, as well as intelligent thinking about whether a given upgrade will also reduce demand. Any load that is on 24/7 will reduce demand.

Demand charges are typically about 30% of the overall bill at Battersea Road.

Recommended Energy Conservation Measures

Fairmount Home & Municipal Offices

Summary of Possible Upgrades

Upgrade	Annual Savings Potential	Capital Cost Estimate	Simple Payback (in years)
Control mixed air dampers*	$3000	$3000	1.0
Reduce fan speed with VFD in air handlers	$12,000	$10,000	0.8
Remove possible exhaust air heating	Unknown	Low to moderate	immediate
Change Kitchen Range Hood Fan to variable speed demand control	$800	$2400	3.0
Install strip curtains on walk-in coolers and freezer	$1000	$1500	1.5
Install ECM motors on cooler & freezer evaporator coils	$550	$2400	4.4
Upgrade Lighting in Coolers and Freezer to LED	$460	$1500	3.3
Install variable speed drives on boiler circulation pumps	$5200	$7500	1.4
Insulate ceiling of Old House	$425	$5000	11.8
Night set back of temperature in Municipal office areas using BAS	$3200	$3000	0.9
Switch laundry to Ozone Cold Water System	$11,200	$15,000	1.3
Convert Old House at Battersea to ASHP	$1800	$60,000	33
Continue replacement of T8 and CFL lighting with LED. Prioritize light that are on 24/7	$1860 (for 124 cabinet lights as an example)	$2356	1.3

*savings is based on 5000 CFM of outside air reduction. Actual level is unknown.

Recommended Upgrades That Are Likely Cost Effective, But Savings Cannot Be Accurately Predicted

- Ensure dishwasher power supply is locked out with overall kitchen schedule to avoid standby heating of water. Provide local override switch with timer.
- When replacing A/C units, consider buying units with heat-pump capability.
- Ensure dishwasher exhaust fans run only when dishwashers are in use.

Upgrades That Require More Study

- Passive cooling for server room
- Demand management
- Power factor correction

Detailed Discussion

Control Mixed Air Dampers

Ventilation air to the facility is provided by six rooftop units (RTUs). Each has a mixed-air damper that controls the amount of air that is recirculated vs replaced by outside air. Running higher levels of outside air increases energy cost due to heating in the winter and cooling and dehumidification in the summer. Outside air levels that are too low cause poor indoor air quality.

Discussion with staff and inspection of one unit revealed that the mixed-air dampers are not actively controlled, and their position is largely unknown. The one unit that was inspected was found to have the damper closed and completely disconnected from the actuator. This would cause 100% outside air to be used, with no recirculation.

Outside air needs can be determined in two ways:

1. Measure CO_2 levels in the return air in real time. A common setpoint is 900 ppm. When CO_2 levels rise above this, the proportion of outside air is increased.
2. Set the level according to building occupancy. A value of 9 L/s per person of outside air is a common target. Using this approach, outside air could be reduced at night when fewer people are in the building, especially in office areas. Actual CO_2 levels could be measured during commissioning and then damper position established and repeated without further measurement.

Reduce fan speed with VFD in rooftop air handlers

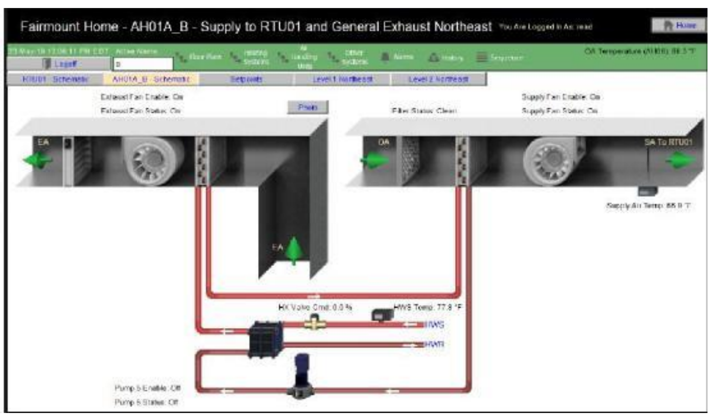
Analysis shows that 3500 to 4500 CFM (cubic feet per metre) of outside air should be adequate to provide proper ventilation to the building. Each air handler (RTUs 1-4) has a capacity far in excess of this – estimated to be 9000 CFM each. These units run at full speed, 24/7. They are not needed to deliver heat to the building, since the delivered air setpoint is only 65F. Their only purpose is to heat the fresh air supply coming from outside.

It is recommended that the actual CFM being moved by these units be measured and then a VFD (Variable Frequency Drive) installed on one as a test. Reduce fan speed and open outside air to maintain max 900 ppm CO_2 in the return air. If the CO_2 level varies a lot through the day, then a demand-based control is warranted. This will allow the fans and outside air to modulate to hold a setpoint of 900 ppm in the return air. If the CO_2 is relatively level, then a new fan speed and damper position can be chosen and fixed.

A 20% reduction in fan speed results in a 50% reduction in energy cost. This has been assumed in the savings. More savings may well be possible.

Remove Possible Exhaust Air Heating

Study of one RTU and the associated graphic in the Building Automation System (BAS) raised the possibility that a design or installation error has created an arrangement where heated boiler water is flowing through a coil in the exhaust air stream, needlessly heating this air before it is exhausted. The graphic from the BAS is reproduced below:



Even if the flow direction in the red glycol pipe was reversed, it is almost impossible that the temperature of the water in the exhaust coil would be lower than the outgoing air (70F). If the water is warmer than the air flowing through the coil, heat is being lost.

An isolated glycol loop with an exhaust coil and an intake coil could transfer heat effectively between exhaust and intake air if it was not connected to boiler water. The intake coil would pre-heat incoming outside air, but then a second coil with boiler water would be needed to finish the heating. On inspection, only one heating coil was found on the intake side of the RTU.

It is recommended that further study of the actual installation be undertaken. If the exhaust coil is warmer than 70F when the boiler is operating, the system can be confirmed to be incorrectly configured and needlessly dumping heat.

The graphics below illustrate properly configured systems:

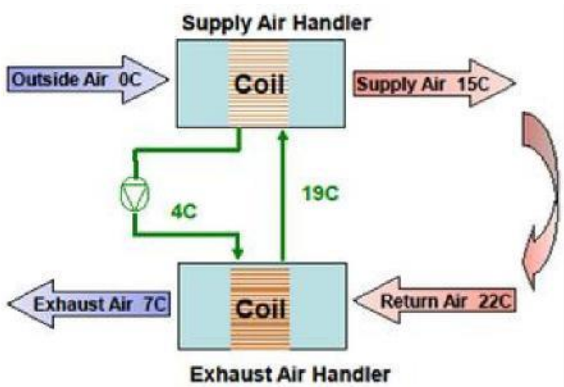


Image source above: www.dac-hvac.com/pumped-glycol-energy-recovery-efficiency-vs-effectiveness.

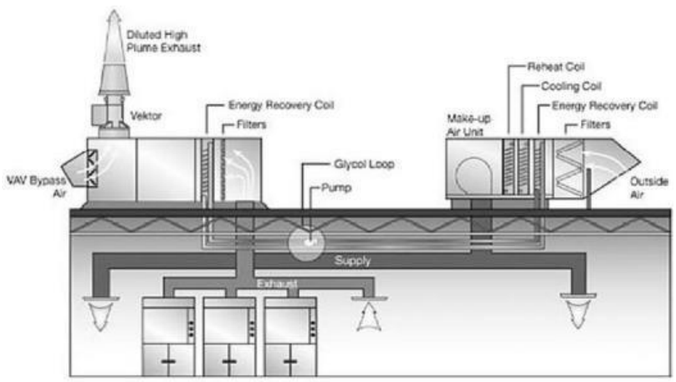


Figure 3 - Design Schematic of Lab Exhaust Heat Recovery (http://www.adehvac.com/)

There are other ways to recover heat from exhaust air, including a heat wheel system, ERV/HRV units, heat pipe systems, or an air-air heat pump. When the existing RTUs need replacement, careful consideration of the options should be made.

The cost of losing this heat has not been calculated, but actual building gas consumption is near the level expected by modelling the building in software, so a large heat waste here is not likely. If even one coil had boiler water running continuously all winter, the gas consumption for the building would not balance with software predictions.

Change Kitchen Range Hood Fan to Variable Speed

The exhaust hood in the kitchen is needed to remove humidity and smoke caused by cooking. It currently is turned on by staff at the beginning of each day and turned off at the end of the day, and runs at constant speed with a 3hp motor the whole time. Reducing unnecessary exhaust saves energy by reducing both the electrical consumption of the motor and the need to heat or cool all the air that must enter the building to replace the exhausted air. Demand-controlled kitchen ventilation (DCKV) systems use sensors in the hood to detect temperature, humidity, or smoke and then run the fan at a variable speed to ensure that just enough air is moved. Enbridge Gas currently offers a $1700 rebate on the installation of this equipment.

www.uniongas.com/business/save-money-and-energy/equipment-incentive-program/foodservice-programs/dckv

Install Strip Curtains on Walk-In Coolers and Freezer

When staff open the doors to coolers and freezers to enter the space, cold air is lost and replaced with warm room air. It was observed that the staff tend to leave the doors open when making short visits to the rooms, which is understandable (given that the doors are heavy and awkward). Clear PVC strip curtains installed inside the doors substantially reduce the ingress of warm air when the doors are opened. They are commonly used at many facilities in Ontario.

Image source: www.steelguardsafety.com/restaurant-refrigeration-strip-curtains

Savings were estimated from the following source:
www.energy.ca.gov/appliances/2004rulemaking/documents/case_studies/CASE_Walk-In_Cooler.pdf

Install ECM Motors on Cooler/Freezer Evaporator Coils

Inefficient motors incur more electricity costs to operate, but even worse, when installed in a cooled space, the substantial extra heat produced by the motors must be removed by the refrigeration system. The motors could not be clearly observed during the audit, but if they have not been upgraded to ECM-type motors, they should be. Savings were estimated using the same reference used for strip curtains, above.

Upgrade Lighting in Coolers and Freezer to LED

Savings are based on changing existing T12 40W to 13W LED. Coolers and freezers have a very high return on upgrading lighting due to the fact that excess heat produced by inefficient lighting must be removed by the refrigeration system. Savings are operating costs plus avoided refrigeration costs.

Install Variable Speed Drives on Boiler Circulation Pumps

Three boiler circulation pumps (7.5 hp each) currently operate continuously whenever the boilers are operating, estimated to be 5,760 hours per year. Full flow is only needed at times of maximum heat load. Savings are based on a conservative assumption that electrical use would be reduced by 50% over a year. Motor speed must only be reduced by 25% to save 50% of input power.

Pump speed is typically controlled by maintaining a fixed ΔT (delta temperate difference) of inlet vs output water at the boiler (e.g., 20 degress F) or by maintaining a fixed ΔP setpoint of pressure difference across the pump (eg 15 psi). The details of this design must be carefully worked out by a hydronics professional with due regard to all aspects of the system, including boiler minimum flow requirements and the effect of outdoor reset controls.

Insulate Ceiling of Old House

The ceiling of the Old House was found to be uninsulated, as was stated in a previous audit report dated 2008. It is recommended that cellulose insulation be blown into the cavity between the ceiling and the floor above. Savings are based on the assumption that 10 inches of material can be put in this area. The rooms above this floor are not in use and the building envelope is in poor repair. Alternatively, insulation could be put one storey higher, above the ceiling of the unused rooms, but this would introduce additional heat loss through the walls and windows of this abandoned area. This option is only recommended if the area is likely to be reclaimed as heated space.

Night Setback of Temperature in Municipal Office Areas

Unlike the rest of the Fairmount facility, municipal offices are not occupied outside of normal business hours. The areas have no mechanical ventilation that can be powered down, but the heating setpoint can be lowered in winter and the cooling setpoint can be raised in summer. The hydronic heating is slower to respond to change than an air-based system, but significant savings can still be realized.

The savings estimated are based on changing setpoint by 5F during unoccupied times. It is recommended that control be managed by bringing this area into the Building Automation System (BAS) and implementing a ‘smart’ control algorithm that changes the set-up time based on outside air temperature. On a cold night, for example, it will take longer to get the space up to setpoint than on a mild night.

Continue to Replace T8 and CFL Lighting with LED

Detailed recommendations are not given for this upgrade, because it is being well managed by the Fairmount facilities team already. Most corridor lighting has been upgraded to LED.
Priority should be given to lights that are on 24/7.

Lighting that is on 24/7 but not yet upgraded to LED includes:

- 2x2 CFL fixtures in the main reception area
- Some basement corridor lighting
- Elevator lighting (currently T12)
- Bowl-type corridor fixtures with three CFL lamps in corridors
- Overhead lighting in 'memory box' cabinets, which is currently 26 W CFL

Inexpensive 'off brand' LED lighting has a poor record for reliability. For major purchases, it is recommended that products from well-established manufacturers be used. Also, keep detailed records and proof of purchase to retain the ability to claim warranty replacement if needed.

Fairmount is paying penalties every month for low power factor. Ensure that LED upgrades have a power factor of 90% or higher, and test samples to be sure.

Here is an example of the economy of replacing a 25W cabinet light with a 12W LED direct plug-in lamp:

Annual savings: 14 W x 8760 h x 0.0962 $/kWh = $11.79
Additional savings from demand reduction: 14/1000 x 19.44 $/kW x 12 month = $3.26
Total savings: $15.04
Cost of LED lamp: $19.00
Payback: 19.0/15.04 = 1.3 years

Ozone Low-Temperature Washing

Laundry washing in hot water is a large consumer of natural gas in Fairmount Home.

Cold water washing using water that has been infused with ozone gas is an alternative that is commercially available and appears to offer the necessary disinfectant properties required in a health care facility. An ozone generator creates ozone gas from ambient air and injects it into the wash water. Ozone is 90% oxygen and opens fibres, releasing stains. References are provided, including reference to a healthcare facility. Enbridge Gas provides partial rebates for ozone laundry installations in Ontario.

Studies show that in addition to natural gas savings, ozone washing offers:

- Decreased drying times due to fibre separation
- Reduction of water use due to less rinse required
- Lower labour costs due to shorter cycle times
- Reduced pollutants in wastewater

Current consumption estimates for laundry hot water:

laundry/bed/day lb*	Beds	Hot Water L/lb	Hot Water L/day	Hot Water L/yr	Gas m^3/yr	Gas $/yr	GHG tonne/yr
12	124	7.96	11,842	4,322,330	41,040	$13,130	78

This number comes from industry 'rules of thumb'. More exact measurement of water use at Fairmount is needed.

Assuming the ozone system results in 85% savings on water heating:

$/yr gas savings	GHG savings, tonne	Estimated Capital Cost*	Payback, yr
$11,160	66	$15,000	1.3

This cost is very approximate and should be confirmed.

Ozone Washing References:

Enbridge incentive
www.uniongas.com/business/save-money-and-energy/equipment-incentive-program/water-heating-programs/ozone-laundry

US Department of Energy Study on Ozone Washing in Healthcare and Hospitality facilities:
www.pnnl.gov/main/publications/external/technical_reports/PNNL-23536.pdf

Other non-vendor references:
betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/Ozone_Tech_Demo_Flyer_508.pdf

www.healthcarefacilitiestoday.com/posts/Ozone-laundry-system-expected-to-mean-energy-savings-Wisconsin-hospital--2551

Washing load in hospitals:
learning.ahe.org/communities/myahe/questions/16fbc603-68d3-4fa6-a893-f68366dc9fc3/linen-use-per-patient-average-lbs

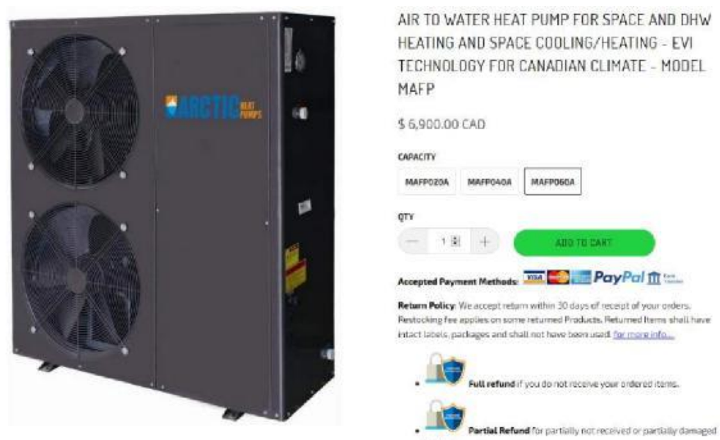
Convert Old House at Battersea Road to ASHP

This conversion does not have an attractive economic return, but it has been modelled because if the space is repurposed and renovated, a change to ASHP would allow for significant GHG reduction by moving off the natural gas hydronic system that is currently in place.

GHG reduction resulting from this upgrade is estimated at 57 tonne/yr, representing an 8.5% reduction in the County's overall GHG emission. The annual operating cost would be about $1800 lower. (The air source heat pump was assumed to have a seasonal COP (Coefficient of Performance) in heating of 2.5.)

Heat pumps are available in air-to-air or air to water configurations. In either case, they tend to produce output (air or water) that is not as hot as a fuel fired appliance. This can mean that changes to ducts or radiators are needed to allow more air flow or greater radiator surface area in order to deliver the same Btu/h to the space.

It is recommended that a renovation at this level be designed by a professional engineer experienced with heat pumps. A sample of an air-to-water heat pump is shown below. This unit has a 20kW output, and three of them would be needed to heat the Old House area. This upgrade does not result in an attractive payback but is presented as an example of what is possible, and needed, to move a building from fossil fuel to low-carbon electric heating.

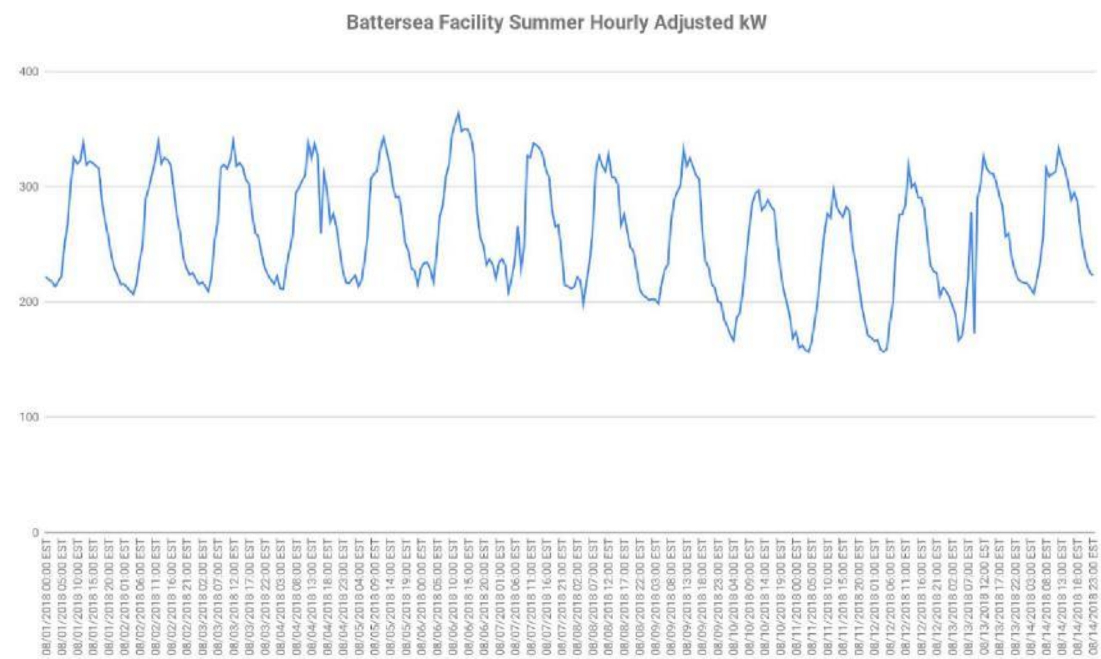


Passive Cooling for Server Room

The room housing the computer servers requires active air conditioning in all months of the year. During the winter, outside air could be ducted to the room instead of operating a compressor-based cooling system. The distance from the server room to an outside wall is approximately 15m. A duct, fan, and controller would be required. Balanced air flow could be achieved by allowing the warm server room air to passively vent into the building through a grille. The best control strategy would be to bring the system into the BAS so that both outside air temp and server room temperature could be used to decide where the passive fan or the A/C system should be operated.

Demand management

As discussed in the utility bill section, Fairmount currently pays $19.44 for every kW of peak demand every month. Reducing these peaks by just 10 kW would save $2300/yr. Another way to think about this is to consider a 1500 W coffee maker unnecessarily left on during a peak electrical cost period almost $30 for that month. An effective demand management strategy involves carefully logging when peaks occur (hourly data is available for download from Hydro One) and discovering all the loads that were on during the peak. In anticipation of a peak, any non-essential loads would be switched off for a short time by a control system. Such loads might include refrigerated vending machines, domestic refrigerators, or even walk-in coolers if a slight temperature rise could be tolerated.



The graphic above shows a sample two-week period in summer for Battersea Road. The peak for each day is obvious, but it can be seen that one is noticeably higher than the others. If this were a month, that high peak would trigger the demand charge for the whole month. Demand charges are about 30% of the overall electricity bill for this facility, so reducing monthly peak demand can have a strong payback.

Power Factor Correction

Power factor penalties are imposed on customers by their utilities when loads in the building cause electrical current and voltage to slip out of timing with each other. A perfect power factor is ‘1’, when current and voltage are rising and falling exactly in time with each other. Certain loads, such as electric motors, tend to cause power factors less than 1. Some fluorescent and LED lights can also have low power factors. When the overall power factor at the service entrance drops below 0.9 or 90%, a penalty is added to the monthly bill. The table below shows the power factor charges that Battersea Road incurred in 2018.

The power factor can be corrected at the service panel entrance by installing capacitor banks. Many vendors are available who specialize in this. It is recommended that a quote be obtained and compared to the annual penalty to determine if power factor correction is cost effective.

When upgrading lighting to LED, choose units with a power factor of 90% or higher. Inexpensive ‘unknown’ brands frequently have a low power factor. Power factor can be easily tested for any device with a plug on it.

Power Factor Correction Penalty (2018)						
			90%			$ 18.00
	kW	**kVA**	**Demand Charge**	**Power Factor**	**Penalty (kW)**	**Penalty Cost**
Jan	246	292	263	84%	16.8	$ 302.40
Feb	249	294	265	85%	15.6	$ 280.80
Mar	250	295	266	85%	15.5	$ 279.00
Apr	245	292	263	84%	17.8	$ 320.40
May	242	289	260	84%	18.1	$ 325.80
Jun	262	316	284	83%	22.4	$ 403.20
Jul	343	400	360	86%	17	$ 306.00
Aug	357	415	374	86%	16.5	$ 297.00
Sep	344	402	362	86%	17.8	$ 320.40
Oct	362	422	380	86%	17.8	$ 320.40
Nov	283	339	305	83%	22.1	$ 397.80
Dec	241	289	260	83%	19.1	$ 343.80
					216.5	**$ 3,897.00**

Paramedic Services Bases

Summary of Significant Upgrades

Additional smaller upgrades are noted building by building in the details section.

Upgrade	Annual Savings Potential	Capital Cost Estimate	Simple Payback (in years)
Convert Heating in Parham to Air Source Heat Pump	$2700	$16,000	5.9
Insulate foundation wall - Parham	$850	$2500	2.9
Palace Road – reduce excessive gas heat *	$1500	$500	0.3
Robertsville - reduce water temperature in radiant floor	$240	$800	3.3

*Capital cost assumes that the problem is resolved with a simple HVAC service and diagnosis.

Recommendations Common to All Bases

- Continue to replace lighting to LED, with emphasis on 24/7 lighting and outdoor lighting
- Convert fossil fuel heating to air source heat pumps to reduce GHG. The first priority is stations that use propane: Robertsville, Parham, Sydenham, and Wolfe Island.
- Convert fuel-fired domestic hot water heating to air source heat pump (hybrid hot water heater) or electric resistance heaters on a case by case basis to reduce GHG.

EMS Station (1) - 250 Palace Rd, Kingston

This large station has a higher energy use intensity (EUI) than any other and exceeds the average for this type of building. The audit visit did not reveal any unusual energy usage or obvious upgrade suggestions. The HVAC systems are mostly inaccessible, as they are located on the former flat roof, which is now an attic space accessible only through a high hatch that could only be accessed with a scissor lift. One RTU was inspected on an outdoor accessible roof.

Analysis has shown that the main cause of the high EUI at Palace Road is heating, not electrical. Palace Road has a heating fuel EUI (in ekWh/m2) approximately 40% higher than the average heating EUI of the other stations. Further work is required to determine the cause of this. Possible causes are:

- Air Handlers are introducing outside air. There is already an HRV and garage exhaust fans, so no additional outside air should be needed. The other stations have none.
- The bay doors are open much more often or for longer than other stations.
- The heating setpoint is too high.
- The RTU's gas burner is malfunctioning and running very inefficiently.

EMS Station (2) - 666 Justus Dr, Kingston (rented building)

As per direction from County officials, the audit team did not visit this building, as it is rented, and the paramedic services housed there are likely to be relocated in the near future.

EMS Station (3) - 1665 Highway 15, Kingston (rented building)

This is a rented building. The station is fully electric and uses no fossil fuels. It is heated with a heat pump using air distribution. The operating cost is 12% less than Parham, and the GHG emissions are the lowest of all the buildings in the group. Bay lights are excellent LED and could serve as a model for upgrading other stations.

The foundation insulation was found to be damaged on the exterior of the building, likely from the use of a weed trimmer:

EMS Station (4) - 10579 Highway 38, Parham

The Parham station is one of the oldest in the group and would benefit from numerous upgrades:

Upgrade	Annual Savings ($)	Annual Saving GHG (tonnes)	Capital Cost Estimate	Payback (in years)
Replace oil furnace with ASHP and replace oil domestic hot water heater with electric resistance heater	$2700	17.72	$16,000	5.9
Insulate Foundation Wall*	$850	0.2	$2500	2.9
Decouple second fan unit in bay	$35	negligible	$0	immediate
Cover sump in basement	$100 (730 kWh)	negligible	negligible	immediate

*savings assumes that the heating has been upgraded to ASHP. It will be more if left as oil heat.

An air source heat pump (ASHP), as installed at the Hwy 15 station, could be considered the 'state of the art' heating system and offers the greatest reduction in greenhouse gas emissions of all the choices. If an electric domestic hot water tank (DHW) was also installed, no propane or oil would be used. The Highway 15 station, which uses air source heat pump technology, operates at a 12% lower overall cost than Parham.

As an alternative, an air source heat pump hot water tank (often called a 'hybrid water heater') could be used. This would also act as a dehumidifier for the basement in the summer, reducing the need for existing plug-in dehumidifiers.

A less expensive option, but one that still uses fossil fuels, would be a condensing propane furnace and an instant condensing domestic water heater. Ensure that water hardness is controlled before installing any instant DHW equipment.

The building has insulated frame walls, but the foundation wall is uninsulated and partially exposed above grade. The savings above are estimated based on adding R-value 15 to the wall, which can be done using rigid XPS foam or sprayed two-component polyurethane. A fire rated coating can be sprayed on top of the foam, eliminating the need for a frame wall.

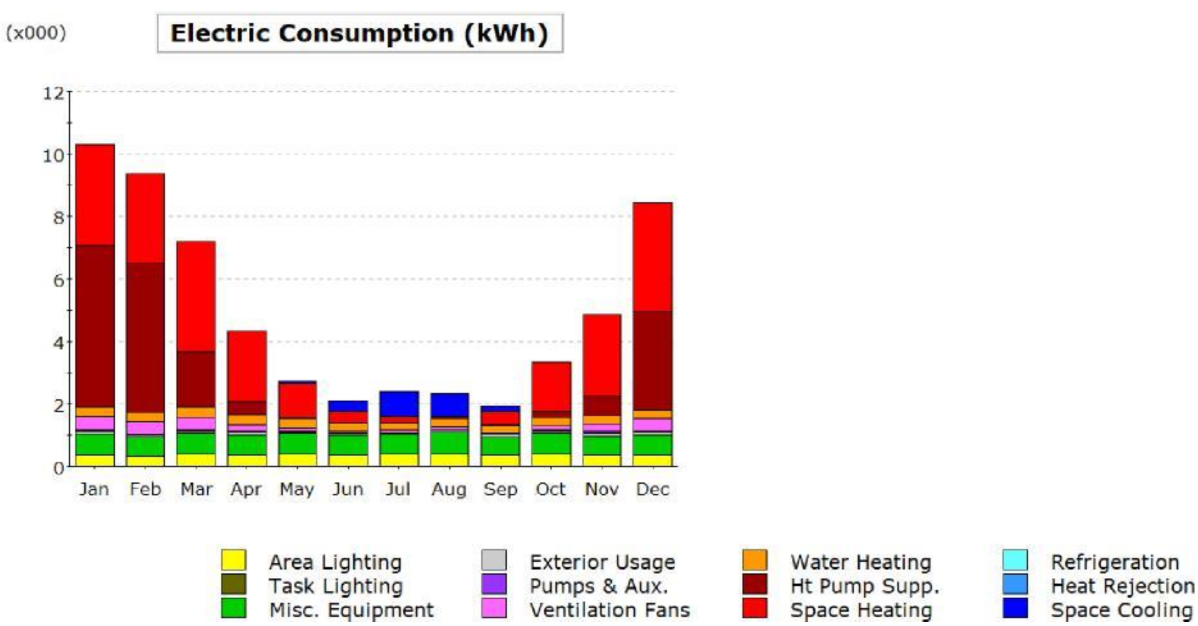
Two dehumidifiers were observed running in the basement. Foam wall insulation will reduce the humidity, but there is also an open sump pit with standing water that is contributing to the humidity. This sump should be covered with a lid to reduce evaporation of moisture that must then be removed by the dehumidifiers. A dehumidifier removing 12 L of water per day uses about $300 of electricity in a year.

The bathroom exhaust fan was found to be running continuously and mostly plugged. It should be cleaned and put on an occupancy sensor or crank timer.

When a vehicle is started and the bay doors opened, an exhaust fan starts to purge carbon monoxide (CO). Simultaneously, a second fan in a self-contained filter unit hanging from the ceiling also starts. This fan unit is designed with filters for dust removal and serves no purpose for removal of CO. No other station has such a dust-removal system. It is recommended that this second fan be removed from the automated circuit.

Above: The ceiling-mounted fan unit does not reduce CO.

Below: Upgraded energy consumption at Parham, with all upgrades included:



EMS Station (6) - 108 Highway 95, Wolfe Island

This station includes two buildings, a garage/lounge building shared with the municipal fire service of the Township of Frontenac Islands, and, behind this, a paramedic lounge/office building behind used only by the paramedic service. Only this rear building is owned by Frontenac County, so the front garage building was not studied by the audit team.

No upgrades are recommended for the building at this time, except continuation of facility-wide upgrading of high-use lighting to LED.

To reduce GHG production, an air source heat pump could be used to replace the propane currently used a fuel to heat the facility.

EMS Station (7) - 4264 Stagecoach Rd, Sydenham

This station is relatively new, and all its systems are in good condition. Minor conditions to upgrade/repair are:

- One small outdoor light at front was found to be on in daytime.
- Garage lights come on automatically with an occupancy sensor, even when there is bright sun and they are not needed. Replace this sensor with a unit that includes light-level sensing.
- The thermostat appeared to be set for 69°F in cooling season. This is too cold. The cooling setting should be 72°F to 75°F for reasonable occupant comfort and energy efficiency.
- The photovoltaic array behind the building features a rack with adjustable slope. The angle should be changed four times every year for reasonable production. On the date of the audit, the angle was observed to be far too steep for that time of year, which substantially reduces production.
- Continue facility-wide upgrading of high-use lighting to LED.

EMS Station (8) – 509 Robertsville Rd

This is the newest of all the stations owned by Frontenac County. The garage exhaust system features an intake air damper and exhaust fan that are both triggered by a CO detector in the garage. This system is efficient and should be used as a model for upgrading other facilities when these systems malfunction.

Heating System Issues

The building is heated with in-floor radiant heat from a high-efficiency propane boiler, an excellent choice for energy efficiency. However, the audit team noted that the boiler appears to be heating both the floor as well as the domestic hot water without the use of a temperature-mixing valve. Domestic hot water typically requires 140°F boiler water, whereas the maximum temperature for a radiant floor is typically 100°F. This problem is usually resolved by including a mixing valve on the floor loop to recycle some of the water and keep the temperature low, or by using a different heating system for the domestic hot water. The staff present reported problems with overheating in some areas in the winter, which would be consistent with water that it too hot being delivered to the floor.

When the return water temperature to the boiler is hotter than 130°F, it cannot run in condensing mode, causing efficiency to drop from mid-90s to low-80s.

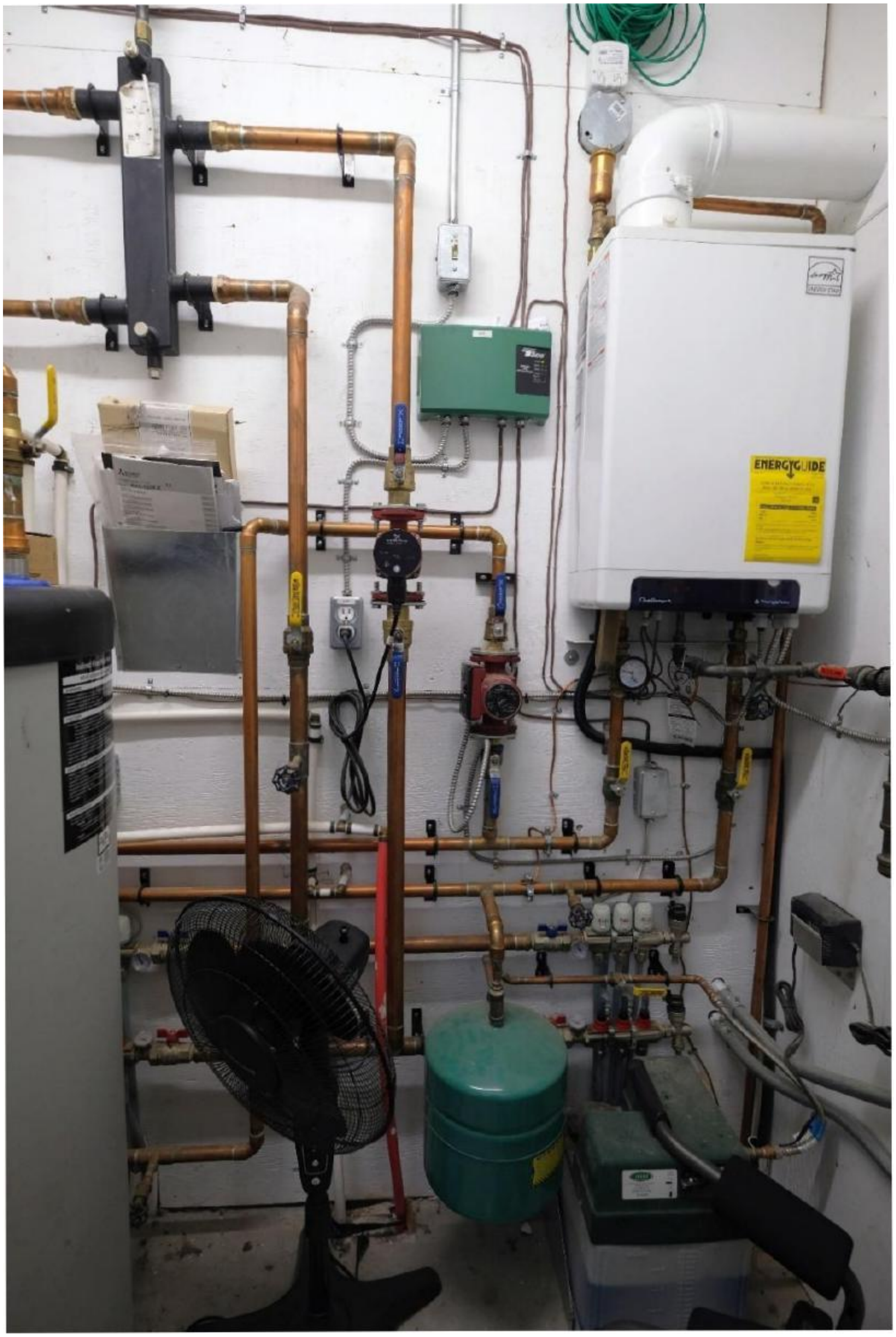
An outdoor reset control appears to be present, but it will not enable efficient low-temperature water production in the present configuration of the boiler. If a separate tankless propane heater for DHW was installed, the boiler could run at the reduced temperatures needed for condensing operation.

It is recommended that a hydronics specialist review this installation and recommend changes. Many smaller contractors do not have the training to adequately configure an advanced system like this. Mechanical drawings from original construction should also be checked to see if the apparent error was included in the design or if the installing contractor made unauthorized changes.

	Annual Savings	Capital Cost	Payback
Reconfigure boiler to operate in condensing mode with outdoor reset	$240	$800	3.3

The photo on the following page displays the heating system.

Heating System



Miscellaneous Issues
The building has many occupancy sensors to control lighting, but many were not operating properly. The garage lights were found to be on 24/7 due to a faulty or misplaced occupancy sensor. Replace the faulty sensors with better quality units that also feature light detection to avoid daytime operation. Solicit feedback from crews after replacement to ensure the problems are resolved.

Formation of ice on the inside of a steel door was reported. Staff suspected the cause was the make-up air duct located above the door. The audit team found the weather-stripping on the door to be of low quality. Replace the weather-stripping with a good-quality magnetic product designed for steel doors, as well as a good-quality airtight threshold and re-assess whether ice is still an issue.

EMS Station (12) - 706 Fortune Cres, Kingston

This large facility is in a rented building and comprises a three-bay garage, supplies storage, repair workbenches, and an equipment washing station. Offices and a small kitchen are at the front. Domestic hot water is electric resistance, and heating in the garage is accomplished with overhead gas unit heaters. For more on this topic, see our comments about lighting in the following section.

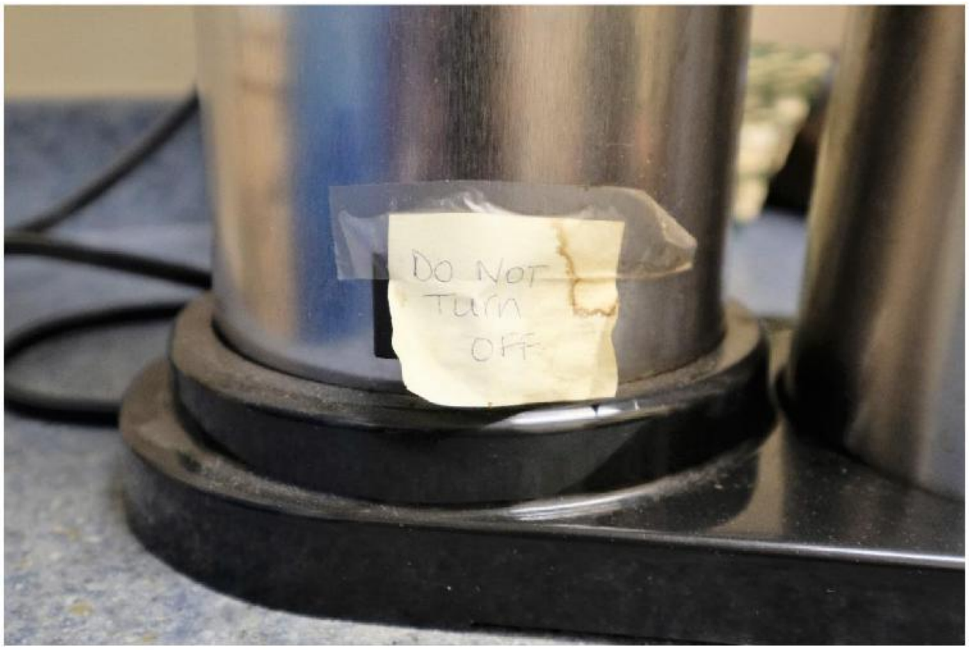
Human Factors and Energy Usage

A key part of achieving energy savings in an organization involves employee training and attitude. Random visits to all FPS bases and the Battersea Road facility allowed the audit team to see the state of lights and appliances on normal days at each facility. Frequently, the lights were off when adequate daylighting was present in FPS bases, and coffeemakers or TV's were rarely found on when unattended. The following photos and comments highlight places where improvements could be made.

This is the control for the HRV at Palace Road. It triggers the HRV to run on high humidity. The control is taped in position and the unit is running.

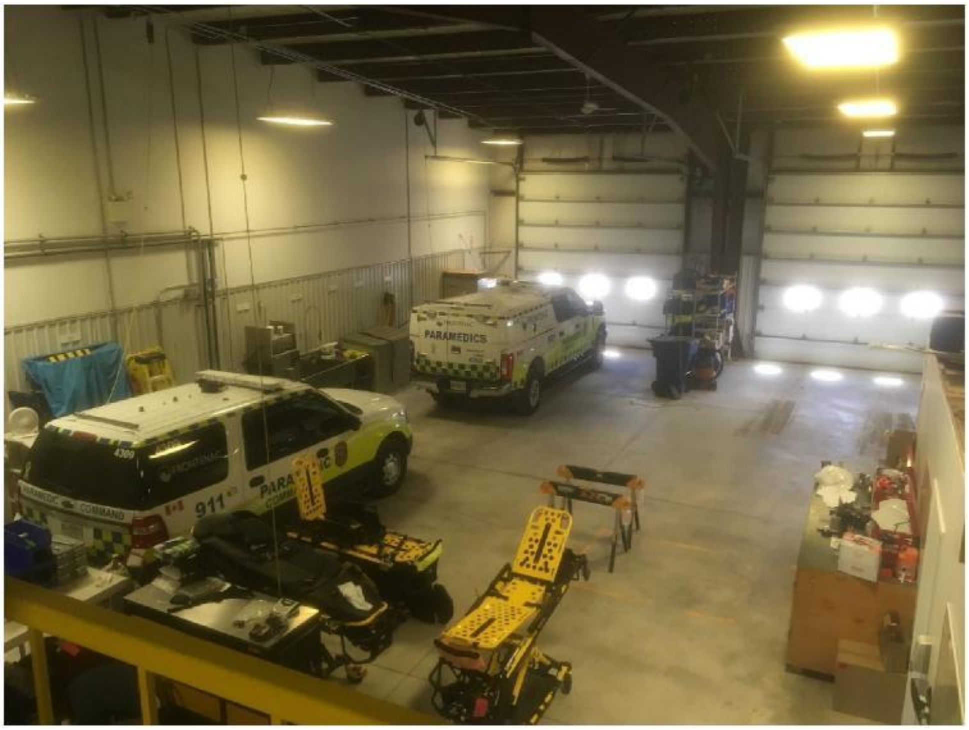
This is the inside of the HRV at Palace Road. The intake filter is heavily blocked.

The switch on this coffee maker is taped, with a request to leave it on, presumably 24/7. The 1500W heater inside will cycle all the time, maintaining hot water in an uninsulated container. (Located main floor, Old House, Battersea Road)



This is a light switch taped on in a washroom. Good-quality occupancy sensors, combined with delay off features, can operate washroom lights effectively. (Image taken near Fairmount boardroom

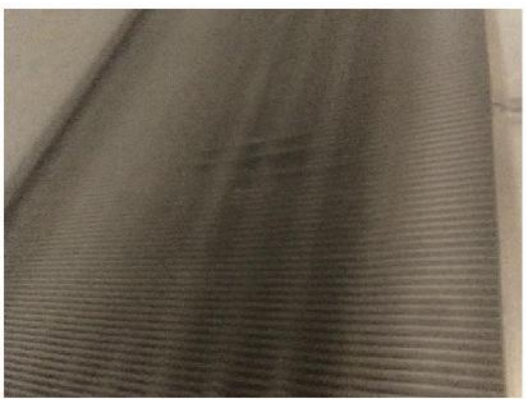
This washroom exhaust fan was found to be running continuously and is very plugged with dust. Continuous exhaust incurs costs not just for the electricity, but also for heating or cooling the air that it exhausts. Crank-style timers are an effective upgrade for small washroom exhaust fans. (Located at Parham FPS)



These lights were found to be left on at Fortune Cres FPS, although nobody was in the building. The lights in this area total 2100 W and costing $0.36 per hour, or $8.57 per 24-hour day. Good- quality occupancy sensors located in multiple places around the room could control these lights effectively.

The garage exhaust fan was found to be running continuously, apparently because it had been turned on by the override switch shown in the photo below. The crew onsite at the time were unaware that the fan was running and why it might have been switched on.

It is recommended that the override be changed to a timer-style control, so that when placed into 'override on' it goes off automatically after a period of time.



This evaporator coil in the walk-in freezer is clogged with dust. Restricted airflow over evaporator coils reduces the thermodynamic efficiency of the refrigeration system and increases runtime of the fans.

Strategies to Achieve 1% Annual GHG Reduction

The County of Frontenac has a policy goal to reduce its GHG emissions by 1% per year.
The table following summarizes the upgrades that offer significant GHG reductions. Usually these involve reducing the volumes of fossil fuels used for heating. Electrical upgrades typically have a much lower GHG impact. Emissions factor for electricity in Ontario is about 40 g CO_2 per kWh of electricity.

The upgrades presented here are explained more fully in the section entitled 'Recommended Energy Conservation Measures'.

Upgrade Measure	Annual GHG Reduction, tonne	% of Current Total
Ozone cold-water laundry at Fairmount	66	9.9%
Convert Old House at Battersea Road to ASHP heating	57	8.6%
Switch Parham station to ASHP for space heating and electric resistance DHW.	18	2.7%
Switch FPS bases with propane heat to ASHP* (Robertsville, Sydenham, Wolfe Island)	Robertsville 5.8 Sydenham 11.3 Wolfe Island 1.9	2.8%
Control ventilation air at Battersea Road	3.2 per 1000 CFM air reduction	unknown
Set back temperature setpoint at Municipal Offices, Battersea Road, when unoccupied	13	2%
Reduce fan speed in air handlers with VFD	8.23	1.2%
Reduce apparent overheating at Palace Road	6.3	1%

*Upgrading these FPS stations to ASHP creates GHG reductions but, at today's energy prices, increased overall cost. (If carbon taxes increase, this could shift.) The increased annual operating costs are:

Robertsville: $1530

Sydenham: $1440

Wolfe Island: $540

Conclusion

This report has summarized the total energy use – as measured in equivalent kilowatt hours – for each facility owned and operated by the County of Frontenac, and contains a variety of recommendations that together will help the County reduce its overall energy use, lower its greenhouse gas (GHG) emissions by 1% per year, and save money on its utility bills.

According to our utility analysis, the County of Frontenac's 2018 energy consumption (expressed in ekWh) was:

- 2,149,129 kWh in electricity
- 2,937,214 ekWh in natural gas
- 106,413 ekWh in propane
- 73,297 ekWh in fuel oil

The Battersea Road Facility accounts for 85% of the total energy consumption in the County of Frontenac. As a result, the bulk of the energy conservation opportunities will focus on this facility.

The greenhouse gas emission reductions calculated through the energy conservation measures are:

- Total GHG reduction estimate from energy savings upgrades: 191 tonnes of CO_2 equivalent.
- Total maximum estimated reduction of the County's GHG emissions: 28%

These energy conservation measures are described in the report, although some will require much more detailed investigation than warranted or mandated for this audit.

Reference was made in the report to the role of individual human behaviour in some aspects of the County's energy use (e.g., lights or coffee makers left on 24/7). Although each individual behaviour or action might seem inconsequential, together they can add up to noticeable increases in energy use and costs to the County. To address these behaviours, the County should consider recruiting a third party to implement a staff training program – possibly tied to the County's current Lean 6 Sigma program – that outlines the financial, energy-use and emissions consequences of various behaviours and simple, effective ways to address them.

Another option the County might consider is annual monitoring of its ECDM and the progress made towards achieving its annual 1% GHG reduction goal. Regular monitoring, along with energy measurement and verification (using tools such as data loggers), is a good way to ensure the ECDM is unfolding as intended and provides opportunities to refocus conservation efforts or equipment upgrades should the circumstances warrant.

Assuming that the County of Frontenac follows up on most or all of the recommendations in this report, it will have to make a number of significant investments in new equipment and infrastructure over the next five years to meet its emissions reduction goal. Fortunately, various grant and incentive programs offered by Ontario's Independent Electricity System Operator (IESO), Enbridge Gas, the Federation of Canadian Municipalities and others can offset the costs of these investments, sometimes to a considerable degree. If the county deems the energy conservation measures in this report financially and environmentally feasible moving forward, a detailed analysis of applicable incentives at the time will be required.

The detail provided in this report will be sufficient for relevant contractors to implement necessary measures to reduce greenhouse gas emissions and potentially reduce energy consumption.

Thank you for the opportunity to conduct this audit.

Red Squirrel Conservation Services

Alec Ross, Executive Director

Appendices

Appendix A Battersea Road

Infrastructure Lighting

Floor	Location	Room/Area	Fixture Type	Lamp Type	# Fixtures	# Lamps	hr/day	day/yr	Lamps Wattage	kWh/yr	
Basement	Old House	Basement	F 4 ft	T8	7	2	0.5	52	32	11.65	
		Hall	F 4 ft	T12	4	2	24	364	40	2,795.52	
		Exit	Exit Sign	Incandescent	2	2	24	364	28	978.43	
		Stairwell	F 4 ft	T8	12	2	24	364	32	6,709.25	10,494.85
	Paramedic Base	Entrance Hall	Pot Light	CFL	4	1	24	364	15	524.16	
		Exit	Exit Sign	LED	4	2	24	364	10	698.88	
		Hall	F 4 ft	T8	13	2	24	364	32	7,268.35	
		Lunch Room	F 4 ft	T8	5	2	4	260	32	332.80	
		Frontenac rm	F 4 ft	T8	21	2	2	260	32	698.88	
		Frontenac rm	Wall Mount	CFL	19	1	2	260	26	256.88	
		Washrooms	F 4 ft	T8	10	2	2	260	32	332.80	
		Main Office	F 4 ft	T8	44	2	8	260	32	5,857.28	15,970.03
	Fairmount Home	Kitchen	2x4 (3 tube)	T8	16	3	10	364	32	5,591.04	
		Kitchen	F 4 ft	T8	3	2	10	364	32	698.88	
		Laundry	2x4 (2 tube)	T8	12	2	8	260	32	1,597.44	
		Hall	F 4 ft	T8	26	2	24	364	32	14,536.70	
		Garbage	F 4 ft	T8	5	1	24	364	32	1,397.76	
		Lockers	F 4 ft	T8	3	2	2	260	32	99.84	
		Staff Room	F 4 ft	T8	7	2	12	260	32	1,397.76	
		Maintenance	F 4 ft	T8	8	2	12	260	32	1,597.44	
		Exit	Exit Sign	LED	8	2	24	364	10	1,397.76	
		Exercise Room	F 4 ft	T8	9	2	1	260	32	149.76	
		Boiler Room	F 4 ft	T8	21	2	2	260	32	698.88	29,163.26
1st	Fairmount Home	Servery	2x4 (3 tube)	T8	9	3	6	364	32	1,886.98	
		Elevator	F	T12	2	2	24	364	40	1,397.76	
		Dining	F 2x2	CFL	15	2	12	364	40	5,241.60	
		Corridor	LED 4ft	LED	24	2	24	364	13	5,451.26	
		Nurse Stn	LED 4 ft	LED	3	2	24	364	13	681.41	
		Lounge N Wing	Wall Sconce	CFL	9	2	8	364	26	1,362.82	
		Corridor	Ceiling Flush Mount	CFL	4	3	24	364	26	2,725.63	
		Lounge	Wall Sconce	CFL	3	2	8	364	26	454.27	
		Activity Room	F 4 ft	T8	6	2	8	364	32	1,118.21	
		Activity Room	F 4 ft	T8	4	1	8	364	32	372.74	
		Corridor	LED 4ft	LED	4	2	24	364	13	908.54	
		Dining 2	2x2 CFL	CFL	16	2	12	364	40	5,591.04	
		Lounge	Wall Sconce	CFL	5	2	8	364	26	757.12	
		Activity Room 2	F 4 ft	T8	11	2	8	364	32	2,050.05	
		Activity Room 2	F 4 ft	T8	3	1	8	364	32	279.55	
		Corridor	LED 4ft	LED	43	2	24	364	13	9,766.85	
		Nurse Stn	LED 4 ft	LED	4	2	24	364	13	908.54	
		Lounge	Wall Sconce	CFL	5	2	8	364	26	757.12	
		Cabinet Light	CFL POT	CFL	62	1	24	364	26	14,082.43	
		Reception	2x2 CFL	CFL	28	2	24	364	40	19,568.64	
		Reception	CFL POT	CFL	15	1	24	364	26	3,407.04	
		Corridor	2x2 CFL	CFL	3	2	24	364	40	2,096.64	
		Pool Table Room	2x2 LED	LED	16	1	4	364	24	559.10	81,425.34
	Auditorium	Auditorium Corridor	2x2 LED	LED	18	1	12	364	24	1,886.98	
		Hanging	4 ft LED	LED	20	1	8	364	50	2,912.00	
		Atrium	2x2 LED	LED	16	1	8	364	24	1,118.21	
		Greenhouse	4 ft LED	LED	5	1	2	364	35	127.40	6,044.58
	Offices	Meeting room	LED	LED	2	2	8	260	10	83.20	
		Meeting room	F 2 ft	T5	6	1	8	260	24	299.52	
		Bathroom	Globe	LED	1	2	8	260	10	41.60	
		Offices	F 4 ft	T8	18	2	8	260	32	2,396.16	2,820.48
	Old House	Offices	F 4 ft	T8	8	2	8	260	32	1,064.96	
		Foyer	F 4 ft	T8	3	2	8	260	32	399.36	
		Foyer	F 4 ft	T8	1	4	8	260	32	266.24	
		Kelly Office	F 4 ft	T8	2	4	8	260	32	532.48	
		Entrance Hall	F 4 ft	T8	5	2	24	364	32	2,795.52	
		Entrance Hall	Pot Light	LED	2	3	24	364	8	419.33	
		Exit	Exit Sign	LED	5	1	24	364	18	786.24	6,264.13

Floor	Location	Room/Area	Fixture Type	Lamp Type	# Fixtures	# Lamps	hr/day	day/yr	Lamps Wattage	kWh/yr	
2nd	Fairmount Home	Servery	2x4 (3 tube)	T8	9	3	6	364	32	1,886.98	
		Dining	2x2 CFL	CFL	15	2	12	364	40	5,241.60	
		Activity Room	F 4 ft	T8	8	2	12	260	32	1,597.44	
		NW Hall	LED 4 ft	LED	8	2	24	364	13	1,817.09	
		NW Hall	Pendant	CFL	2	4	24	364	28	1,956.86	
		NW Wing	LED 4 ft	LED	7	2	24	364	13	1,589.95	
		NW Wing	Pendant	CFL	2	4	24	364	28	1,956.86	
		Spa	LED 4 ft	LED	3	1	2	260	13	20.28	
		Spa	Ceiling Flush Mount	CFL	4	1	2	364	28	81.54	
		Shower	Ceiling Flush Mount	CFL	2	1	2	364	28	40.77	
		Shower	LED 4 ft	LED	2	1	2	364	13	18.93	
		Lounge	Wall Sconce	CFL	4	2	8	364	26	605.70	
		N Hall	LED 4 ft	LED	14	2	24	364	13	3,179.90	
		Lounge	Wall Sconce	CFL	6	2	8	364	26	908.54	
		E Hall	LED 4 ft	LED	20	2	24	364	13	4,542.72	
		Foyer	Wall Sconce	CFL	5	1	24	364	26	1,135.68	
		Office	F 4 ft	T8	2	2	8	260	32	266.24	
		Office	F 4 ft	T8	4	2	8	260	32	532.48	
		Therapy	F 4 ft	T8	11	2	8	260	32	1,464.32	
		Family	Wall Sconce	CFL	6	2	3	364	26	340.70	
		Office	Ceiling Flush Mount	CFL	7	2	8	260	28	815.36	
		S Hall	LED 4 ft	LED	40	2	24	364	13	9,085.44	
		Lounge	Wall Sconce	CFL	5	2	8	260	26	540.80	
		Shower	Ceiling Flush Mount	CFL	2	1	2	364	28	40.77	
		Shower	Ceiling Flush Mount	LED	2	1	2	364	18	26.21	
		S Foyer	Wall Sconce	CFL	8	2	24	364	26	3,634.18	
		Lounge	F 4 ft	T8	15	2	8	364	32	2,795.52	
		SW Hall	LED 4 ft	LED	7	2	24	364	13	1,589.95	
		Dining	2x2 CFL	CFL	15	2	12	364	40	5,241.60	
		Foyer	F 4 ft	T8	6	2	24	364	32	3,354.62	
		Cabinet Light	CFL POT	CFL	62	1	24	364	26	14,082.43	**70,391.46**
	Old House	Nancy Office	F 4 ft	T8	2	2	8	260	32	266.24	
		Kevin Office	F 4 ft	T12	2	2	8	260	40	332.80	
		2nd Foyer	F 4 ft	T8	1	4	10	260	32	332.80	
		Exit	Exit Sign	LED	4	1	24	364	18	628.99	
		2nd Hall	Ceiling Flush Mount	CFL	4	2	8	260	28	465.92	
		Jannette Office	F 4 ft	T8	2	2	8	260	32	266.24	
		Office	F 4 ft	T8	6	2	8	260	32	798.72	
		Office	F 4 ft	T8	3	2	8	260	32	399.36	
		Bathroom	Globe	CFL	3	1	8	260	26	162.24	**3,653.31**
All	Stairwells		1 F 4 ft	T8	10	2	24	364	32	5,591.04	
			2 F 4 ft	T8	10	2	24	364	32	5,591.04	
			3 F 4 ft	T8	10	2	24	364	32	5,591.04	
			4 F 4 ft	T8	10	2	24	364	32	5,591.04	
			5 F 4 ft	T8	10	2	24	364	32	5,591.04	
			6 F 4 ft	T8	10	2	24	364	32	5,591.04	**33,546.24**
All	Resident Rooms Main		Wall Sconce	CFL	372	2	8	364	26	56,329.73	
		Bathroom	Pot Light	LED	124	1	8	364	13	4,694.14	**61,023.87**
Main	Exterior Lighting		Wall Sconce	CFL	31	1	12	364	26	3,520.61	
			Lamp Post	HID	36	1	12	364	150	23,587.20	
			Flood Light	LED	6	1	12	364	40	1,048.32	
			Wall Pack	HID	10	1	12	364	175	7,644.00	
			Wall Sconce	Incandescent	1	1	12	364	60	262.08	
			Flood Light	HID	1	1	12	364	175	764.40	
			Flood Light	HID	1	1	12	364	175	764.40	**37,591.01**
									Total kWh/yr	**358,388.58**	

Other Electrical Equipment

Electrical Load Estimate					
Floor	**Location**	**Description**	**Count**	**Estimated kW**	**Total kW**
Fairmount Residence	Rooms	TV	58	0.06	3.48
	Rooms	Mini Fridge	40	0.15	6
	Spas	Dehumidifier	4	0.6	2.4
	Lounge	Fridge/Freezer	2	0.35	0.7
		Dishwasher	2	1.8	3.6
		Stove/Range	2	4	8
		TV	2	0.06	0.12
	Supply Rm	Blanket Warmer	2	0.01	0.02
		Oxygen refill	3	0.02	0.06
	Room	Portable AC	1	0.89	0.89
Fairmount 1st	Games Rm	Vending Machine	3	0.5	1.5
	Offices	Water Cooler	1	0.25	0.25
		Mini Fridge	1	0.15	0.15
		Computer	12	0.06	0.72
		Monitor	24	0.04	0.96
	General Store	Nescafe Coffee	1	1.3	1.3
		Hot Water (tea)	1	1.4	1.4
		Freezer	1	0.35	0.35
		Sliding Door Fridge	2	2	4
	Hair Salon	Salon Hair Dryer	1	2	2
Fairmount Basement	Staff Room	Fridge/Freezer	1	0.35	0.35
		Microwave	1	1	1
		Toaster	2	0.9	1.8
		Water Cooler	1	0.25	0.25
Fairmount Kitchen		Dishwasher	1	15	15
		Commerical Steamer	1	10	10
		Commerical Ice Mach.	1	0.86	0.86
		Commercial Toaster	1	1.7	1.7
		Commercial Microwave	1	1	1
		Meat Slicer	1	0.19	0.19
		Blender	1	1.4	1.4
		Walk-In Fridge	3	2.8	8.4
		Commercial Fridge	2	1	2

Electrical Load Estimate					
Fairmount Serveries		Dishwasher	2	15	30
		Hot table	4	3.5	14
		Commercial Fridge	2	1	2
		Vitality Juice Machine	2	1	2
		Commercial Coffee	2	1.3	2.6
Auditorium	Kitchen	Stove/Range	1	4	4
		Dishwasher	1	1.8	1.8
		Fridge/Freezer	1	0.35	0.35
		Coffee Machine	3	0.85	2.55
		Microwave	1	1	1
		Water Cooler	1	0.25	0.25
FPS Office	Kitchen	Water Cooler	1	0.25	0.25
		Toaster	1	0.9	0.9
		Coffee Machine	2	0.85	1.7
		Microwave	2	1	2
		Fridge/Freezer	1	0.35	0.35
		Stove/Range	1	4	4
		Dishwasher	1	1.8	1.8
	Offices	Computer	20	0.06	1.2
		Monitor	40	0.04	1.6
Old House 2nd	Offices	Computer	16	0.06	0.96
		Monitor	32	0.04	1.28
		Water Cooler	1	0.25	0.25
		Printer	1	0.3	0.3
Old House 1st	Offices	Computer	11	0.06	0.66
		Monitor	12	0.04	0.48
	Kitchen	Mini Fridge	1	0.15	0.15
		Coffee Machine	1	0.85	0.85
		Dishwasher	1	1.8	1.8
		Microwave	1	1	1
		Toaster	1	0.9	0.9
		Water Cooler	1	0.25	0.25
Fairmount	Laundry	Commercial Washer	4	0.4	1.6
		Commercial Dryer	4	5	20
				Total kW	**186.68**

Mechanical Load Estimate				
Location	**Type**	**Description**	**HP**	**kW**
Roof	Air Handling Units	RTU 1 Fan	10	7.457
		RTU 1 Compressor		30
		RTU 2 Fan	10	3.7285
		RTU 2 Compressor		30
		RTU 3 Fan	10	7.457
		RTU 3 Compressor		30
		RTU 4 Fan	10	7.457
		RTU 4 Compressor		30
		RTU 5 Fan	5	3.7285
		RTU 5 Compressor		20
		RTU 6 Fan	5	3.7285
		RTU 6 Compressor		20
Old House	Split AC	Compressor		1.4
		Fan	0.07	0.05
	Split AC			1.00
	Split AC	Compressor		1.00
		Fan	0.25	0.19
Fairmount	Mitsubishi Split AC	4 Count		9.20
Fairmount	Exhaust Fan	Fan	4.00	2.98
	Exhaust Fan	Fan	0.25	0.19
	Exhaust Fan	Fan	0.25	0.19
	Exhaust Fan	Fan	0.25	0.19
	Exhaust Fan	Fan	3.00	2.24
	Pumps	Recirc. Pump	0.8	0.6
		Heating Pump 1	7.5	5.6
		Heating Pump 2	7.5	5.6
		Heating Pump 3	3	2.2
		Heating Pump 4	3	2.2
		Boiler Circ. Pump 1	0.5	0.4
		Boiler Circ. Pump 2	0.5	0.4
		Circ. Pump	0.25	0.2
		Circ. Pump	0.25	0.2
		DHW Pump	0.5	0.4
		DHW Pump	0.5	0.4
		DHW Pump	0.25	0.2
		DHW Pump	0.25	0.2
		Booster Pump	5	3.7
		Booster Pump	7.5	5.6
Fairmount	Unit A	Fan	0.25	0.2
		Compressor		1.4
	Unit B	Fan	0.5	0.4
		Compressor		1.7
	Unit C	Fan	0.25	0.2
		Compressor		1.4
	Unit D	Fan	0.5	0.4
		Compressor		1.4
Fairmount	Roof Defrost			2.4
			Total kW	**249**

Fuel Fired Equipment

Unit	Count	Btu/hr Input	Btu/hr Output
Lochinvar CBN1797 Natural Gas Boiler	3	1,795,000	1,454,760
Lochinvar CWN0647PM Natural Gas DHW	2	645,000	522,450
Lochinvar CBN0985 Natural Gas	2	985,000	797,850

Appendix B Paramedic Stations Infrastructure

Lighting

Station	Total kW
Station 1-250 Palace Rd	3.1
Station 3-1665 Highway 15	1.8
Station 4-10579 Highway 38	1.3
Station 6-108 Highway 95 (includes fire hall)	4.1
Station 7-4264 Stagecoach Rd	1
Station 8-509 Robertsville Rd	.37
Station 12-706 Fortune Cres	2.6

Miscellaneous Electrical Loads (Not HVAC)

Station	Total kW
Station 1-250 Palace Rd	7.8
Station 3-1665 Highway 15	3.3
Station 4-10579 Highway 38	5.1
Station 6-108 Highway 95 (includes fire hall)	3.7
Station 7-4264 Stagecoach Rd	4.1
Station 8-509 Robertsville Rd	3
Station 12-706 Fortune Cres	7.1

HVAC Equipment

Base	Base Heat	Garage Heat	Base A/C	Garage cooling	HRV	Air Exchanger
01 Palace Rd	Carrier Weather Master 48HJE004351HQ	Infrasave Radiant	Carrier Weather Master 48HJE00351HQ	Fans	Carrier	Extractor
2 Justice Dr	York D7CG036N07958A	Reznor gas heater & Modine gas heater	York D7CG036N07958A	Fans	None	Lennox Air X
3 Hwy 15	ASHP + Baseboard	2 x Fan Heaters	Carrier 40AQO30350JR	None	None	Airmation AMB 302ND x 2
4 Parham	Oil Furnace (separate unit to garage furnace)	Oil Furnace (separate unit to base furnace)	Yes	Fans	None	Airmation AMB 302ND x 1 and extractor fan
6 Wolf Island	Luxaire TG9S040A08MP11A	Owned by fire hall	Luxaire S42566A50	Fans	None	Fan extractor
7 Sydenham	Lifebreath Air Handler AHU2	Lochinvar Knight floor heat	Luxaire TCGF2454153A	Fans	None	Honeywell extractor
8 Robertsville	Venmar Model #41500, Serial #BA0Z140100012	See base heat	Mitsubishi Model #MSY-GE15NA-8, Serial #3002190	Fans	None	Extractor
12 Fortune Cres	Base board heaters in offices; PTAC Unit	Reznor gas heater x 2	2 x wall units in offices EKTC09-135J	Fans	None	Extractor

Appendix C Energy Unit Prices (June 2019)

Electricity

Monthly fixed fees are approximately. $340 per year for each electric meter/account.

Rates vary due to different utilities and different time of use profiles. Hydro one also charges more for rural locations than urban.

Location	$/kWh
Battersea Road	0.0962 + $19.44/kW peak demand
FPS Station 8 - Robertsville	$0.171
FPS Station 4 - Parham	$0.171
FPS Station 7 - Sydenham	$0.170
FPS Station 3 - Pittsburgh	$0.172
FPS Station 12 - Fortune Cr.	$0.138
FPS Station 2 - Justus Dr.	$0.135
FPS Station 1 - Palace Rd.	$0.188
FPS Station 6 - Wolfe Island	$0.204

Fossil Fuels

Natural Gas, Typical $/m^3$	Propane, typical $/L	Oil, typical $/L
$0.40	$0.57	$1.17