CITY OF HAMILTON
2016 ANNUAL ENERGY REPORT






Hamilton

Introduction

The City of Hamilton underwent some big changes in 2016, unveiling its Strategic Plan for 2016-2025. To support the City's Vision, to be the best place to raise a child and age successfully, and the City's Mission, to provide high quality cost conscious public services that contribute to a healthy, safe and prosperous community, in a sustainable manner, a series of strategic priorities were developed. These strategic priorities align with those priorities identified by the 54,000 citizens that participated in creating Our Future Hamilton, the new 25-year Community Vision.

A key strategic priority relative to the City's corporate energy reporting is to be "Clean and Green". The City of Hamilton continues to demonstrate municipal leadership in managing its corporate energy costs by reducing its energy use and thereby reducing its carbon foot print. This is achieved through several energy related initiatives such as energy conservation, demand management and renewable energy generation. The City's management and mitigation of rising energy costs is further assisted by effective management and monitoring of energy commodities, utility rate and billing review, energy controls and energy data capture.

The 2016 Annual Report details the 2016 energy usage, costs, energy performance, procurement efforts, conservation, savings and avoided costs as well as the cumulative results dating back to 2006 for corporate sites. The total cumulative avoided costs, energy efficiency savings and incentives are $58.4 million since 2006, with $12.2 million achieved for the calendar year 2016.

As technologies and regulatory legislation evolves, it is imperative the City remains diligent in both the reporting on energy-related usage and costs and the promotion of renewable energy and environmental options. Becoming clean and green is an ongoing process. The City's own Corporate Energy Policy is one way it supports the goal that Hamilton is the best place to raise a child and age successfully.

Visit:

www.hamilton.ca for further information on the 2016-2025 Strategic Plan and www.hamilton.ca/energy for further links to policies and reports referenced in this report.

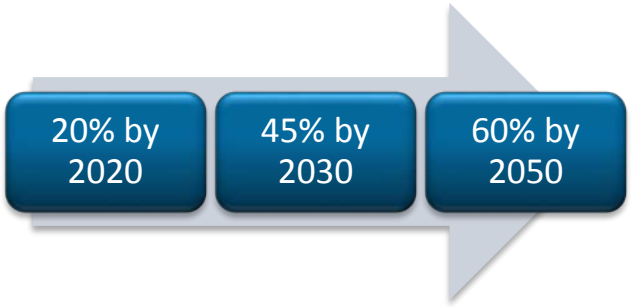
Corporate Energy Policy Review

In 2014, Council approved the City's second version of the Corporate Energy Policy (PW14050). The new policy outlines specific targets for a variety of key performance measures and the guidelines to achieve them. Changes in the 2014 Energy Policy were designed to:

- **Facilitate the achievement of City-wide energy and emission reduction targets;**
- **Address the legislated reporting requirements e.g. Green Energy Act;**
- **Define policies for capital investment related to energy;**
- **Define policies related to energy procurement; and**
- **Address regulations concerning greenhouse gases (GHG) emissions.**

The policy itself calls for an energy intensity reduction target of 45% by 2030 and 60% by 2050 in corporate buildings. The initial target of 20% reduction by 2020 was achieved in 2013. Achieving the 2030 target alone is anticipated to deliver an additional $50 million from avoided costs, incentives and direct savings. A series of actions outlined in the Policy was established to provide a set of guidelines and protocols to assist in the making of decisions relative to energy using equipment, processes, systems and activities. The intent of these guidelines, once they are implemented, is that it will lead to further energy reduction and further emissions reduction which will result in a direct benefit to the City both environmentally and financially.

Energy Intensity Targets Outlined in the Policy:



The energy intensity reduction for 2016 as compared to the base year of 2005 was a **23.1%** reduction. Energy Intensity, measured as equivalent kilowatt-hour of usage per square foot (ekWh/sqft) is one of the key performance indicators of the corporate energy policy.

Avoided Costs, Incentives and Energy Savings

Each year that the City completes energy efficient projects, applies for incentives, implements rate optimization, or completes energy bill review, there is potential for savings and/or avoided costs. Tracking this information is a key performance indicator of the City's efforts to reduce energy usage and costs through various activities.

In 2016 the total avoided costs, incentives and energy savings was $12.2 million. The total cumulative value from 2005 to 2016 was $58.4 million.

Avoided Costs and Savings are broken down into three categories, explained below:

Utility Rates and Cost Avoidance

This category is classified as electricity and natural gas costs that would have incurred had no action been initiated by the City. Actions include procurement plans and strategies such as natural gas commodity hedging and optimizing utility rates such as switching rate classes to benefit from Global Adjustment (GA) savings opportunities. With the converting of some of its large user accounts from a general service Class B to Class A rate, the City has avoided costs of almost $4.7 million in 2016 in GA charges alone. The avoided costs in this category totalled $5.1 million for 2016.

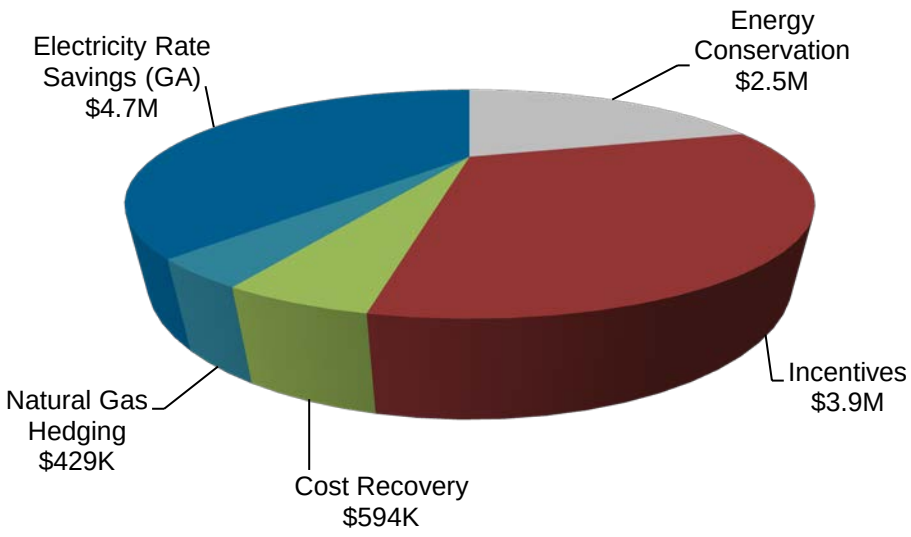
Cost Recovery

This category is classified as the costs recovered due to the City's continuous efforts in monitoring and analyzing its utility accounts. Recoveries can be attributed from adjustments made from billing errors, billing anomalies or rate corrections. The costs recovered totalled $594,000 in 2016.

Energy Conservation and Incentive Programs

This category is classified by savings achieved from the implementation of energy efficient measures, equipment and processes that lead to lower consumption and any financial incentives received for the energy efficient projects. Many of the City's capital projects are eligible for a variety of financial incentives from our utility providers and from the Independent Electricity System Operator (IESO). Energy projects and incentives totalled almost $6.5 million for 2016. A large part of the 2016 total in this category was the receipt of one of the largest incentives awarded for a conservation project, $3.86 million for the Street Lighting High Wattage Replacement project, completed by the Engineering Services division in 2015.

Figure 1: 2016 Breakdown of Savings and Avoided Costs*



* Due to rounding, dollars may not be exact.

Overall Costs

The City tracks and measures the costs and consumption for electricity, natural gas, water and fuel against the previous year and to the baseline year of 2005. Costs for sites also connected to the district energy loop (and supplied by HCE Energy Inc.), including City Hall, Hamilton Convention Centre, Hamilton Place, Central Library, Lister Block and FirstOntario Centre are included in electricity or natural gas costs. High utility costs continue to be a concern for corporate buildings. While conservation efforts can help reduce consumption of utilities and mitigate rising costs, changes in the costs

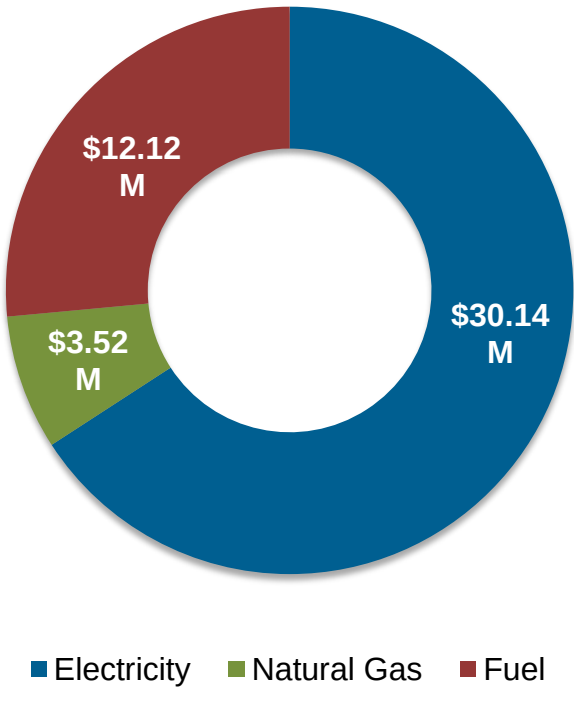
themselves are impacted by more than just usage. Regulatory action, rates, inflation and global markets, process changes and weather can also impact cost. For example, electricity in Ontario has seen costs rise at an alarming rate. Regulatory impacts have resulted in costs increasing overall, despite increased efforts to reduce usage by conservation and other energy efficient measures.

Of note in 2016, weather played a role in increased electrical consumption at sites across the City. Hamilton had a warm, long summer, with its cooling degree days 64% higher than those reported in 2015, resulting in higher consumption during the summer. Eight out of the ten top peak demand days in Ontario were in August and September.

Comparing cost, consumption, unit pricing and energy intensity can give a clearer picture on the entire utility spend within the City.

The City's expenditure on utilities included in this report (electricity, natural gas and fuel) for 2016 was $45.8 million. This is a cost increase of 2% compared to 2015. Figure 2 below outlines the individualized costs for each of the utilities.

Figure 2: 2016 Utilities Costs in Millions (M)



The costs are incurred by all City-owned facilities, Hamilton Water, Public Works Operations, Street and Traffic lighting, and exclude City Housing Hamilton. Utilities include Union Gas, Horizon and Hydro One. In addiiton, any sites linked to the District Energy system have the utility costs from HCE included. The fuel information reported includes all Fleet, Operations and Transit vehicles but does not include Hamilton Police Services or Darts. Fuel costs include those for diesel, unleaded gasoline and compressed natural gas (CNG). Sites that have only a partial year of utility data for 2016 are not included as part of this report. Those sites will be included once a full year data set becomes available. (ie. Tim Horton's Field has been added to the report as 2016 was its first full year of operations.

The results are:

- **Overall electricity costs were $30.1 million in 2016, 7% higher than in 2015.**
- **Overall natural gas costs were $3.5 million in 2016, 3% less than 2015.**
- **Overall Fuels costs (Diesel and Natural Gas) were $12.1 million in 2016, 8% less than 2015.**

Energy Performance

In order to better identify energy performance, energy costs and consumption for electricity and natural gas are tracked for all City-owned sites, excluding City Housing Hamilton. Consumption patterns for electricity and natural gas can vary and are impacted by such things as weather and temperature as well as changes to square footage from the addition and removal of facilities. Increases or decreases in costs are reflected by the consumption changes, and are further impacted by regulatory and market activity. Therefore, it is not unusual to see higher costs even when consumption is lower, particularly with electricity, where the increase to regulatory costs is outpacing reductions of consumption.

Additionally, tracking unit costs and energy intensity allows the City to compare buildings and narrow down areas of concern and focus on improvements. Energy intensity measurement is a key performance indicator to the success of the Corporate Energy Policy and broader City priorities and strategies.

The combined cost and consumption results for electricity and natural gas are measured in equivalent kilowatt-hours (ekWh) as shown in Figure 3 below:

Figure 3: Combined Cost and Consumption for Electricity and Natural Gas

				Comparisons	
Total Energy Overview	2005	2015	2016	2016 vs 2005	2016 vs 2015
Total Energy (ekWh)	400,722,256	359,460,344	351,654,327	-12%	-2%
Total Energy Cost ($)	$27,177,303	$31,766,870	$33,666,645	24%	6%
Total Energy ($/ekWh)	$0.068	$0.088	$0.096	41%	8%

ekWh= equivalent kilowatt-hours

Electricity Cost and Consumption

As the largest utility expenditure for the City, electricity is comprised of commodity as well as costs associated with distribution, transmission, regulatory and delivery. The City is serviced by two local distribution companies (Horizon Utilities and Hydro One). The City's cost and consumption are approximately 85% from Horizon Utilities and 15% from Hydro One. While the utility rates may vary between the utilities, both are regulated by the Ontario Energy Board (OEB) and must seek approvals for any rate or cost of service adjustments.

Costs for electricity have increased overall since the base year (2005) by 41%. This is due to increases in both regulated (i.e. Global Adjustment) and commodity costs in general. Overall, a slight increase in consumption for cooling during summer, higher commodity costs, and the addition of Tim Horton's Field to the data reporting, can explain the increase in costs compared to 2015.

Below is the comparison for year over year and to the base year for cost and consumption of electricity.

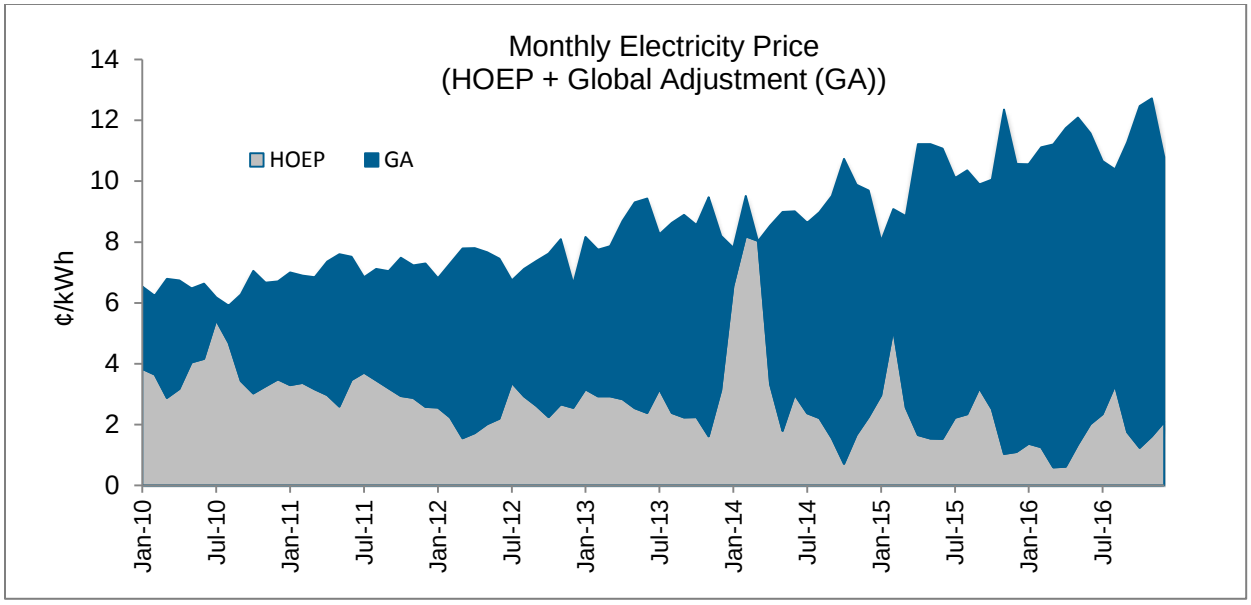
Figure 4: Electricity Cost and Consumption Comparison

				Comparisons	
Electricity Overview	2005	2015	2016	2016 vs 2005	2016 vs 2015
Total Electricity (kWh)	236,362,045	223,881,250	224,322,011	-5%	0.2%
Total Electricity ($)	$20,657,050	$28,121,815	$30,144,778	46%	7%
Total Electricity ($/kWh)	$0.087	$0.126	$0.134	54%	7%

kWh = kilowatt-hour

The electricity commodity portion of the overall electricity price is a combination of the Hourly Ontario Energy Price (HOEP) which is market-based and the Global Adjustment (GA) which is regulated. The graph below shows the relationship between HOEP and GA, which makes up the commodity portion of electricity, costs.

Figure 5: Monthly Electricity Commodity Price (HOEP + GA)



Natural Gas Cost and Consumption

Natural gas costs include commodity and regulated costs for storage and delivery from Union Gas. Regulated costs for natural gas are also approved by the OEB. Natural Gas consumption is particularly impacted by cold winter weather. Prices for natural gas are typically higher during the peak-consuming times. However, because the City can purchase (hedge) natural gas on the wholesale market, the City is able to mitigate the fluctuations in commodity cost. Overall, natural gas costs for the City have decreased significantly over the past decade, down 46% from 2005. This is due to both the City's procurement program, and an overall trend of declining commodity prices.

Consumption was down compared to 2015 by 6%, due in part to milder winter temperatures. Below is the comparison year over year and to the base year for cost and consumption of natural gas for facilities, and does not include compressed natural gas (CNG) used for Transit buses.

Figure 6: Natural Gas Cost and Consumption Comparison

				Comparisons	
Natural Gas Overview	2005	2015	2016	2016 vs 2005	2016 vs 2015
Total Natural Gas (m^3)	15,403,956	12,949,293	12,161,635	-21%	-6%
Total Natural Gas ($)	$6,520,253	$3,645,054	$3,521,867	-46%	-3%
Total Natural Gas ($/m^3$)	$0.423	$0.281	$0.290	-32%	3%

m^3 = cubic meter

As of January 2017, a new government-regulated charge for Cap & Trade was added to the delivery charges on natural gas utility invoices. The impacts to costs vary depending on rate class, but on average, 3.4 cents per m3 is added to the total bill. This will impact the overall costs for the upcoming year. The effects of the Cap & Trade charge will be reported in the 2017 annual reporting as actual costs are tracked throughout the year.

Energy Intensity (City-Owned Sites)

Energy intensity is the measure of usage in equivalent kilowatt-hours per square foot (ekWh/sqft). The ekWh figures shown below are a combination of electricity and natural gas consumption. Energy Intensity is one of the key performance indicators for the City's Corporate Energy Policy reduction targets compared to the base year. The energy intensity for 2016 compared to base year of 2005 was a reduction of 23%. Corporately, looking at energy intensity per Department/Division allows for a better understanding of where the City could concentrate efforts to reduce usage.

Figure 7: Energy Intensity City-Wide Total for City-owned Sites

				Comparisons	
Energy Intensity	2005	2015	2016	2016 vs 2005	2016 vs 2015
City Total (ekWh/sqft)	45.69	36.79	35.14	-23%	-4%
City Total ($/sqft)	$2.67	$2.56	$2.74	3%	7%
Reported Square Footage	5,138,852	5,206,155	5,528,712	8%	6%

ekWh = equivalent kilowatt-hour sqft= square foot

The table (below) outlines the energy intensity totals by site category (type) with a comparison to base year (2005) and to the previous year. Categories that have an "n/a" are not included in the energy intensity calculation as they are operations (e.g. street lighting, Hamilton Water pumping operations) and do not have relevant square footage information.

Figure 8: Energy Intensity Comparison by Reporting Category Grouping

Energy Intensity	ekWh/sqft				
	2005	2015	2016	2016 vs 2005	2016 vs 2015
City/Town Halls	39.6	22.3	23.0	-42%	3%
Corporate Facilities	44.6	20.1	17.1	-62%	-15%
Street Lighting	n/a	n/a	n/a	n/a	n/a
Traffic Lighting	n/a	n/a	n/a	n/a	n/a
Other City Operations	n/a	n/a	n/a	n/a	n/a
Hamilton Water	n/a	n/a	n/a	n/a	n/a
Yards	38.1	32.7	34.1	-11%	4%
Arenas	51.3	46.3	43.8	-15%	-5%
Community/Senior Centers	31.1	22.2	24.9	-20%	12%
Rec Centres/Pools	78.6	76.2	68.4	-13%	-10%
Rec Parks/Stadiums/Golf	36.5	40.6	32.9	-10%	-19%
Lodges (Macassa Lodge, Wentworth Lodge)	113.6	47.4	46.4	-59%	-2%
Culture	35.5	38.2	36.3	2%	-5%
Fire/ EMS	45.2	39.6	37.3	-17%	-6%
Hamilton Public Libraries	25.2	26.6	27.5	9%	3%
First Ontario Centre	22.5	23.0	21.9	-3%	-5%
Hamilton Convention Centre	49.2	33.4	28.3	-43%	-15%
Hamilton Place	43.7	52.4	46.5	6%	-11%
Hamilton Police Services	59.8	38.9	35.2	-41%	-10%
City Wide Total	**45.69**	**36.79**	**35.14**	**-23%**	**-4%**

Additional tables showing energy intensity by portfolio are provided in the Appendix A (pages 26 to 33).

Corporate Average Fuel Economy (CAFE)

Corporate Average Fuel Economy is the traditional method for measurement of the fuel consumed per 100 kilometers (km) of a vehicle and is used to monitor performance in fuel consumption, efficiency and fuel management activity. The long term target is a 20% reduction in fuel economy by 2030. Reaching this level of improvement can be achieved through emerging technologies, fit-for-purpose fleet vehicles, acquiring new vehicles with better engine/drive technology, and reductions in horsepower requirement for fleet needs over time. Reduced idling time can assist in improving fuel economy as well.

As of 2016, there was an overall 7% reduction as compared to the base CAFE level, shown in the table below.

Figure 9: Corporate Average Fuel Economy 2016 to Base Comparison

Diesel Litre Equivalent (DLE) per 100KM	BASE	2016	Change
Unleaded *	21.0	18.5	-12%
Diesel *	54.0	52.5	-3%
CNG	66.2	58.9	
Total	46.2	42.9	
Overall % Change in DLE/100 KM Base		-7%	

* Base as indicated in the Corporate Energy Policy

Fuel Cost and Consumption

The City makes bulk purchases of fuel for its fleet of vehicles, including buses, waste collection vehicles, snow removal trucks, street sweepers, departmental vehicles, as well as Fire and Emergency Services (EMS) vehicles. A large portion of these vehicles use traditional diesel and unleaded gasoline, with a small volume of dyed diesel for small equipment. Transit also has a growing number of natural gas-fuelled buses.

In 2016, City departments used approximately 11.1 million litres (L) of diesel fuel, a 7% reduction over 2015 purchases. The City used 2.2 million litres of gasoline, a 6% increase over 2015. Average cost of Diesel in 2016 was $0.88/L and Gasoline was $0.85/L. However, cost per litre of fuel is expected to increase in 2017 with the onset of Cap & Trade embedded into fuel prices.

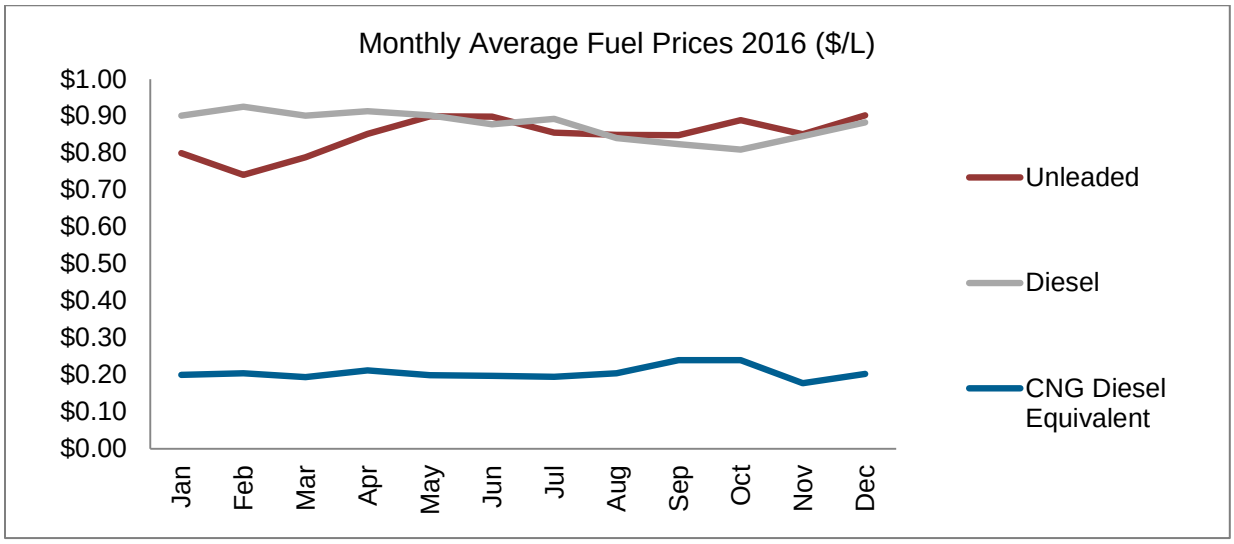
Figure 10: 2016 Cost and Consumption of Diesel and Gasoline

2016	Consumption Litres	Total Cost	Average Cost per Litre
Diesel	11,067,857	$9,684,841.35	$0.88
Gasoline	2,200,718	$1,863,469.77	$0.85

One of the primary reasons diesel purchases have reduced is Transit's replacement program of diesel buses with compressed natural gas (CNG) fueled buses. Natural gas volumes used by Transit have increased by 53% over 2015. By year end 2016, there were 74 CNG buses. The compressed natural gas station, which was commissioned in September 2015, operates under a natural gas storage contract and is managed daily to accommodate the growing fleet and natural gas volumes. The natural gas purchases are included in the City's procurement strategy.

The City's monthly fuel price including the CNG price (converted to diesel equivalent (DLE)) is shown in the graph below.

Figure 11: 2016 Monthly Fuel prices in DLE



In 2016 CNG buses travelled over 3.5 million kilometres, and used 2,535,070 m3 of natural gas which is 2,616,192 DLE. The average CNG bus operated at 74% efficiency per DLE when compared to the average diesel bus usage. Natural gas costs to fuel the CNG buses were $570,309. When converted into diesel equivalent dollars, and adjusting for efficiency, the resulting avoided cost of using CNG buses instead of diesel buses is $1,133,355.

Renewable Energy

Renewable energy generation initiatives have contributed to further reduce GHG emissions for the City's corporate operations as follows:

The City, through Hamilton Renewable Power Inc. (HRPI), owns and operates three 1.6 Megawatt (MW) renewable gas fuelled units. Two units are located at the Glanbrook landfill site. The third unit is located at the Hamilton Water site on Woodward Avenue, and is a cogeneration unit that produces electricity and heat. These units use methane as a renewable fuel source to produce electricity which is secured through long term contracts with the province. These operations all contribute to a more efficient and sustainable process as they continue to displace use of conventional fuels and offset GHG emissions. The system produces approximately 31,000,000 kWh of renewable energy annually with a reduction of emissions in excess of 100,000 tonnes CO2e (CO2

equivalent). In 2016, the net benefit from all HRPI operations was approximately $1.3 M for the City, with a cumulative total of $15.1 for the period from 2006 to 2016.

The Hamilton Water Biogas Purification Unit captures excess methane gas from the anaerobic digestion process of waste water products. The methane is purified, treated and conditioned to yield utility grade natural gas that is injected into the Union Gas distribution system. This gas is sold at market rates and can result in emission reductions of roughly 15 tonnes CO2e.

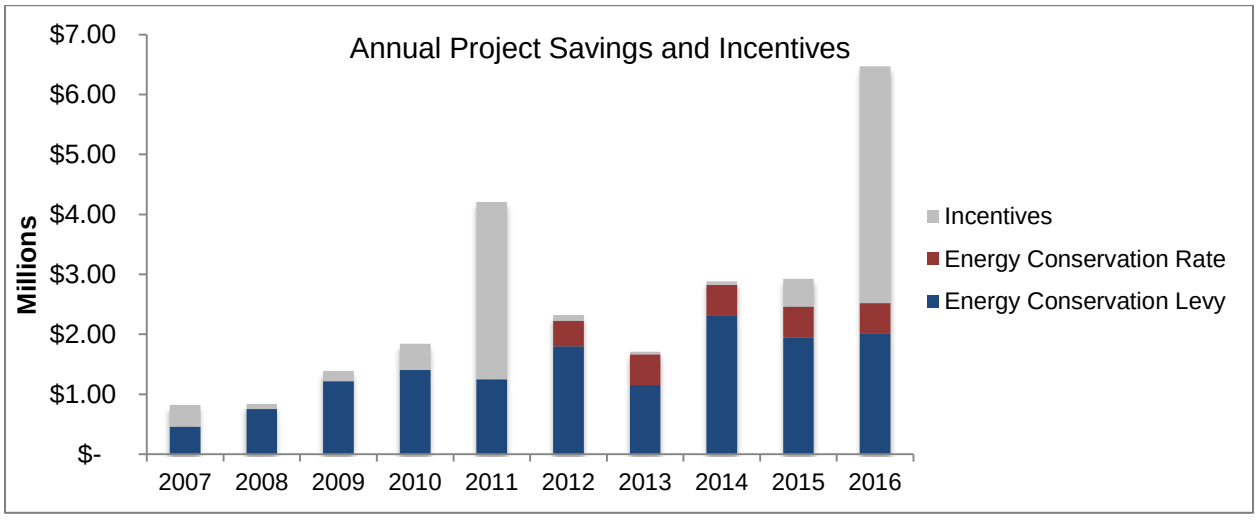
Energy Conservation

Energy conservation projects are an integral part in achieving energy reduction goals. Not only do the projects increase efficiencies and embrace emerging technologies, but the City can continue to track the savings achieved after a project is complete. The approved International Protocol for Monitoring and Verification (IPMV) is used to validate savings and avoided costs.

Project teams work in conjunction with consultants, engineers, utility personnel and other industry experts to maximize efficiency and ensure incentive applications are completed with appropriate Monitoring and Verification (M&V) plans as required.

The 2016 energy savings contribution from projects is $2.5 million, plus nearly $4 million received for incentives (includes the Street Lighting incentive of ~$3.8M), for a total of $6.5 million. The cumulative value since the 2005 baseline year is $25.4 million for projects and incentives.

Figure 12: Annual Project Savings (Rate & Levy) and Incentives



2016 Project Updates

A variety of energy efficient projects were undertaken in 2016. Several initiatives included upgrades to lighting systems, including the use of Light Emitting Diode (LED) where it was deemed feasible. LED lamp technology provides excellent lighting quality which enhances user safety, security and work environment, with the added benefit of reduced maintenance frequency due to long lamp life and lower energy consumption.

Figure 13: 2016 Projects

Capital Lighting Upgrade (Phase I) at 700-900 Woodward Ave

- Upgraded some of the existing lighting to more energy efficient systems using LEDs where possible in Maintenance Shop, High Lift Station, Filter Plant, Lower Stores, Pump House.
- Benefits include improved lighting conditions, reduction to lamp maintenance costs.
- 439,222 kWh annual reduction and $36,000 in annual savings.
- $21,960 in incentives to be expected from IESO SaveOnEnergy program.

Parkade Lighting

- Replacement of High Pressure Sodium and Metal Halide lighting with an LED lighting retrofit in parking garages at York Blvd, Hamilton Convention Centre and Summers Lane.
- Benefits include enhanced user safety and security and reduced maintenance costs.
- 1,136,364 kWh annual reduction and $170,455 in annual savings.
- $79,100 in incentives to be expected from IESO SaveOnEnergy program.

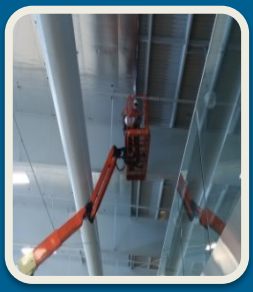
Mountain Transit Center- Energy Efficient Lighting Upgrade

- Upgraded lighting to more energy efficient systems using LEDs where possible and lighting control systems of bus parking garage, maintenance garage and outdoor area lighting.
- Benefits include enhanced user safety and security and reduced maintenance costs.
- 744,753 kWh annual reduction and $111,713 in annual savings.
- $44,685 in incentives to be expected from IESO SaveOnEnergy program.

Stoney Creek City Hall Direct Digital Controls Upgrade

- Installation of a new Direct Digital Control system, replacement of existing control systems, and a web based connection to the City's host server.
- The purpose is to create a smarter building with energy efficiency and benefits include improved thermal comfort for the building occupants.
- 62,632 kWh annual reduction and $7810 in annual savings.
- $7,075 in incentives to be expected from IESO SaveOnEnergy program.

Harry Howell Arena Low E Ceiling Project



- Installation of Low Emissivity Ceilings (low E ceilings). Low E ceilings block radiated heat from the ice surface and the refrigeration system does not have to work as hard.
- Benefits include reduced electrical consumption and less wear.
- 268,100 kWh annual reduction and $40,215 in annual savings.
- $27,000 in incentives to be expected from IESO SaveOnEnergy program.

Arena's – Floating Head Pressure Control Pilot Project

- This pilot project at Olympic and Carlisle Arenas. The technology utilizes controls and variable frequency drives to optimize the efficiency of the refrigeration process.
- Benefits include less wear on refigeration units.
- 117,300 kWh annual reduction and $12,400 in annual savings.
- $12,000 in incentives to be expected from IESO SaveOnEnergy program.

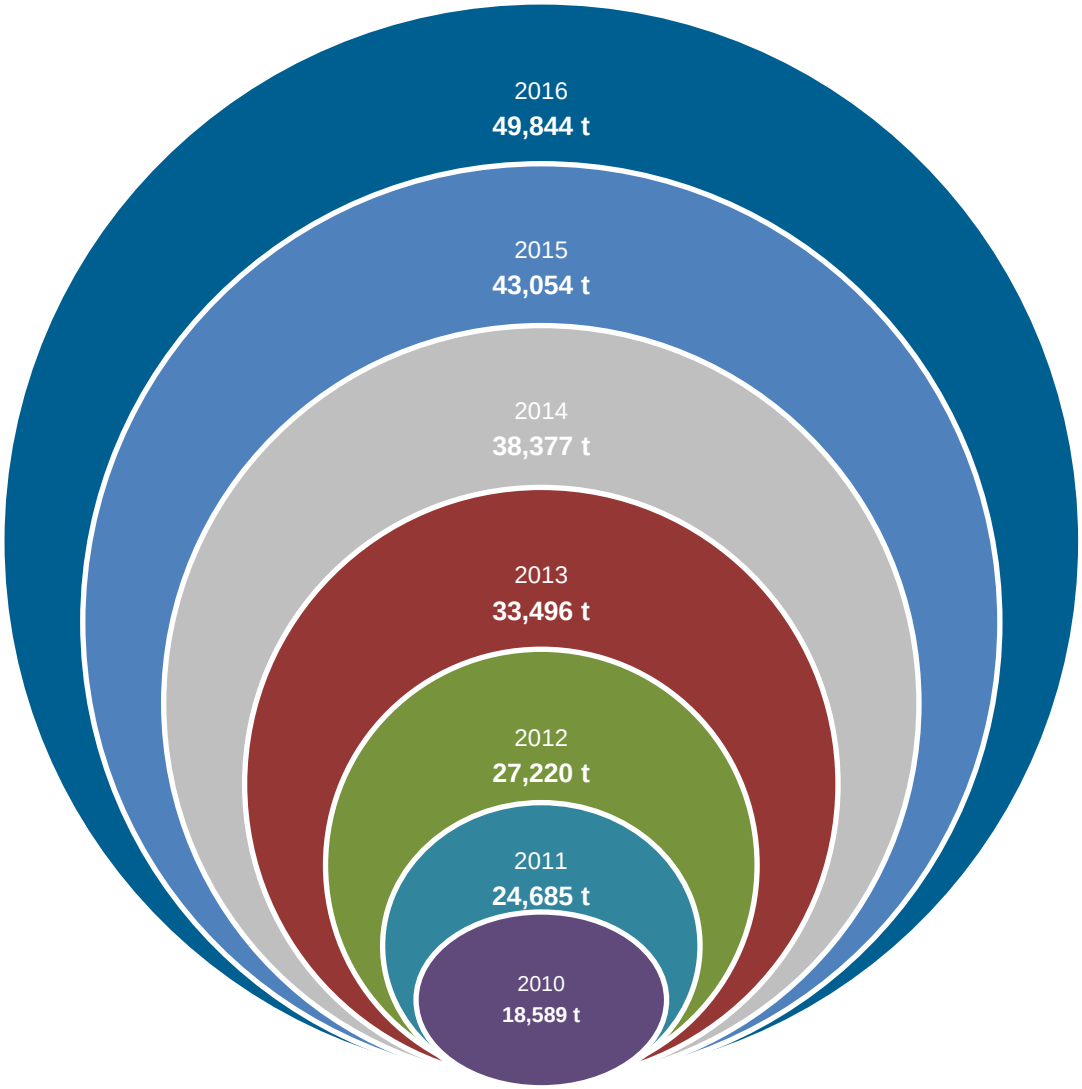
2017 List of Upcoming Projects

- Upgraded LED lighting at Macassa Lodge and Wentworth Lodge.
- Upgraded LED lighting in select (~30) Fire Stations.
- Upgraded LED lighting and controls at FirstOntario Centre and Hamilton Place.
- Arena Ice Plant Optimization for remaining Arenas (an expansion of the pilot project in 2016 to modulate system head pressure to increase efficiency).

- Installation of Low E Ceiling at Parkdale and Morgan Firestone Arenas.
- Upgraded LED lighting at various arenas, community centres and pools throughout the City.

Energy conservation projects can reduce energy consumption and lower operating costs. Additionally, there are GHG savings associated with efficiency projects. The diagram below shows the cumulative GHG reductions that occur due to reduction in energy use as a result of energy efficiency projects.

Figure 14: 2010-2016 Cumulative GHG Reductions from Energy Conservation Initiatives in Tonnes (t) CO_2e)



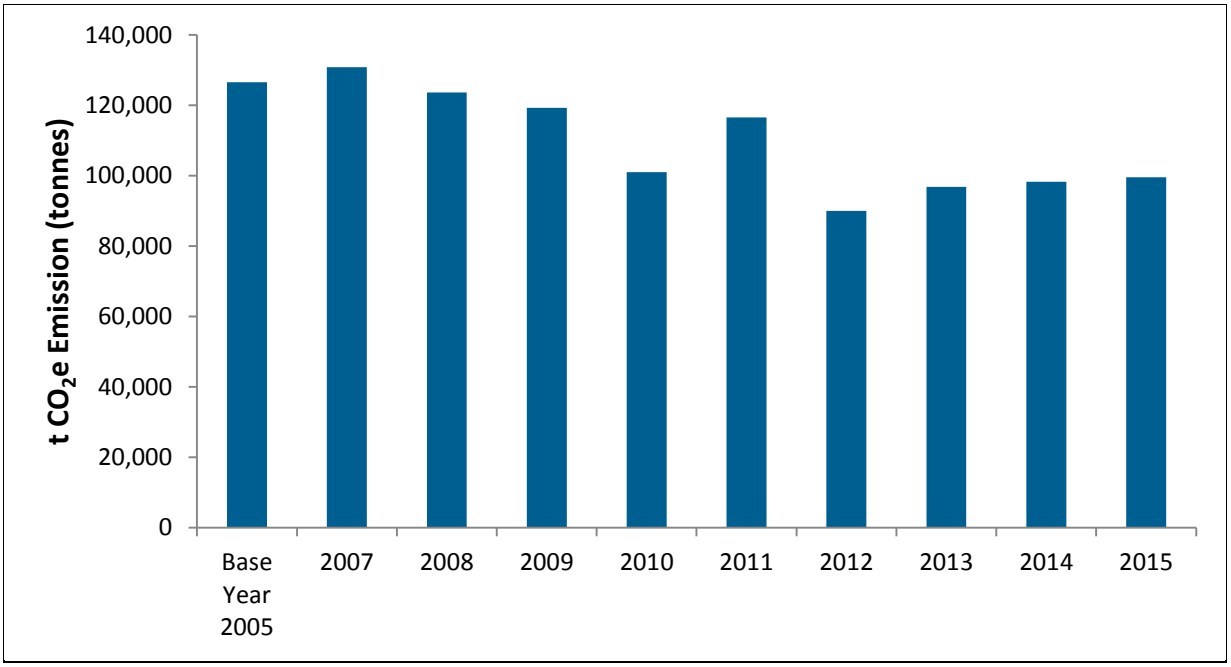
Greenhouse Gas Emissions 2015 Report

GHG emissions related to Corporate operations have been inventoried and reported annually since the adoption of the Corporate Air Quality and Climate Change Strategic Plan (PED06336(a)) in 2008. The plan established Hamilton's Corporate emission targets of a 20% reduction of 2005 GHG's levels by 2020. The City achieved the 2020 target in 2012. New GHG emission targets have been established and aligned with the Council approved Corporate Energy Policy (CEP) (PW14050) and the Board of Health Climate Change Actions 2012 report (BOH13024). The target is an 80% reduction in Greenhouse Gas Emissions by 2050 from a base year of 2005. An interim emission reduction target has been set through the CEP at 50% by 2030.

Data for the GHG report is one year behind, therefore the data shown is for the 2015 calendar year.

In the 2015 reporting year, the GHG emissions inventory was 99,540 tonnes carbon dioxide equivalent (tCO_2e). This represents a 21% reduction (27,027 tCO_2e) from the base reporting year of 2005 with 126,567 tonnes CO_2e generated.

Figure 15: City of Hamilton Corporate GHG Emissions Yearly Trends 2005 - 2015

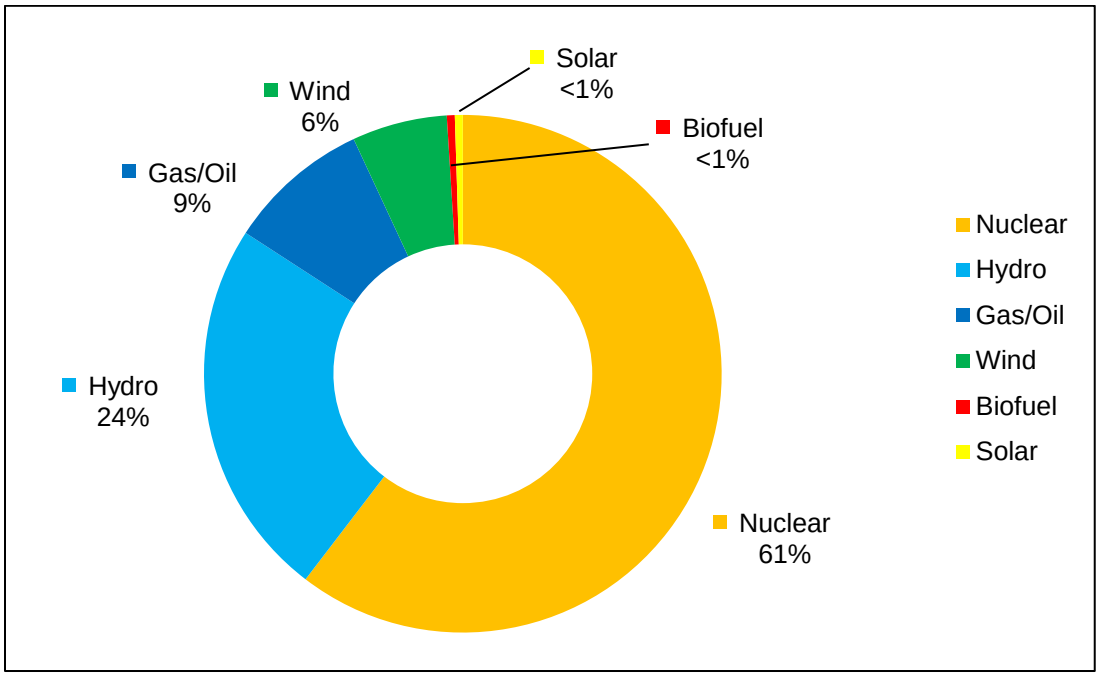


Generally, there is a trend of decreasing emissions in the Corporate GHG inventory since the base year. Decreasing emissions are due in large part to energy efficiency initiatives and the resulting reduction in energy consumption. However, the changing Ontario electricity emission factor has also had an impact. The Ontario electricity

emission factor, which is a measurement of the CO_2e intensity of electricity generation, reflects the system-wide electricity supply mix. The CO_2e intensity has significantly decreased with the Ontario Government's phase out of coal fired electricity generation. For instance, coal made up about 19% of the generation mix in 2005.

The graph below, from data reported by the Independent Electricity System Operator (IESO) shows the energy output by fuel type for 2016 for transmission-connected generation. This annual data varies depending on real-time data output. It does not include embedded generation. Of note, most solar facilities in Ontario are connected to the distribution system.

Figure 16: 2016 Energy Output by Fuel Type



Source: Transmission-Connected Generation - IESO Generation Mix 2016 Output

The City's Corporate GHG Emissions are generated from the following energy sources: electricity, natural gas, diesel, and gasoline. The breakdown of this mix for the City is shown in the chart below.

Figure 17: 2015 Percentage tCO_2e Emissions Contribution by Fuel Source

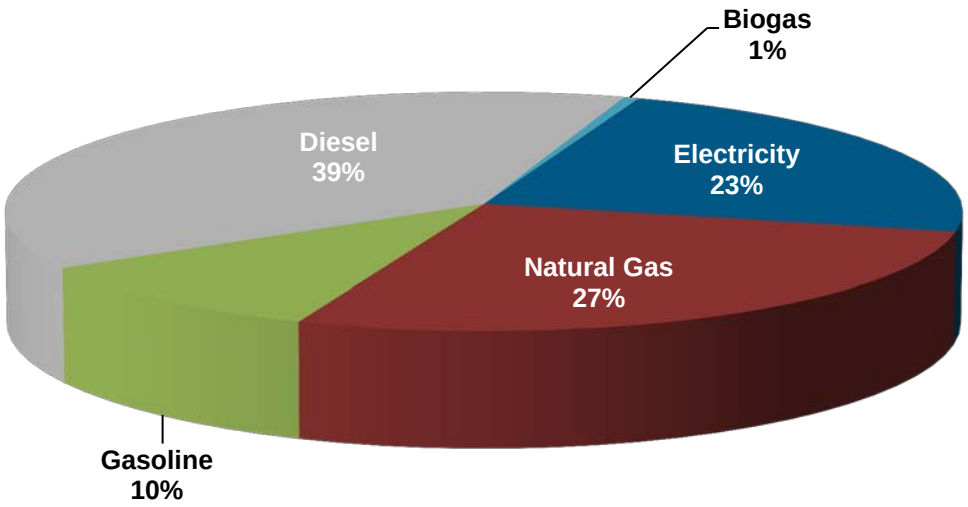
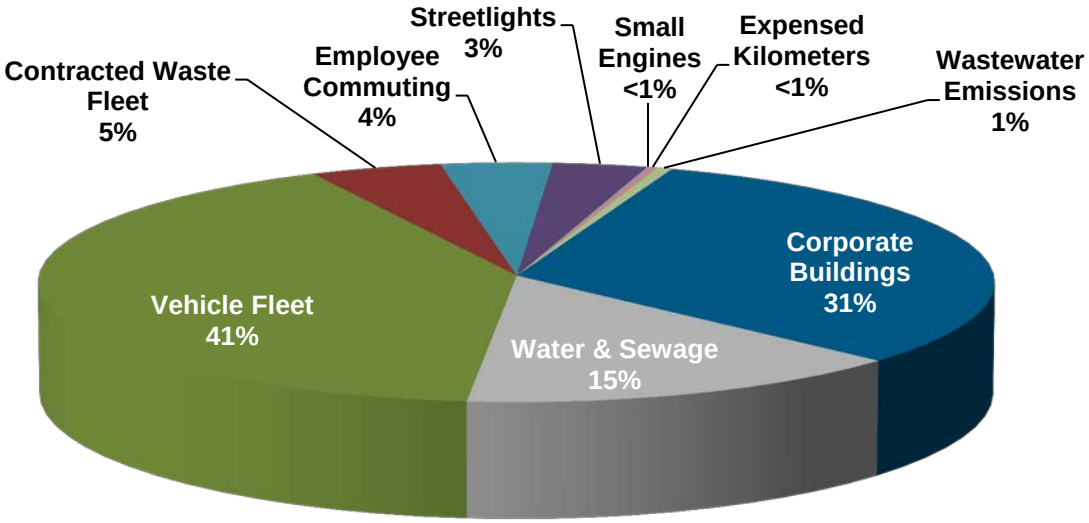


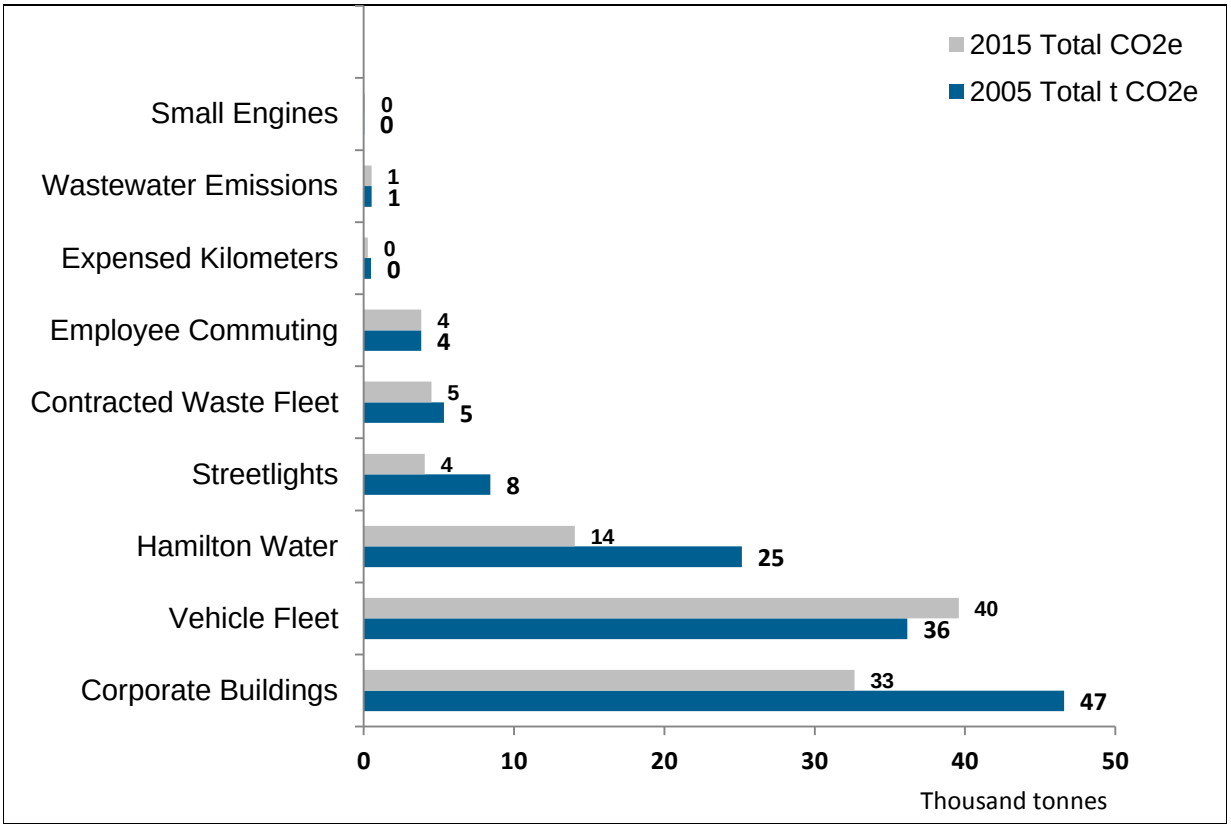
Figure 18: 2015 Total Percentage Breakdown of Tonnes CO_2e by Sector



The figure above shows the breakdown of the 2015 GHG emissions by reporting sector. The two largest emitters of GHG's are the City's Vehicle Fleet, including Transit (39,578

t CO_2e) and Corporate Buildings (32,640 t CO_2e). Hamilton Water is third (13,036 t CO_2e). The remainder of the sectors contribute 5% or less.

Figure 19: 2015 to 2005 Base Year Comparison by Sector



Of note on the above are the significant reductions in Street Lighting (52%), Hamilton Water (44%), and Corporate Buildings (30%). The emission reductions have been primarily driven by energy conservation projects and energy efficiency measures. In 2015, lighting efficiency upgrades to LED lighting technology contributed to the majority of the reductions in emissions. Most sectors do show a downward trend but Vehicle Fleet (including Transit) has increased CO_2e emissions by 9% over the base year 2005. While efficiency of vehicles has improved since 2005, fuel consumption itself has increased as a result of increasing fleet size.

Final Comment

Ontario's energy landscape is evolving and challenges lay ahead. With the rising costs of electricity, by way of the Global Adjustment and rising natural gas and fuel costs by way of the Cap and Trade program, it is important more than ever to reduce consumption, choose renewable technologies and become more efficient. Hamilton is

poised to work with the challenges as evidenced by both the specific policy framework in the Corporate Energy Policy, and the adoption of broader strategic plans for a “Clean and Green” City.

By monitoring and reporting the Corporate energy data, in particular consumption and energy intensity, the City can achieve a better understanding of where to focus efforts to reduce usage. This would positively impact the City’s performance and reduce GHG emissions.

Find additional detailed information on energy data related to 2016 in the attached Appendix A.

Appendix A

This Appendix provides additional tables, charts and graphs to further illustrate the information provided in the report.

Avoided Costs and Savings

Figure A-1: Cumulative Avoided Costs, Incentives and Savings

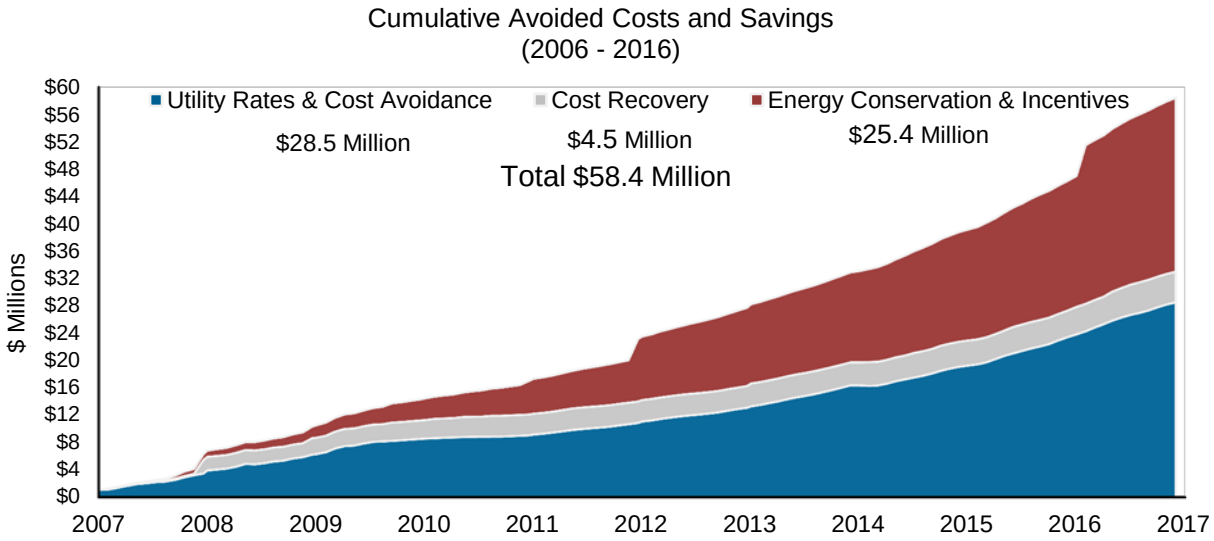


Figure A-2: Three Year History of Avoided Costs, Incentives and Savings by Category

Category	Past 3 Years			2006-2016
	2014	2015	2016	Cumulative
Levy RPP/Interval Change	$0	$0	$0	$2,886,651
Rate RPP/Interval Change	$0	$0	$0	$2,873,163
Levy Global Adjustment	$276,053	$994,677	$1,279,622	$3,794,124
Rate Global Adjustment	$2,072,524	$2,916,622	$3,402,587	$12,319,351
Levy Natural Gas	$290,146	$352,603	$365,430	$5,613,383
Rate Natural Gas	$67,054	$59,040	$63,111	$1,005,661
Energy Conservation Levy	$2,308,250	$1,947,669	$2,008,166	$14,294,148
Energy Conservation Rate	$513,415	$513,415	$513,415	$2,479,861
Incentives	$62,197	$465,362	$3,948,039	$8,668,344
Cash Recovery Levy	$302,615	$221,993	$593,832	$4,245,932
Cash Recovery Rate	$0	$0	$0	$235,375
Totals	$5,892,255	$7,471,381	$12,174,201	$58,415,992

Overall Consumption, Costs and Performance (Electricity and Natural Gas)

Figure A-3: Total Annual Consumption (Electricity and Natural Gas)

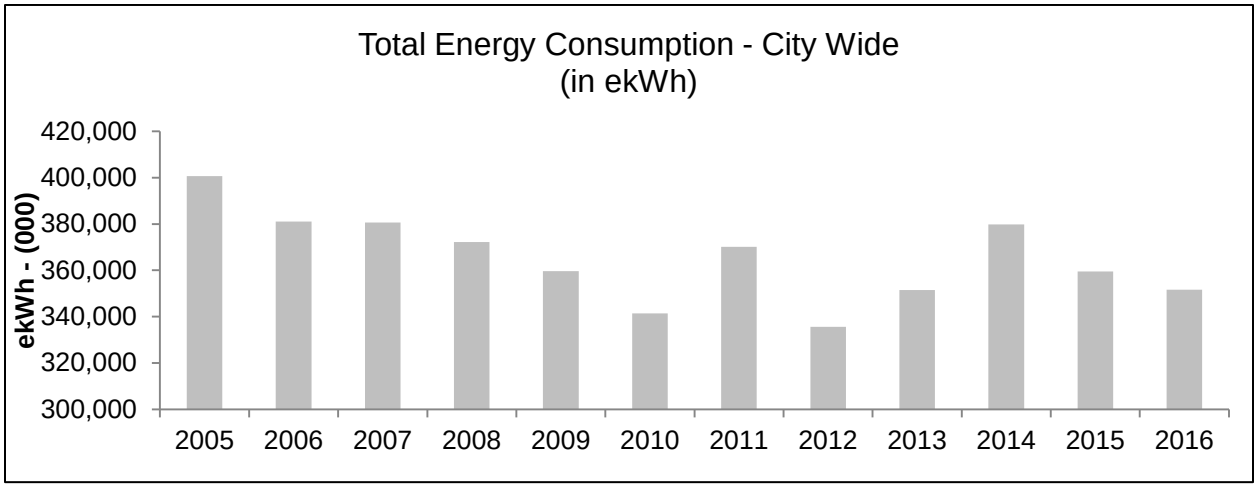


Figure A-4: Total Consumption Comparison by Reporting Group (Electricity and Natural Gas) in ekWh

Total Energy	**in 000's of ekWh**			**Comparisons**	
Consumption	**2005**	**2015**	**2016**	**2016 vs 2005**	**2016 vs 2015**
City/Town Halls	13,775	7,451	8,242	-40%	11%
Corporate Facilities	17,188	9,568	8,147	-53%	-15%
Street Lighting	33,603	30,922	26,775	-20%	-13%
Traffic Lighting	5,688	1,965	2,022	-64%	3%
Other City Operations	5,618	6,096	5,687	1%	-7%
Hamilton Water	121,040	128,919	122,873	2%	-5%
Yards	39,589	27,323	28,068	-29%	3%
Arenas	39,904	36,641	34,656	-13%	-5%
Community/Senior Centers	3,834	3,607	3,452	-10%	-4%
Rec Centres/Pools	26,789	28,200	27,221	2%	-3%
Rec Parks/Stadiums/Golf	8,332	4,519	14,241	71%	215%
Lodges (Macassa Lodge, Wentworth Lodge)	24,938	16,444	16,097	-35%	-2%
Culture	5,383	4,777	4,643	-14%	-3%
Fire/ EMS	10,698	13,203	12,538	17%	-5%
Hamilton Public Libraries	9,343	10,806	10,559	13%	-2%
First Ontario Centre	10,122	10,315	9,840	-3%	-5%
Hamilton Convention Centre	4,656	4,182	3,541	-24%	-15%
Hamilton Place	5,466	4,914	4,363	-20%	-11%
Hamilton Police Services	14,757	9,608	8,688	-41%	-10%
City Wide Total	**400,722**	**359,460**	**351,654**	**-12%**	**-2%**

Figure A-5: Total Annual Reported Costs (Electricity and Natural Gas)

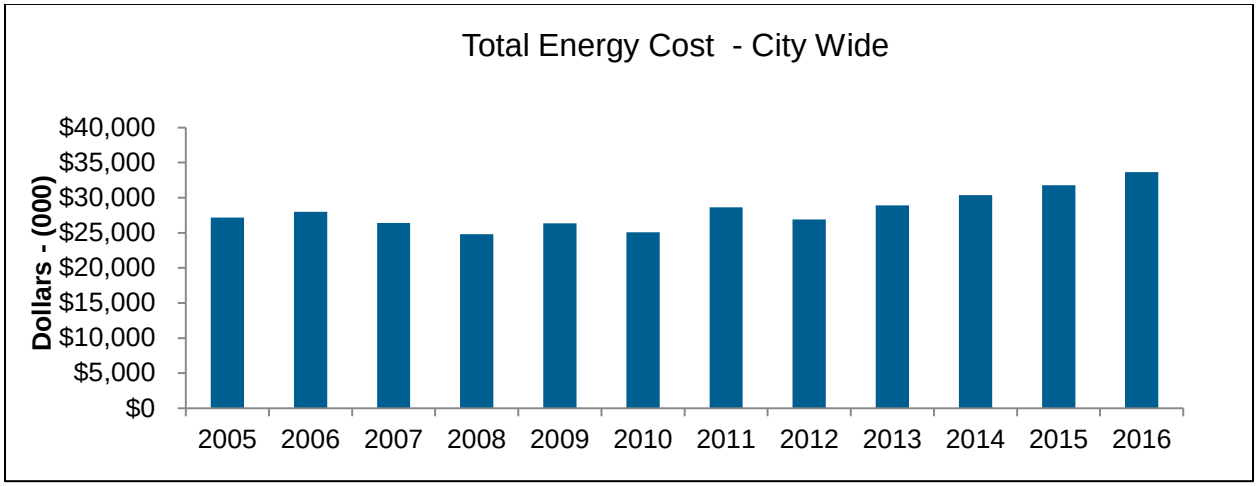
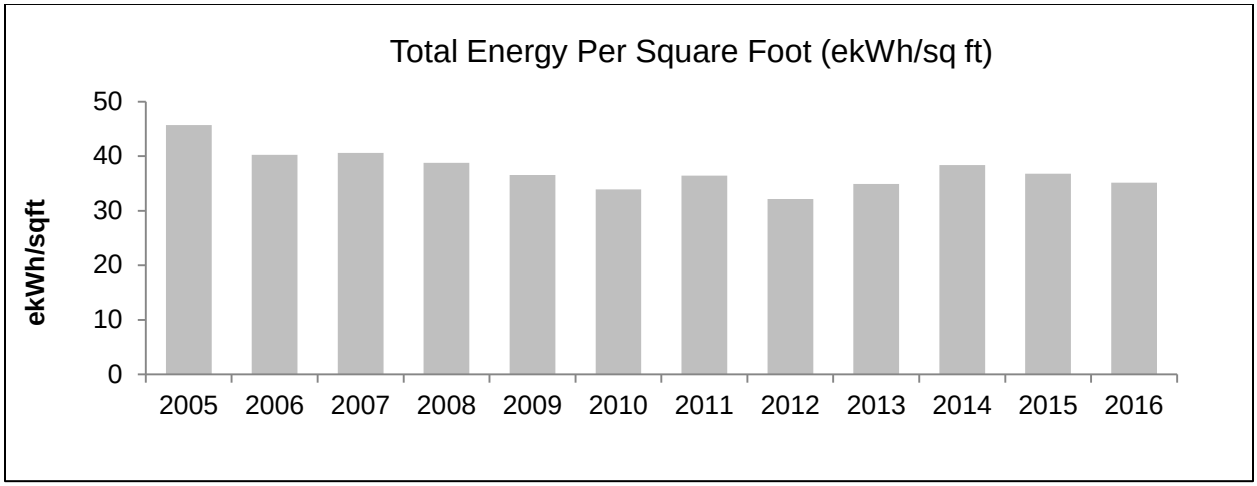


Figure A-6: Total Cost Comparison by Reporting Group (Electricity and Natural Gas)

Total Energy-$	in 000's of $			Comparisons	
Cost	2005	2015	2016	2016 vs 2005	2016 vs 2015
City/Town Halls	$860	$651	$710	-17%	9%
Corporate Facilities	$866	$756	$732	-15%	-3%
Street Lighting	$2,895	$5,689	$5,302	83%	-7%
Traffic Lighting	$462	$347	$381	-17%	10%
Other City Operations	$534	$895	$916	71%	2%
Hamilton Water	$9,590	$11,483	$11,892	24%	4%
Yards	$2,205	$1,673	$2,057	-7%	23%
Arenas	$2,455	$2,877	$2,950	20%	3%
Community/Senior Centers	$224	$247	$269	20%	9%
Rec Centres/Pools	$1,192	$1,337	$1,556	31%	16%
Rec Parks/Stadiums/Golf	$564	$340	$1,279	127%	276%
Lodges (Macassa Lodge, Wentworth Lodge)	$1,087	$968	$1,109	2%	15%
Culture	$338	$275	$281	-17%	2%
Fire/ EMS	$614	$896	$983	60%	10%
Hamilton Public Libraries	$827	$961	$909	10%	-5%
First Ontario Centre	$840	$911	$979	16%	7%
Hamilton Convention Centre	$387	$330	$254	-34%	-23%
Hamilton Place	$454	$377	$304	-33%	-19%
Hamilton Police Services	$783	$753	$804	3%	7%
City Wide Total	**$27,177**	**$31,767**	**$33,667**	**24%**	**6%**

Figure A-7: Total Energy Intensity City-Wide (ekWh/sqft)



The following series of graphs break down the energy intensity levels per site for 2016 within their specific reporting category (group). Energy Intensity is calculated by using the equivalent kilowatt-hours (ekWh) divided by the reported square footage (sqft) for the site. Sites that do not have recorded square footage may show as a zero value on the energy intensity graphs below.

Figure A-8: Corporate Facilities

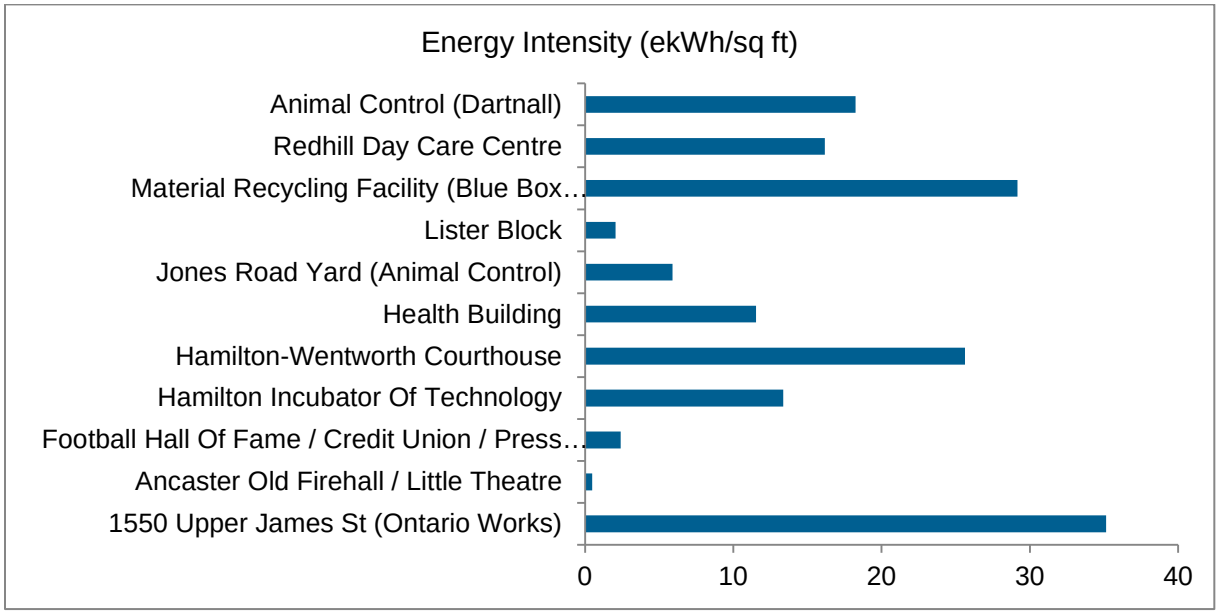


Figure A-9: City and Town Halls

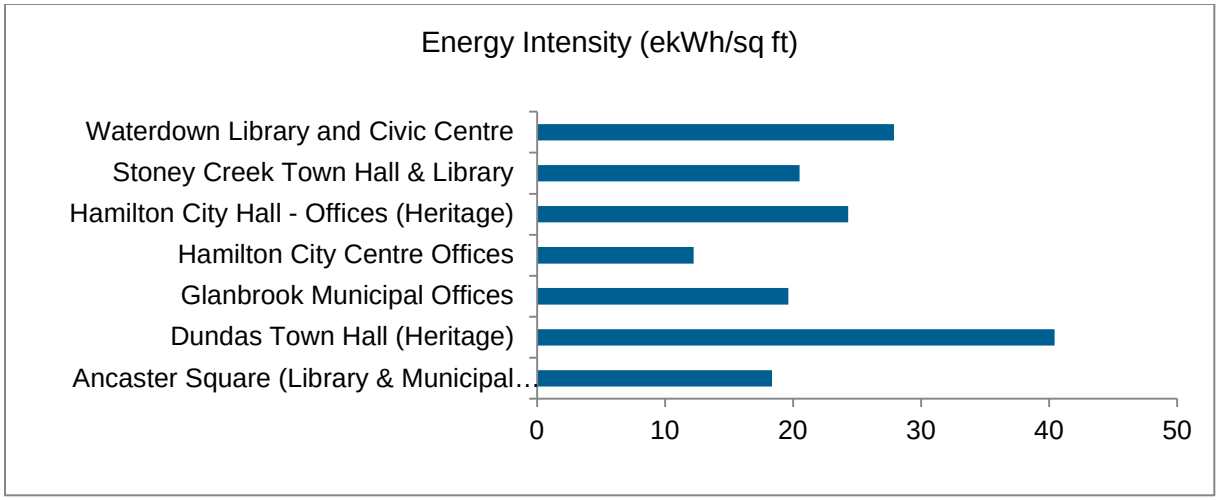


Figure A-10: Arenas

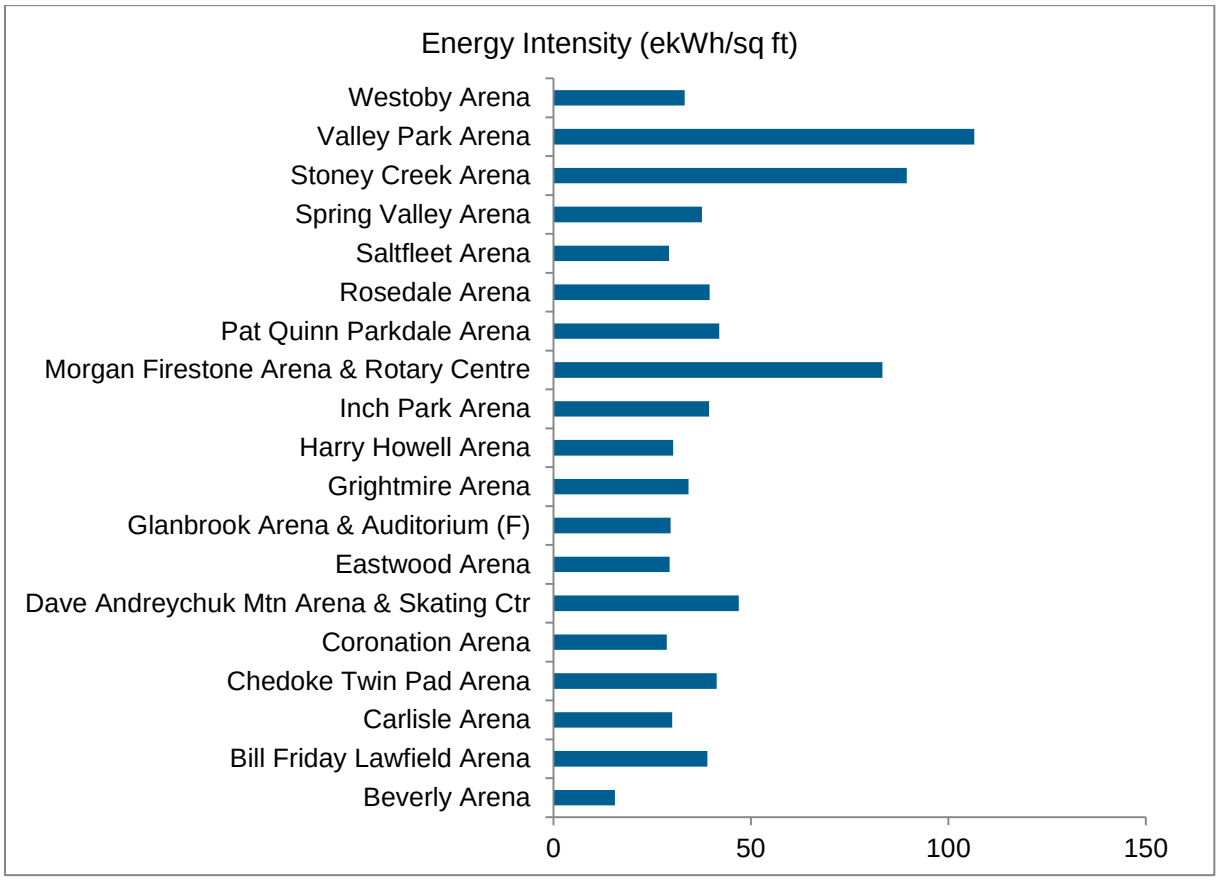
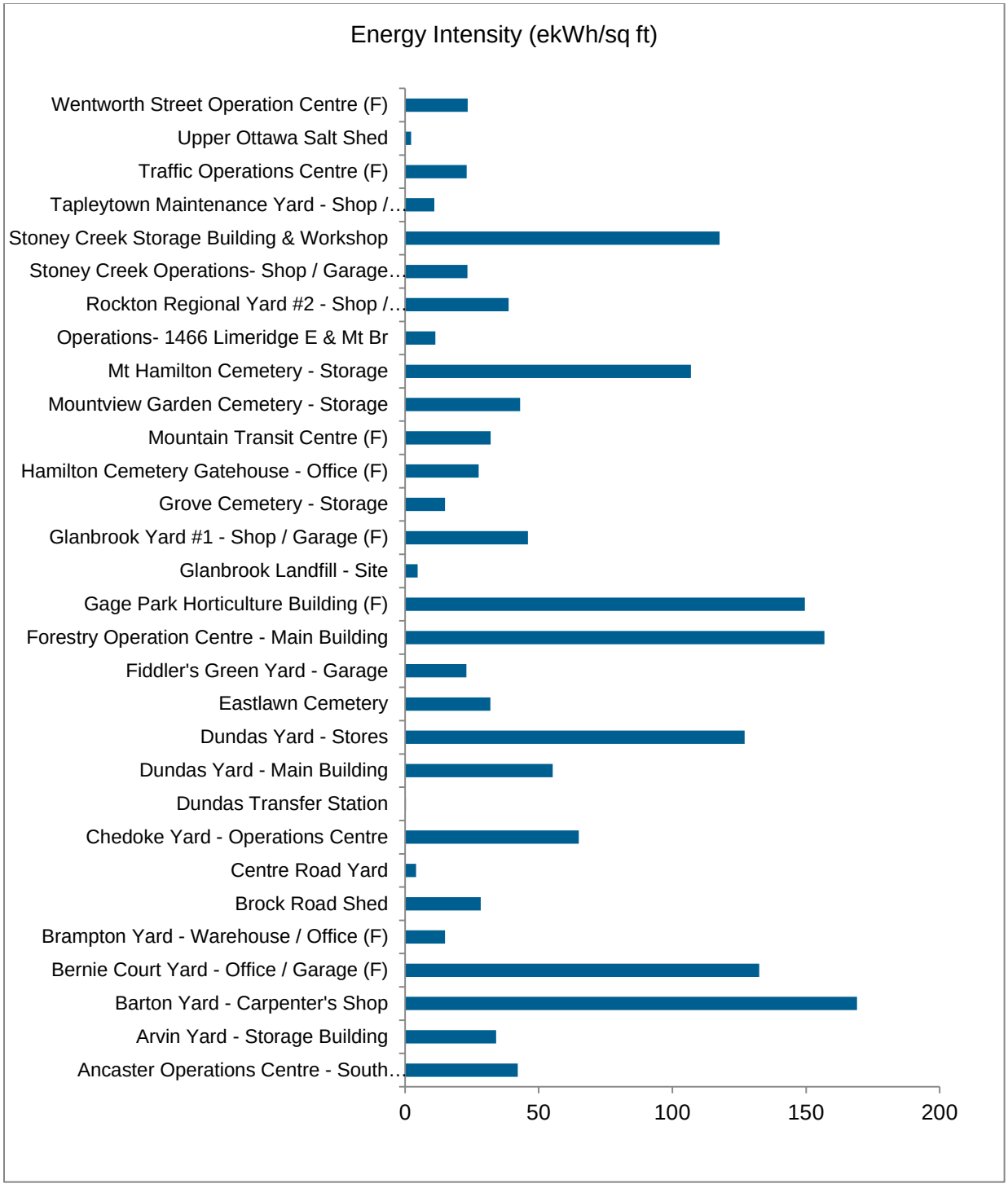


Figure A-11: Yards



(F) = Fuel site

Figure A-12: Community Centres

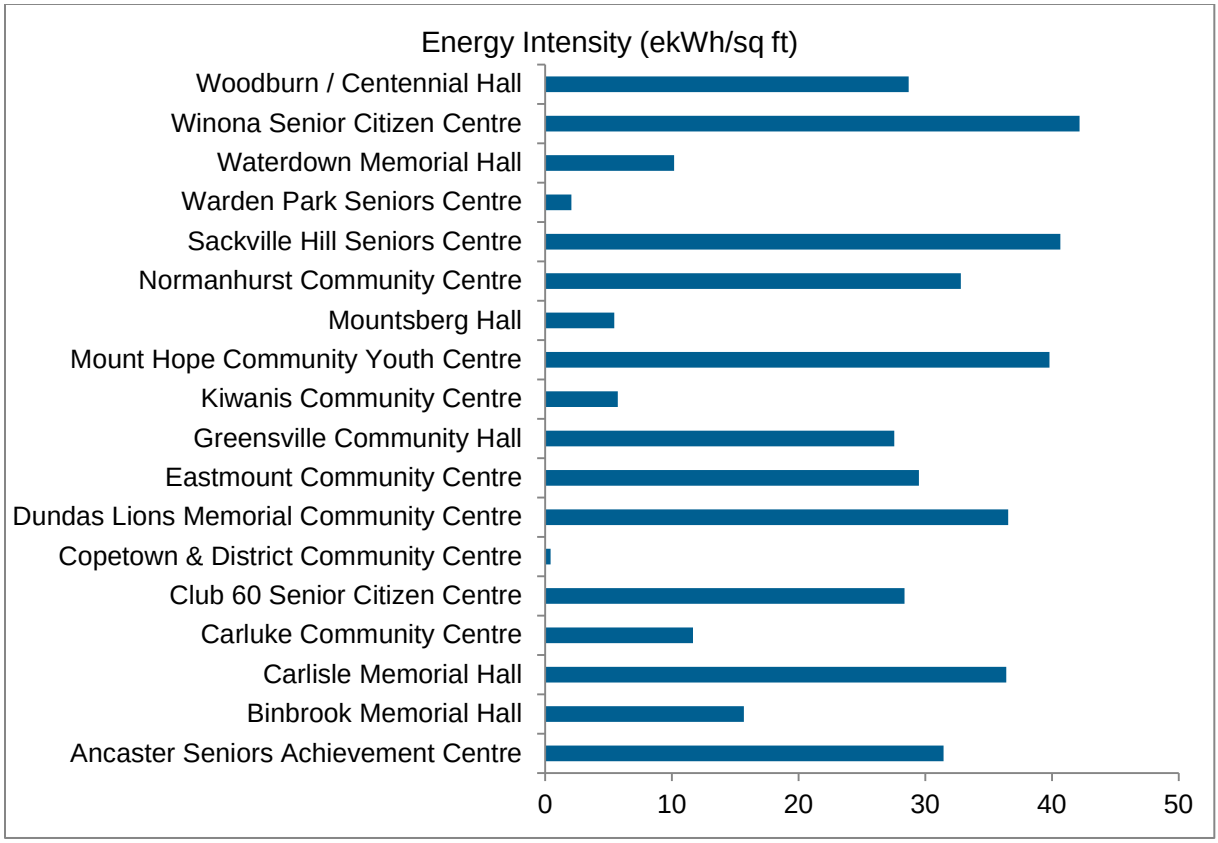


Figure A-13: Entertainment Facilities

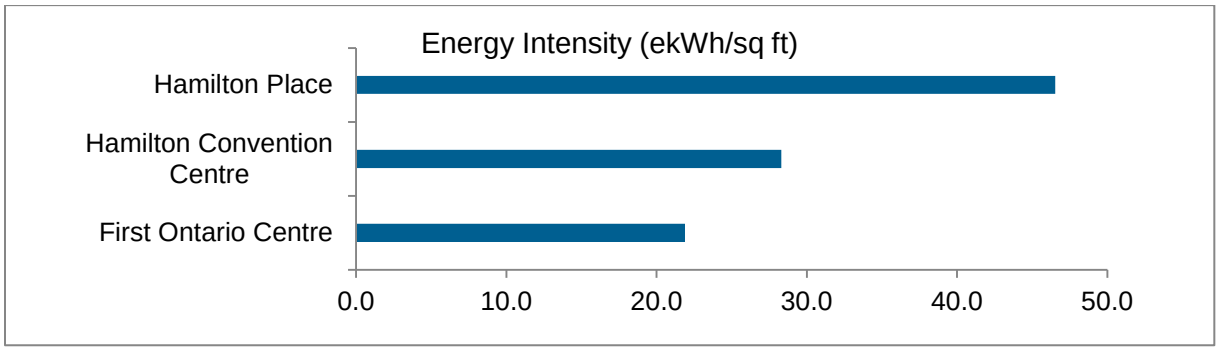
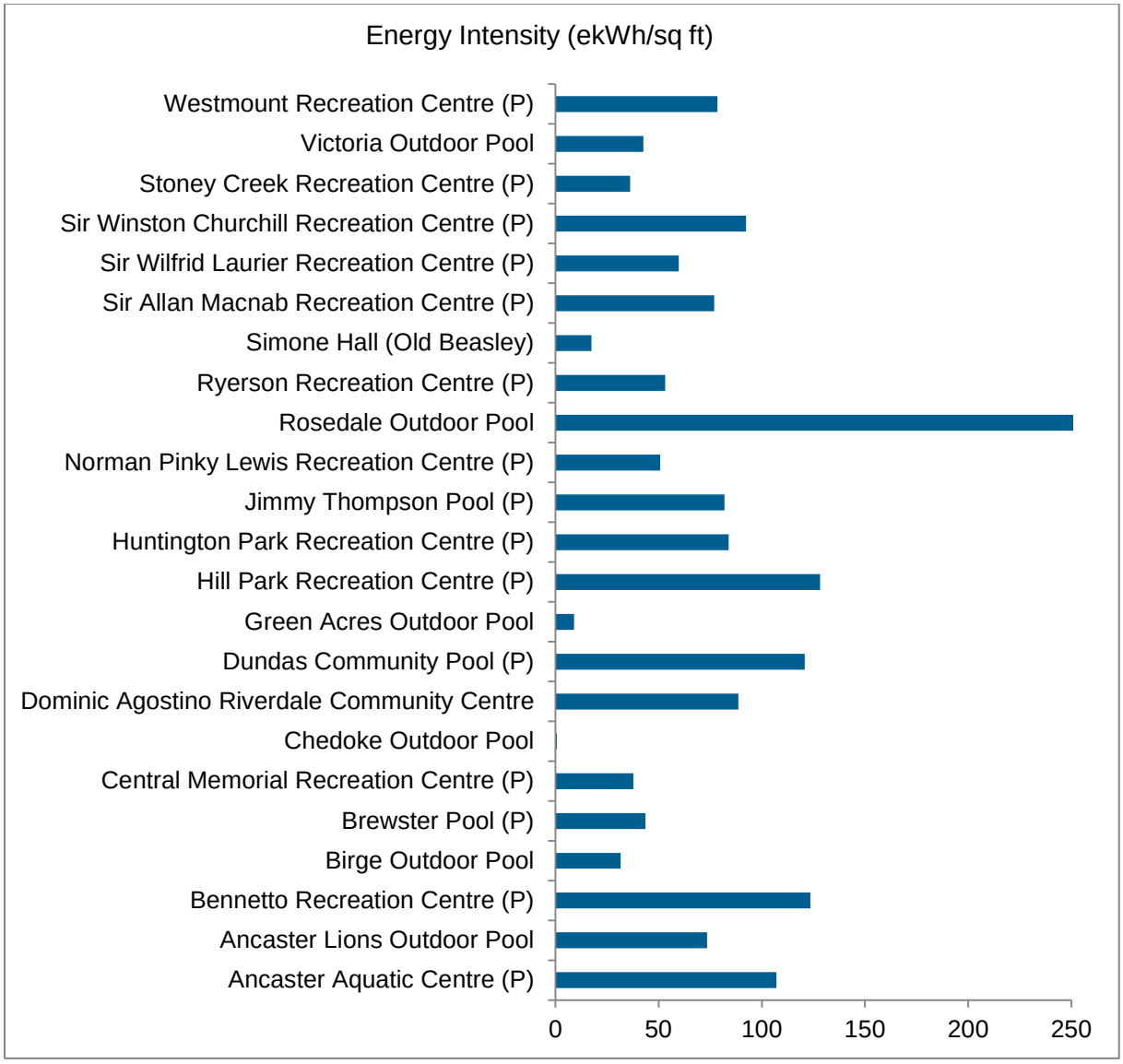


Figure A-14: Recreation Centres and Pools



(P) = Pool

Figure A-15: Lodges

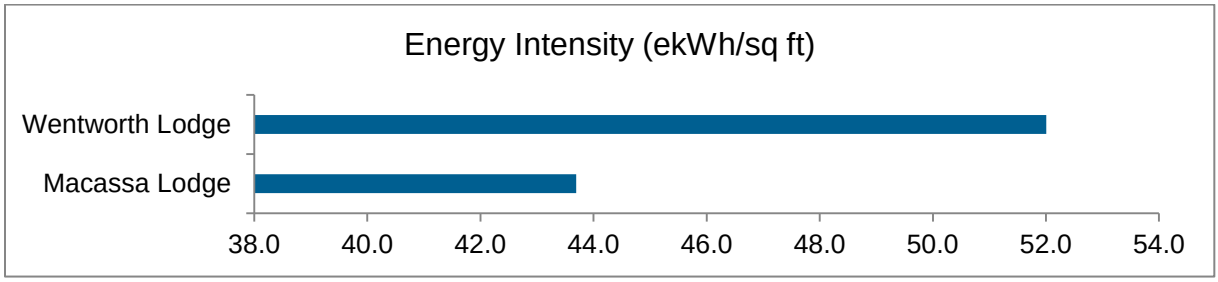


Figure A-16: Culture (Museums & Historical)

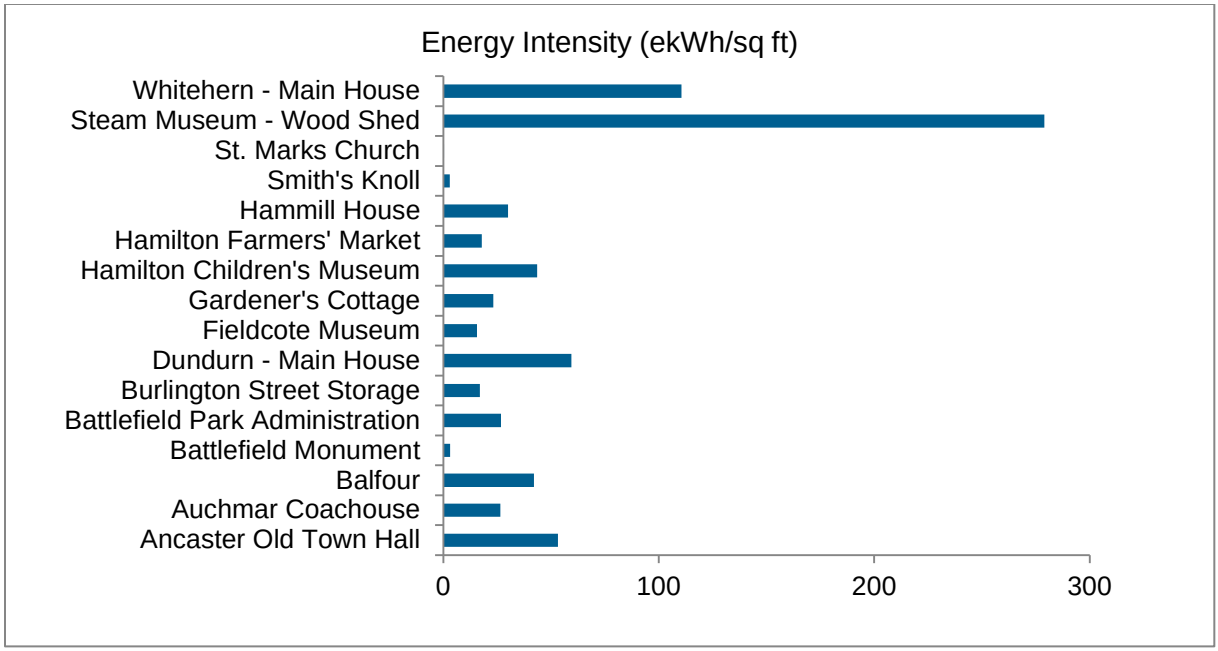


Figure A-17: Libraries

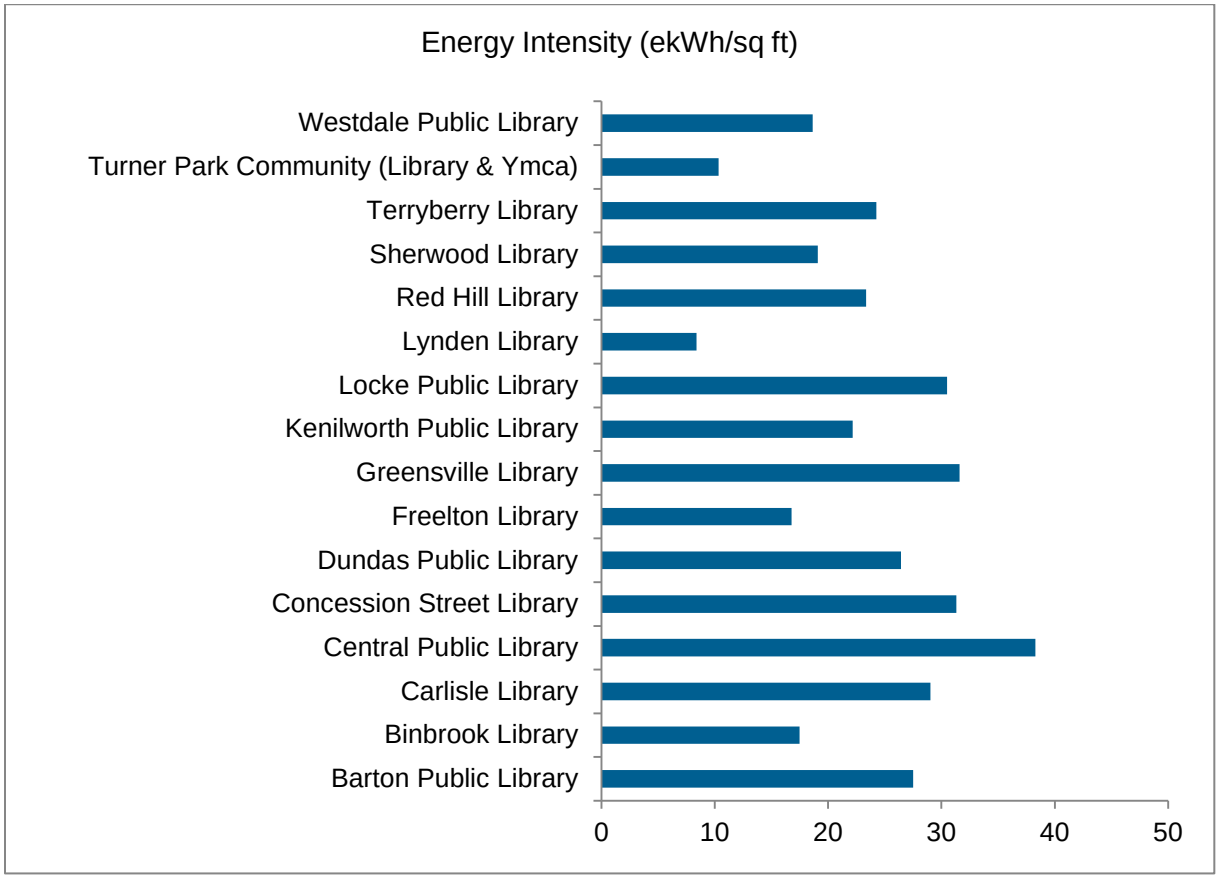
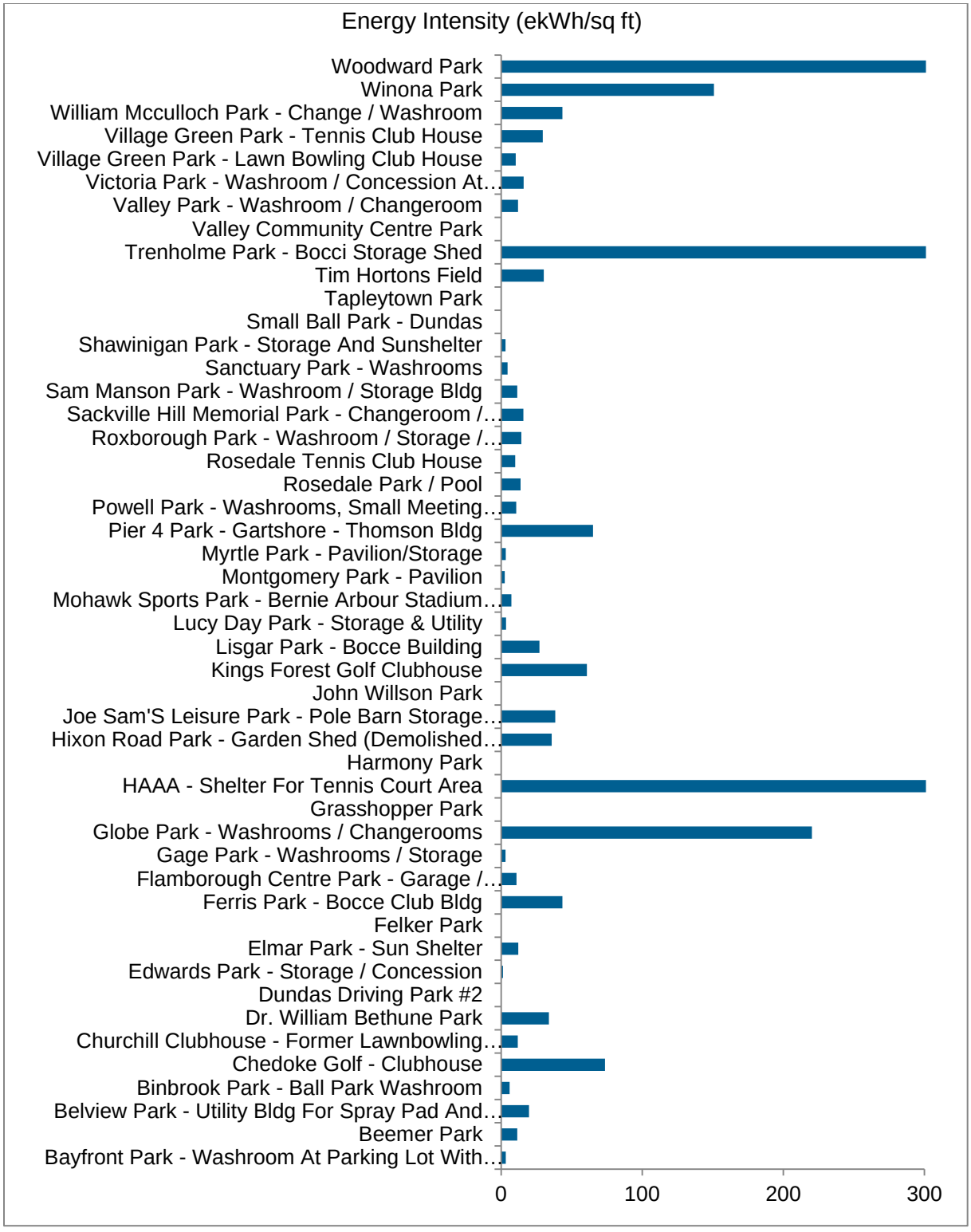
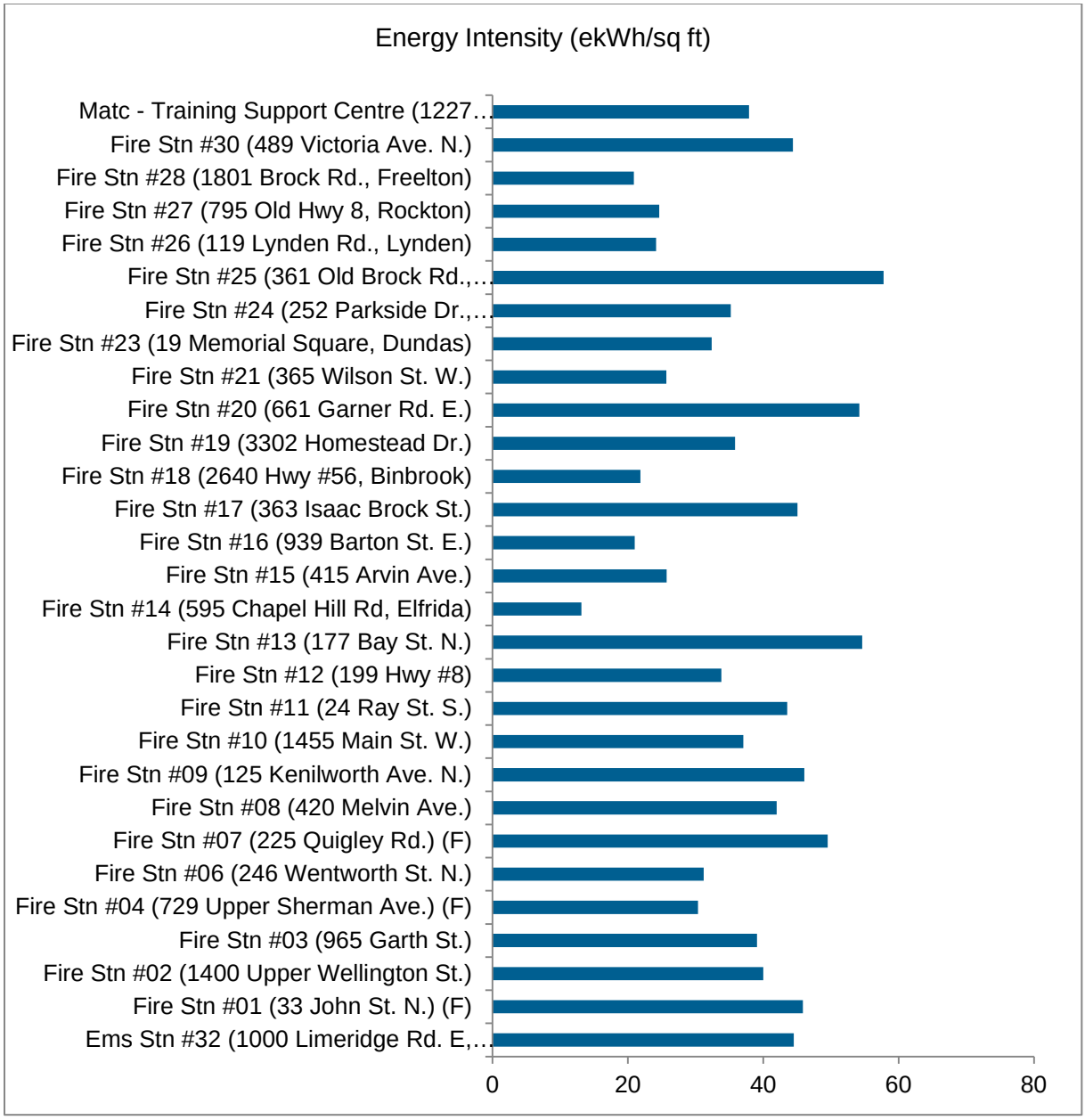


Figure A-18: Stadiums, Recreation Parks and Golf Courses



Note: 300 ekWh/sqft was set as a maximum for this grouping, some may exceed that amount

Figure A-19: Fire/EMS



Weather Data

Weather and temperature can impact consumption of electricity, natural gas and fuel. The following are heating and cooling degree day data.

Figure A-20: 2016 Weather Data for Hamilton (Environment Canada)

Month	Mean Temp (◦C)	HDD	CDD	2016 vs 2015 HDD	2016 vs 2015 CDD
Jan-16	-4.2	687.3	0	-13%	
Feb-16	-2.6	598.7	0	-32%	
Mar-16	2.7	474.9	0	-26%	
Apr-16	4.2	415.1	0	21%	
May-16	13.8	156.8	26.5	51%	-13%
Jun-16	18.5	36.3	50.2	-27%	143%
Jul-16	22.2	1.4	126.1	-84%	59%
Aug-16	22.6	0	141.4	-100%	163%
Sep-16	18	41.1	41.7	-11%	-22%
Oct-16	11.1	217.2	4.7	-18%	
Nov-16	6.1	357.5	0	2%	
Dec-16	-2.5	634.4	0	42%	
2016 Annual Total		**3620.7**	**390.6**	**-8%**	**64%**

* HDD = Heating Degree Days/ CDD = Cooling Degree Days

Figure A-21: Heating Degree Days 2013-2016

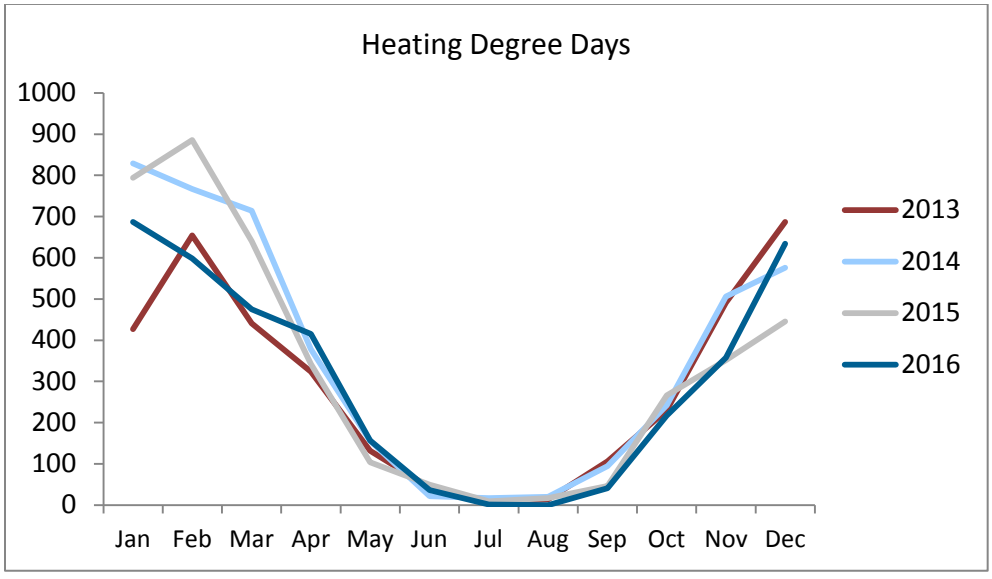
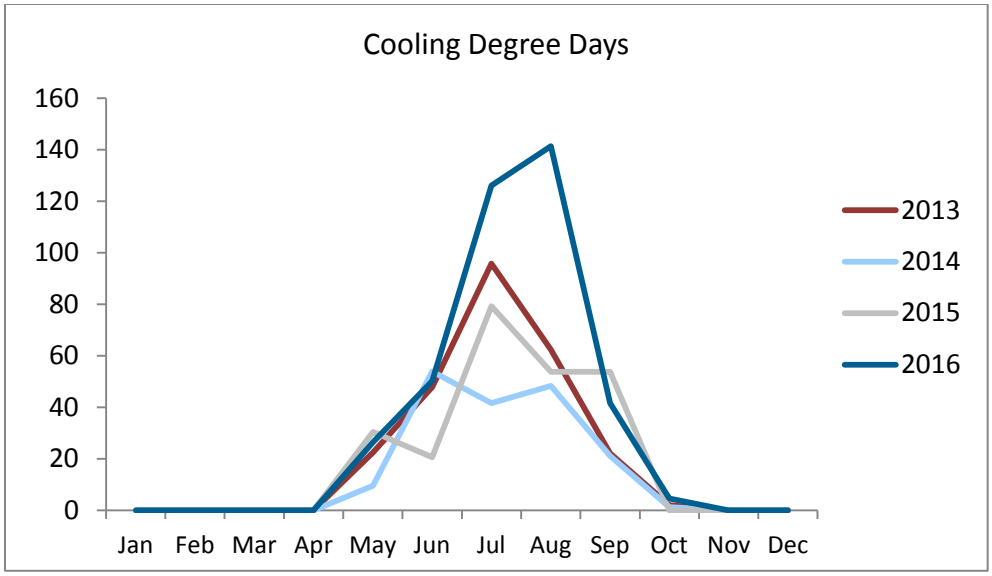


Figure A-22: Cooling Degree Days 2013-2016



Global Adjustment

Class A sites include 900 Woodward; 850 Greenhill; 1579 Burlington St; FirstOntario Centre; and CUP Operations. The rate class change resulted in avoided costs of almost $4.7 million in 2016.

Figure A-23: 2016 Class A Global Adjustment Cost Avoidance

2016	Standard Global Adjustment Charge	Actual Global Adjustment Charge	Avoided Cost (Savings)
Jan	$776,233	$377,884	$398,349
Feb	$772,140	$375,432	$396,707
Mar	$871,375	$395,353	$476,022
Apr	$859,974	$384,949	$475,025
May	$867,928	$374,395	$493,533
Jun	$740,387	$351,294	$389,093
Jul	$706,260	$362,627	$343,633
Aug	$586,459	$324,536	$261,922
Sep	$708,518	$357,416	$351,102
Oct	$824,651	$392,782	$431,869
Nov	$764,258	$397,458	$366,801
Dec	$654,780	$356,631	$298,148
Total	$9,132,962	$4,450,757	**$4,682,206**

The cumulative total for avoided costs since 2011 is $16.1million as shown in the table below:

Figure A-24: Global Adjustment Avoided Costs 2011-2016

Year	Standard Global Adjustment Charge	Actual Global Adjustment Charge	Avoided Cost (Savings)
2011	$ 2,703,065	$ 1,640,102	$ 1,062,963
2012	$ 3,852,903	$ 2,354,335	$ 1,498,568
2013	$ 5,720,669	$ 3,220,565	$ 2,500,104
2014	$ 5,574,562	$ 3,127,867	$ 2,446,695
2015	$ 7,931,504	$ 4,020,207	$ 3,911,297
2016	$ 9,132,962	$ 4,450,757	$ 4,682,206
Grand Total	$ 34,915,666	$ 18,813,832	**$ 16,101,833**

Peak Days – 2016

Peak Day information and tracking is extremely important for Class A assets. Class A Global Adjustment charges are calculated based on a percentage of usage during peak hours during the peak setting period. Using tools to predict peak times and shifting operations and/or minimizing usage during those peak periods is one method to decrease costs.

Figure A-25: Top 10 Ontario Demand Peaks from May 1, 2016 to April 30, 2017

Rank	Date	Hour Ending	Ontario Demand (MW)*	AQEW (MW)
1	07-Sep-16	17	23,213	22,527
2	10-Aug-16	18	23,100	22,637
3	11-Aug-16	17	22,812	22,318
4	13-Jul-16	18	22,659	22,189
5	12-Aug-16	17	22,402	21,904
6	04-Aug-16	17	22,312	21,868
7	06-Sep-16	17	22,150	21,641
8	22-Jul-16	17	22,024	21,665
9	08-Sep-16	18	21,963	21,200
10	05-Aug-16	13	21,926	21,408

Source Data – IESO Peak Tracker (as of 9 March 2017)

Fuel

Figure A-26: Fuel Usage by User Group

Group	Diesel Litres	Unleaded Litres	CNG DLE	Total Litres (DLE)
Corporate Assets & Strategic Planning	131,145	165,666	n/a	296,811
Engineering Services	0	39,753	n/a	39,753
Environmental Services	425,560	364,563	n/a	790,123
Hamilton Water	179,928	209,597	n/a	389,525
Operations	2,000,959	355,473	n/a	2,356,432
Other	331,424	966,083	n/a	1,297,508
Transit	7,998,841	99,582	2,616,192	10,714,615

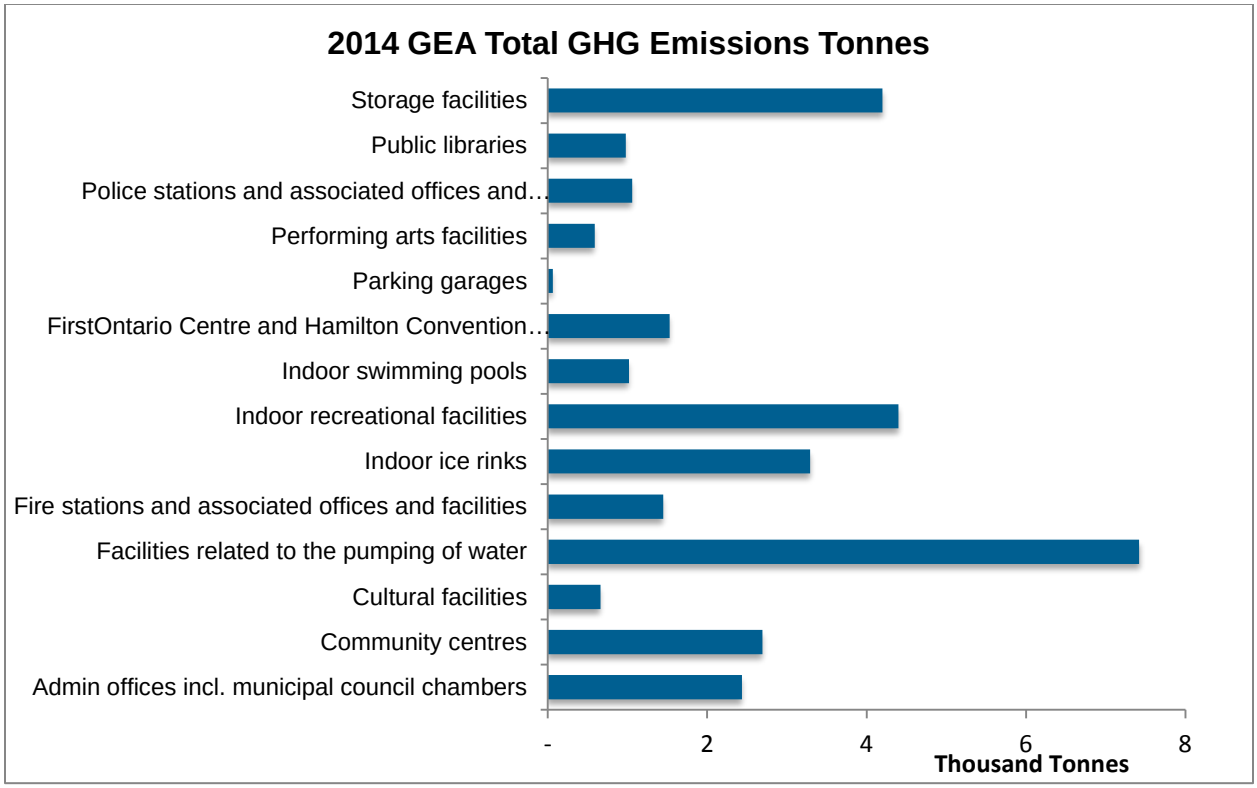
CNG = Compressed natural gas DLE = Diesel litres equivalent

Note for clarification: Transit includes Transit Operations, Route Planning and Transit Yard Support. Operations includes Waste Management, Landfill, Roads and Support Services. The "Other" group includes Public Health, Recreation, Tourism and Culture, Library, By-Law Services, Mayor's Office, City Clerk, Digital Technology, and Information Services.

Green Energy Act (GEA) Reporting

In addition to its internal reporting requirements as outlined in the Corporate Energy Policy, the City is also required to report to the provincial government on its energy use as part of the adherence to the Green Energy Act (GEA). The most recent data set submission was for the 2014 calendar year. According to the GEA's reporting formula the City-owned corporate facilities are responsible for emitting 31,772 tonnes of Carbon Dioxide equivalent (CO_2e). It should be noted that the GEA facility type reporting categories are pre-set and do vary from internal reporting categories. However they do continue to represent corporately-owed assets.

Figure A-27: 2014 GEA Total GHG Emissions Submitted



For further information on City of Hamilton energy policies and the relevant reports referenced herein, see: https://www.hamilton.ca/city-initiatives/strategies-actions/office-energy-initiatives