2017

City of Hamilton 2017 Annual Energy Report

Our Mission

"To provide high quality cost conscious public services that contribute to a healthy, safe and prosperous community, in a sustainable manner."

Hamilton

Introduction

In 2016 the City unveiled its Strategic Plan for 2016-2025. The plan outlined several strategic priorities to align with the City's Community Vision and to support 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*.

The City continues to demonstrate municipal leadership in managing its corporate energy portfolio. The Clean and Green strategic priority has allowed for promotion of several energy initiatives such as a variety of energy conservation projects, demand management efforts and renewable generation to be broadly supported. The City's Corporate Energy policy acts as a guideline to facilitate energy initiatives and principles for the City's new and existing corporate buildings.

With an eye on mitigating rising costs and reducing energy use and emissions, the 2017 Annual Report details energy usage, costs, energy performance, procurement efforts, energy conservation initiatives and greenhouse gas emissions reductions for the 2017 calendar year. The report also details cumulative corporate results to 2006.

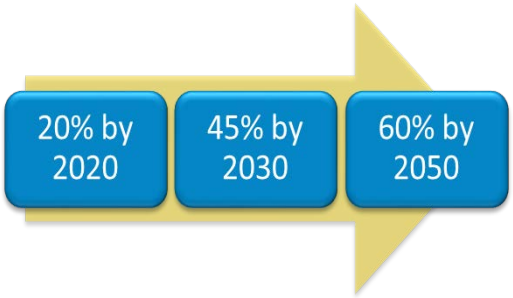
Becoming clean and green is an ongoing process. Leveraging new technologies, adapting to changing regulatory legislation and supporting sustainable, efficient and renewable options for our corporate buildings will not only be desired, but necessary for the Hamilton of the future. Tracking and reporting on continuous progress is key in recognizing where we are currently, and where we need to be in order to meet our strategic goals.

Corporate Energy Policy Review

The current Corporate Energy Policy (PW14050) outlines specific targets for a variety of key performance measures and the guidelines to achieve results. The policy is intended to:

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

One of the key performance measures for the City is the energy intensity reduction targets established in the Corporate Energy Policy. The policy calls for energy intensity reduction targets of 45% by 2030 and 60% by 2050 in corporate buildings overall. The initial target of 20% reduction was achieved in 2013.



The energy intensity reduction for 2017 as compared to the base year of 2005 was a 28% reduction.

A series of policy actions was established in the Corporate Energy Policy to provide a set of guidelines and protocols to assist in making decisions relative to energy equipment, processes, systems and activities. The intent of the guidelines is to support energy-related changes and improvements that will lead to further energy reductions and further emissions reductions to benefit the City both environmentally and financially.

Energy Strategies and Programs KPI's

Every year the City takes steps to reduce or mitigate rising costs. Completing energy conservation projects that reduce usage, applying for incentives, recovering costs from bill review, or undertaking rate optimization strategies are all contributing factors to saving or mitigating costs for the City. Tracking this information is a key performance indicator (KPI) of the City's efforts.

The total results from the energy strategies and programs undertaken in 2017 were $9.65 million. The total cumulative from 2005 to 2017 was $68 million.

The different energy programs and strategies included here are described below.

Utility Rates and Commodity Strategies

This category is classified as the electricity and natural gas costs that would have been incurred had no action been initiated by City. Actions include procurement plans and hedging strategies, as well as optimizing utility rates such as switching rate classes to benefit from Global Adjustment (GA) savings opportunities. In 2017 the eligibility requirements for Class A allowed for two additional sites to be converted from general service Class B to the Class A rate. Tim Horton's Field and the Hamilton Water site at 111 Kenilworth were added in July. Peak day tracking of provincial demand for Class A assets allow staff to respond to potential peaks, resulting in further cost reductions. The GA Class A program resulted in a total of $5.98 million of costs avoided by the City for the year. Including commodity hedging, this category totalled nearly $6.5 million for 2017.

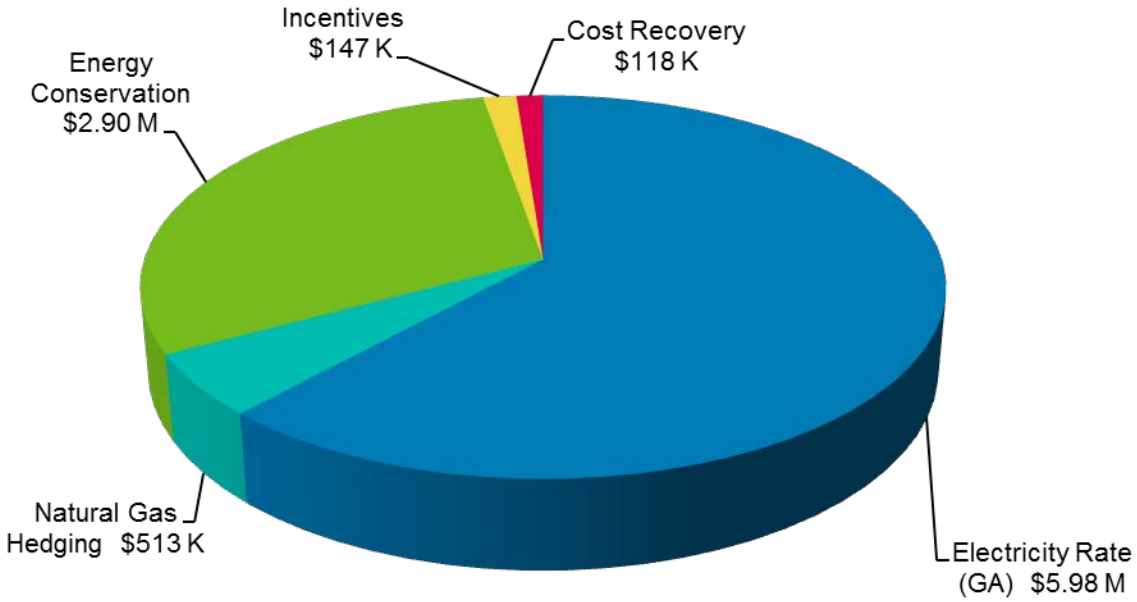
Cost Recovery

This category is classified as the costs recovered due to the City's continuous efforts in monitoring and analyzing its utility accounts. Recovery from billing errors or rate corrections totalled $118,000 in 2017.

Energy Conservation and Incentive Programs

This category is classified by the savings achieved from the implementation of energy efficient measures, equipment and processes that lead to lower consumption, and any financial incentives received for those projects. There are a variety of financial incentives available for eligible projects, from Utility providers and the Independent Electricity System Operator (IESO), to provincial and federal government funding options. Savings from energy projects and incentives totalled $3.05 million in 2017.

Figure 1: 2017 Total Breakdown on Energy Programs and Strategies



Overall Energy Costs

The City tracks and measures the costs and consumption for electricity, natural gas and fuels against the previous year and to the baseline year of 2005. Costs for the sites also connected to the district energy loop (and supplied by HCE Energy Inc.) e.g. City Hall, Central Library, Lister Block, FirstOntario Centre, FirstOntario Concert Hall and Hamilton Convention Centre are included in electricity or natural gas costs.

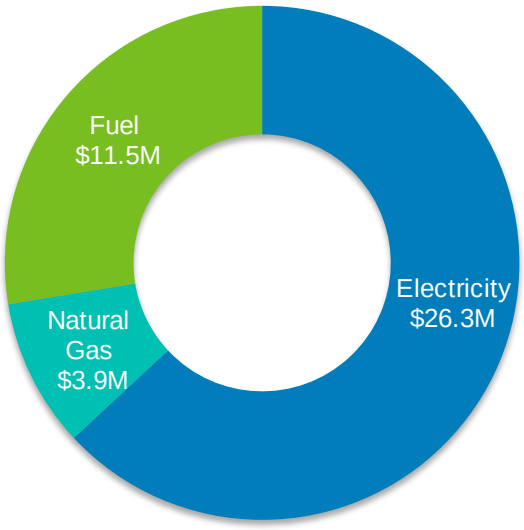
Utility costs are a significant component of operating costs for corporate buildings. Conservation and energy efficient upgrades to equipment that reduce consumption can mitigate rising costs, but costs themselves are impacted by more than usage. Utility rates, regulatory changes, inflation, global markets and weather can influence costs.

In Ontario, regulatory changes in the past few years have trended upwards with electricity costs, in particular, increasing dramatically. In the summer of 2017, the provincial government responded to high rates with rebates and rate changes to offer some relief to residential and small commercial consumers. Natural gas costs increased in 2017 with the introduction of Cap & Trade regulations. While the City can do little to combat regulatory driven increases, conservation and efficiency upgrades play a significant role in reducing the impacts of those increases. The City has recognized the importance of consumption reduction on mitigating costs by focusing on energy efficiency.

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

In 2017, the City spent $41.7 million on electricity, natural gas and fuels. Overall, this is a cost decrease of 9% when compared to 2016. This can be attributed to conservation, weather, fuel switching and regulatory changes.

Figure 2: 2017 Energy Costs in Millions (M)



The costs are incurred by City-owned buildings/facilities and exclude City Housing Hamilton. Utilities include Alectra Utilities, Hydro One, and Union Gas. In addition, sites linked to the district energy system have utility costs from HCE included electricity or natural gas. Fuel includes diesel, unleaded gasoline and CNG for all Fleet, Operations and Transit vehicles but does not include Hamilton Police Services or Darts. Sites with only partial data are excluded.

The results are:

- Overall electricity costs were $26.3 million in 2017, 13% lower than in 2016
- Overall natural gas costs were $3.9 million in 2017, 12% higher than in 2016

- Overall fuels costs (diesel, unleaded gasoline and natural gas) were $11.5 million in 2017, 5% lower than in 2016.

It is important to note that the corporate make-up of buildings reported here may change year over year. In any given year, buildings may be added, either built or purchased, or removed, due to property sale or demolition which impacts their inclusion in the report. Square footage numbers for reporting will also change. This report includes full year data sets for City (non-leased) sites, excluding City Housing Hamilton.

Energy Performance KPI's

Tracking and reviewing costs is important. However cost does not tell the whole picture. More importantly, costs do not always reflect what is happening within a building or across the City. While lowering consumption is a reasonable indicator that costs should decrease, changes in total costs can be influenced by more than just consumption. Unit cost is a good indicator of cost impact. Unit cost includes fixed and variable costs and can show how, even with a reduction in overall usage, the cost per unit may increase or decrease.

Regulatory activity has led to big impacts on prices over the past few years, particularly with electricity where the increases to electricity rates have generally outpaced the reductions in consumption. Cap & Trade legislation introduced this year automatically led to cost increases for heating customers on natural gas and other fuels.

Furthermore, consumption patterns themselves are impacted by more than just the users. Weather, occupancy or program changes and process improvements are just some of the forces affecting the usage in a building.

Creating and consistently reporting on key performance indicators (KPI), leveraging technology, and measuring results are all important in determining performance. It leads to transparency, accountability and ownership but also helps drive new initiatives. To identify energy performance, the data for electricity and natural gas costs, consumption and energy intensity is tracked for all City-owned sites, excluding City Housing Hamilton. As a key performance indicator outlined in the Corporate Energy Policy, energy intensity allows for us to focus in on areas of concern and identify opportunities for improvement to support the City's Strategic Plan.

Electricity Consumption and Cost

Electricity is the largest energy expenditure for the City. Hamilton is served by two local distribution companies (Alectra Utilities and Hydro One). Approximately 85% of the City's cost and consumption is billed by Alectra and 15% comes from Hydro One, which serves our more rural areas. Electricity costs are made up of commodity, distribution, transmission, regulatory and delivery charges. Although the utility rates may vary

between Alectra Utilities and Hydro One, both are regulated by the Ontario Energy Board (OEB) and must seek approvals for any rate changes.

Over the past several years the costs for electricity continued to rise. To combat rising electricity costs for consumers, in particular residential and small commercial customers, the provincial government introduced Ontario's Fair Hydro Plan in the summer of 2017. The program has helped to reduce costs to current customers, and is expected to be in place until 2020.

Costs and consumption for electricity do show a decrease in 2017. The reduction in consumption is due in part to an array of efficiency projects, but is also impacted by weather. The cooling degree days, which are a measure of how much (in degrees), and for how long (in days), outside air temperature was higher than a specific base temperature, were 40% lower in 2017 than 2016. This can help reduce electrical consumption during the shoulder and summer months, thus lowering cost. An additional weather-related impact is the City's response to peak day activity. When potential peak days occur, shifting operations and taking steps to reduce consumption during peak periods can positively impact cost overall.

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

Figure 3: Electricity Cost and Consumption Comparison

				Comparisons	
Electricity Overview	2005	2016	2017	2017 vs 2005	2017 vs 2016
Total Electricity (kWh)	236,362,045	224,322,011	215,322,168	-9%	-4%
Total Electricity ($)	$20,657,050	$30,144,778	$26,341,588	28%	-13%
Total Electricity ($/kWh)	$0.087	$0.134	$0.122	40%	-9%

Natural Gas Consumption and Cost

Natural Gas costs include commodity and regulated costs for storage and delivery from Union Gas. Cap & Trade, which was implemented in January 2017, are imbedded in Union Gas delivery charges. Although it varied slightly, depending on rate class, the Cap & Trade program added approximately 3.4 cents per m^3 of consumption to the delivery charge. Similar to electricity, regulated costs are also approved by the OEB. Natural gas consumption is particularly impacted by cold weather, and prices are typically higher during peak-consuming times. However, because it is possible to purchase (hedge) natural gas on the wholesale market, the City is able to mitigate the fluctuations in commodity cost.

2017 did have a slight increase in consumption of less than 1% compared to 2016. Heating degree days, which are a measure of how much and for how long the outside air temperature was lower than a specific base temperature, were in line with 2016. The first part of 2017 was milder than the previous year and November and December were colder.

In the past costs had steadily decreased year over year. Compared to the base year both cost and consumption is down. However, with the added Cap & Trade charges in 2017, the year over year costs have increased almost 12% compared to 2016.

Below is the comparison year over year and to the base year for cost and consumption of natural gas for facilities. The figures below do not include compressed natural gas (CNG) used for Transit buses.

Figure 4: Natural Gas Cost and Comparison

				Comparisons	
Natural Gas Overview	2005	2016	2017	2017 vs 2005	2017 vs 2016
Total Natural Gas (m^3)	15,403,956	12,161,635	12,227,595	-21%	1%
Total Natural Gas ($)	$6,520,253	$3,521,867	$3,935,717	-40%	12%
Total Natural Gas ($/m^3$)	$0.423	$0.290	$0.322	-24%	11%

Combined Costs and Consumption (Electricity and Natural Gas)

The combined consumption and cost results for electricity and natural gas are measured in equivalent kilowatt-hours (ekWh).

Figure 5: Combined Cost and Consumption for Electricity and Natural Gas

				Comparisons	
Total Energy Overview	2005	2016	2017	2017 vs 2005	2017 vs 2016
Total Energy (ekWh)	400,722,256	351,654,327	343,345,087	-14%	-2%
Total Energy Cost ($)	$27,177,303	$33,666,645	$30,277,305	11%	-10%
Total Energy ($/ekWh)	$0.068	$0.096	$0.088	30%	-8%

Energy Intensity (City-Owned Sites)

Comparing buildings on consumption per square foot and cost per square foot serves to easily recognize where issues may be and where attention should be focused. Energy intensity is the measure of usage in equivalent kilowatt-hours per square foot

(ekWh/sqft). As one of the key performance indicators for the City's Corporate Energy Policy, looking at energy intensity can pinpoint what appropriate measures could be undertaken to reduce the City's usage, and improve corporate building performance.

The energy intensity for 2017 as compared to the base year was a reduction of 28%, which is on track to meet the next intensity reduction milestone in 2030.

Figure 6: Energy Intensity City-Wide Total for City-owned Sites

				Comparisons	
Energy Intensity	2005	2016	2017	2017 vs 2005	2017 vs 2016
City Total (ekWh/sqft)	45.69	35.14	32.88	-28%	-6%
City Total ($/sqft)	$2.67	$2.74	$2.44	-9%	-11%
Reported Square Footage	5,138,852	5,528,712	5,633,585	10%	2%

To further compare energy intensity performance, the table below outlines energy intensity totals by site categories (portfolio). Categories that have an "n/a" are not included in the energy intensity calculation as they are operational (e.g. street lighting, park lights, Hamilton Water pumping operations) and do not have relevant square footage information.

Square footage was updated for 2017 to include any added or removed buildings, as well as updates to correct previous inaccuracies in multi-building sites or multi-use single building sites.

Figure 7: Energy Intensity Comparison by Reporting Portfolio Category

Energy Intensity	ekWh/sqft				
	2005	2016	2017	2017 vs 2005	2017 vs 2016
City/Town Halls	39.6	23.0	23.1	-42%	0%
Corporate Facilities	44.6	17.1	20.6	-54%	20%
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	34.1	26.1	-31%	-23%
Arenas	51.3	43.8	39.0	-24%	-11%
Community/Senior Centers	31.1	24.9	23.4	-25%	-6%
Rec Centres/Pools	78.6	68.4	69.2	-12%	1%
Tim Horton's Field	0.0	25.2	22.7	n/a	-10%
Rec Parks/Stadiums/Golf	36.5	32.9	34.5	-5%	5%
Lodges (Macassa, Wentworth)	113.6	46.4	45.1	-60%	-3%
Culture	35.5	36.3	30.4	-14%	-16%
Fire/ EMS	45.2	37.3	36.0	-20%	-3%
Hamilton Public Libraries	25.2	27.5	26.9	7%	-2%
First Ontario Centre	22.5	21.9	20.4	-10%	-7%
Hamilton Convention Centre	37.2	28.3	29.7	-20%	5%
First Ontario Concert Hall	57.8	46.5	49.7	-14%	7%
Hamilton Police Services	59.8	35.2	35.2	-41%	0%
City Wide Total	**45.69**	**35.14**	**32.9**	**-28%**	**-6%**

Additional tables showing energy consumption, costs and energy intensity by portfolio are provided in Appendix A (pages 23 to 34).

Corporate Average Fuel Economy

Fuel used for the City's fleet of vehicles is tracked and measured annually and continues to be a large spend for City. Corporate Average Fuel Economy (CAFE) is the measurement method for determining fuel consumption efficiency. CAFE is measured as fuel consumed in diesel litre equivalent (DLE) per 100 km. As a KPI for fleet, the Corporate Energy Policy outlined targets for improving CAFE. A 20% reduction in fuel economy by 2030 is the current long term target in place.

Improving and managing CAFE can be achieved by improved engine/drive technology, through purchasing decisions around fit-for-purpose vehicles and operator training. Additionally, the City has Anti-idling bylaws in place to help in reducing fuel consumption overall.

As of 2017, there was an overall reduction of 1% as compared to the base CAFE level shown in the table below.

Figure 8: Corporate Average Fuel Economy 2017 to Base Comparison

Diesel Litre Equivalent (DLE) per 100 KM	BASE (2012)	2017
Unleaded Gasoline	20.7	19.6
Diesel	54.5	55.8
CNG	66.2	68.0
Total	46.2	45.5
Overall % Changed in DLE/100 KM		-1%

The tracking of fuel use per vehicle has been around for several years; however tracking accurate mileage of those same vehicles has been more difficult to manage. New tracking technologies are being considered to improve the reliability of the data, and more accurately measure CAFE in the future.

Fuel Cost and Consumption

The City makes wholesale fuel purchases for its fleet of vehicles. The City's fleet includes, but is not limited to, buses, waste collection vehicles, snow removal trucks, street sweepers, departmental vehicles, and Fire and Emergency Services (EMS) vehicles. The fuels used for the majority of vehicles are traditional diesel and unleaded gasoline; however the City is continuously expanding its fleet of compressed natural gas-fuelled buses.

In 2017, the City used approximately 9.4 million litres of diesel fuel, a 15% decrease as compared to 2016 purchases. The average cost of diesel in 2017 was $0.91/L. The City used 2.1 million litres of unleaded gasoline, a 3% decrease as compared to 2016. The average cost of gasoline in 2017 was $0.95/L.

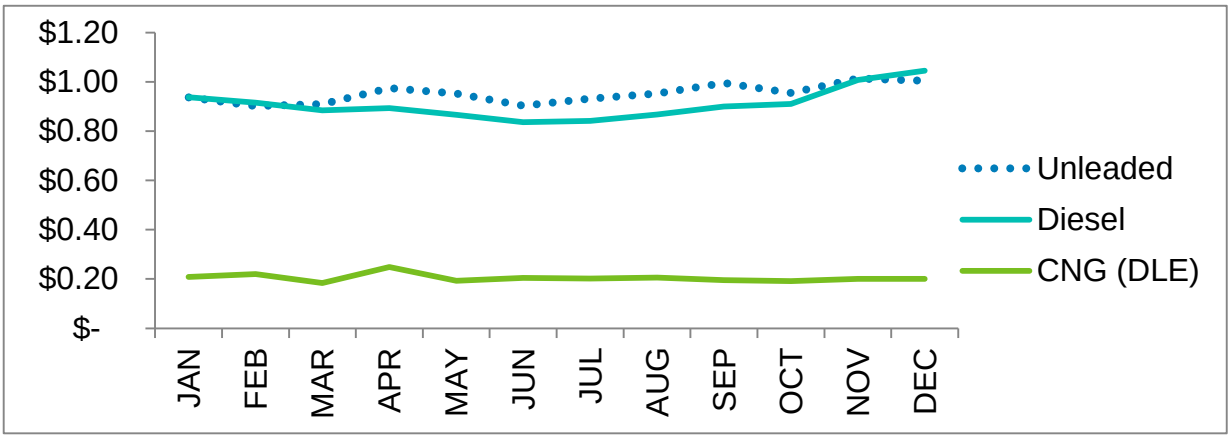
While diesel purchases decreased in 2017, the purchase of compressed natural gas (CNG) increased. The primary reason for this is Transit's bus replacement program, retiring diesel buses and replacing them with CNG-fuelled buses. The City used 4.2 million litres in diesel litre equivalent (DLE) of CNG in 2017, which was a 60% increase over 2016.

Figure 9: 2017 Consumption and Costs of Fuels

Fuel Type	Consumption Litres	Cost	Average $/L
Diesel	9,404,408	$ 8,544,954	$ 0.91
Unleaded Gasoline	2,138,446	$ 2,034,279	$ 0.95
CNG (DLE)	4,195,759	$ 910,464	$ 0.22

CNG is a lower cost fuel for buses, but they do operate at approximately 75% efficiency per diesel litre equivalent when compared to diesel fueled bus usage. However, despite a lower efficiency, the resulting lower cost for fuel and lower GHG emissions is of benefit to the City. The City's monthly fuel price is shown in Figure 10.

Figure 10: 2017 Monthly Fuel Prices in DLE



When converted to diesel equivalent dollars and adjusting for efficiency, Transit spent $1.9 million less running their CNG buses than they would have using only diesel buses.

Renewable Energy

Existing renewable generation operations for the City are managed through Hamilton Renewable Power Inc. (HRPI). HRPI owns and operates three 1.6 MW renewable gas fuelled units. Two of the units are located at the Glanbrook landfill site. The third unit, a cogeneration unit, producing electricity and heat, is located at the Hamilton Water site at Woodward Avenue. The three units use methane as a renewable fuel sources to produce electricity for the power grid through a long-term contract with the province. Using renewable fuel contributes to a more efficient and sustainable process, and further offsets GHG emissions. The systems produce 28,000,000 kWh of renewable energy annually, with a reduction of 100,000 tonnes CO_2e. In 2017 the net benefit from

all HRPI operations was approximately $1.5 M, with a cumulative total of $16.6 M from 2006.

Renewable natural gas can be created using Hamilton Water Biogas Purification Unit, which captures excess methane gas from the anaerobic digestion process of waste water products. The methane is purified, treated and conditioned to yield utility grade renewable natural gas that can be injected into Union Gas distribution system.

Energy Conservation

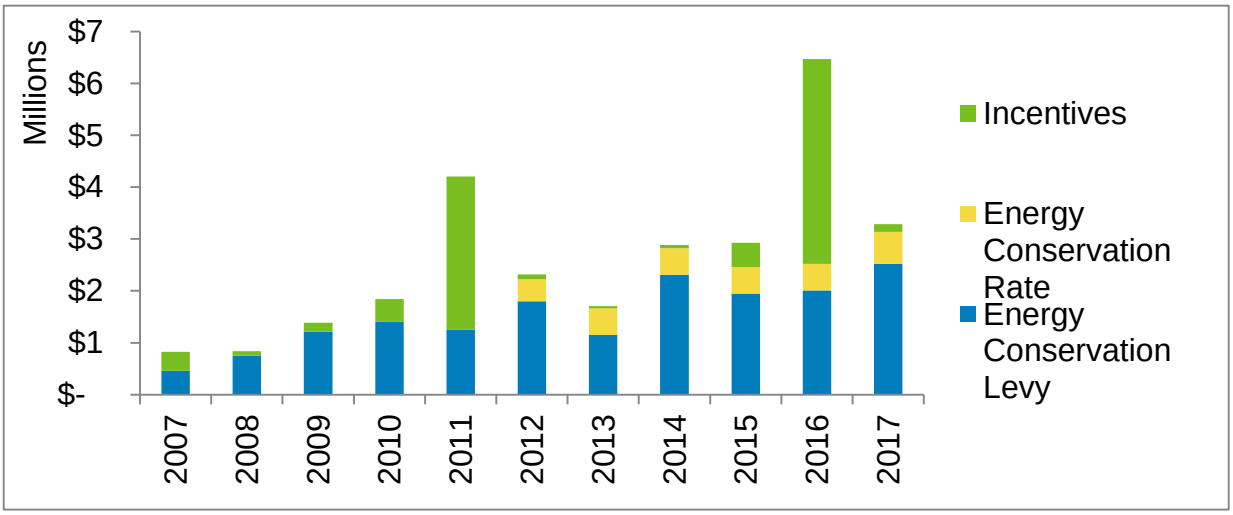
Energy conservation projects are one of the methods the City uses to help achieve energy intensity reduction targets and GHG reduction targets. Making upgrades to existing building, or adopting emerging technologies in new builds are one way to improve efficiencies, reduce GHG emissions and operate more cost-effectively.

The City can both track immediate changes with the building, but also track energy savings once the projects are complete.

Project teams work with consultants, engineers, utility personnel and industry experts to maximize efficiencies and ensure that funding opportunities, incentives and Monitoring & Verification (M&V) plans are utilized.

The 2017 energy savings contribution from projects is $3.14 million, with $147,000 in incentives for a total of $3.23 million in conservation savings. The cumulative value since the 2005 baseline year is over $28 million for project savings and incentives.

Figure 11: Annual Project Savings (Rate and Levy) and Incentives



Spotlight on Street Lighting

Hamilton streets are looking a whole lot brighter these days. For the past 4 years, street lighting projects have been happening throughout the City, upgrading to light emitting diode (LED) technology.

The 'Lighting Asset Modernization Project' (LAMP) is the next phase of LED street lighting upgrades. In 2015, approximately 10,000 street lights were upgraded to LED. The 2015 project has resulted in positive savings which have recouped the capital cost outlay and reduced the 2018 street lighting operating budget by $750,000. LAMP is targeting 27,000 cobra-head style street lights and once completed the majority of the City's 45,000 street lights will be LED leaving only non-cobra head style street lights remaining. The current project is being completed in 4 phases with expected completion by the end of 2018.

LED street lights installed by the LAMP project will consume approximately 60% less electricity than their HPS counterparts. The LED street lights also have a long in-service life expectancy in excess of 15 years thereby reducing the City's operating costs and further enhancing service levels. Once completed, LAMP will reduce the City's energy usage by approximately 2.1 mega-watts, equal to the amount of electricity consumed by over 1,000 homes.

2017 Project Highlights

A variety of energy efficiency projects were completed in in 2017. Below is a highlight of the projects that helped to reduce energy usage and improve efficiencies.

Arena's LED Lighting Retrofit Project

- Installation of new LED Lighting in 18 of the City's Arena's, including Ice surface lighting & controls, change rooms & common area lighting.
- Benefits include improved lighting conditions, dimmable/selectable ice lighting levels. Benefits also include a reduction in lamp maintenance costs.
- 1,150,000 kWh annual reduction and $205,000 in energy and maintenance savings.
- $124,000 in incentives to be expected from IESO SaveONenergy program

First Ontario Centre Ice Surface Lighting Retrofit Project

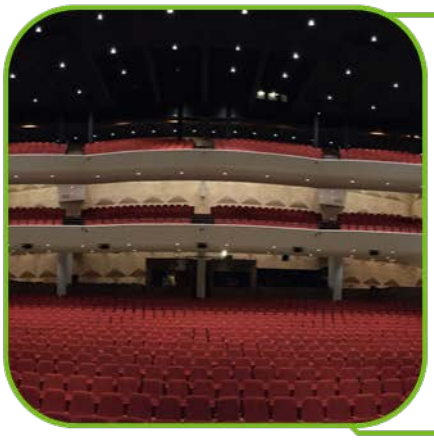
- Installation of new, highly efficient LED lighting over the Ice surface replacing old HID lighting technology.
- Benefits include instant on lighting, improved lighting colour, higher light levels and new lighting controls.
- 494,300 kWh annual reduction and $65,000 in annual energy and maintenance savings.
- $35,000 in incentives to be expected from IESO SaveONenergy program.

Macassa & Wentworth Lodge, LED Lighting Retrofit Project

- Installation of new, energy efficient LED Lighting in all areas of the Lodges including exterior lighting & controls.
- Benefits include improved lighting colour, higher light levels that meet or exceed Ministry lighting standards, reduced lighting maintenance.
- 760,000 kWh annual reduction and $117,000 in annual energy and maintenance savings.
- $57,000 in incentives to be expected from the IESO SaveONenergy program.

Morgan Firestone & Parkdale Arenas - Low E Ceilings Project

- Installation of Low Emissivity Ceilings (low E ceilings). Low E ceilings block radiated heat from the ice service and the refrigeration system does not have to work as hard.
- Benefits include less wear on refrigeration units.
- 200,000 kWh annual reduction and $30,000 in annual energy savings.
- $30,000 in incentives to be expected from the IESO SaveONEnergy program.



First Ontario Concert Hall - General Area LED Lighting Retrofit Project

- Installation of new LED lighting throughout the facility including lobby & mezzanine, hallways, offices, the Studio & Great Hall theatre seating area.
- Benefits include improved lighting colour, lighting levels and lighting controls and reduced lighting maintenance. 450,000 kWH expected annual reduction and $60,000 in annual energy savings.
- $55,000 in incentives to be expected from the IESO SaveONEnergy program.

Riverdale Community Centre - BAS Upgrades

- Upgrade of the existing building automation system to connect to City's centralsed Building Control Centre.
- Benefits include improving the building operations and thermal comfort of the building.
- 20,500 kWh and 2,400 m^3 in expected annual reduction and $3,800 in annual energy savings.
- $3,000 in incentives to be expected from the IESO SaveONEnergy program.

Hamilton City Hall -2nd Floor Lighting Upgrades

- Installation of new LED Lighting on the 2nd floor of City Hall.
- Benefits include improved lighting conditions for health and safety, and a reduction in lighting maintenance time and costs.
- 28,900 kWh expected annual reduction and $2,300 in energy savings.
- $4,400 in incentives to be expected from IESO SaveONenergy program.

Macassa Lodge Chiller Refurbishment

- Refurbishment of a 220 ton chiller.
- Benefits include providing chiller with increased reliability, energy efficiency, and to avoid unscheduled downtime to enhance resident comfort.
- 159,000 kWh expected annual reduction and $15,900 in energy savings.

2018 – Upcoming Projects

Ice Arenas Refrigeration Controls

An expansion on the 2017 pilot to 13 arenas. The technology utilizes controls and variable frequency drives to optimize the efficiency of the refrigeration process and is expected to generate operational savings of over $200,000.

Fire Stations Interior LED Lighting Upgrade

The project addresses upgrading the interior lighting that is often on 24 hours a day to LED, with the projected operational savings of $36,000.

Valley Park Aquatic Centre Interior LED Lighting

This project addresses upgrading to more efficient lighting in a high use aquatic facility, with the projected operational savings of $30,000.

Aquatic Centres Exterior LED Lighting

This project addresses exterior LED lighting systems in 9 aquatic facilities to enhance safety, efficiency and modernize appearance. There is a projected operational savings of $18,000.

Wentworth Lodge HVAC and BAS Upgrades

This project proposed to utilize new systems and controls to improve resident comfort and improve efficiency. There is a projected operational savings of $6,000.

Macassa Lodge Chiller Upgrade

This project addresses capital replacement of three 60 ton air cooled chillersto enhance occupant comfort and has a projected operational savings of $23,000.

Woodward Ave Water and Wastewater – LED Lighting Upgrade

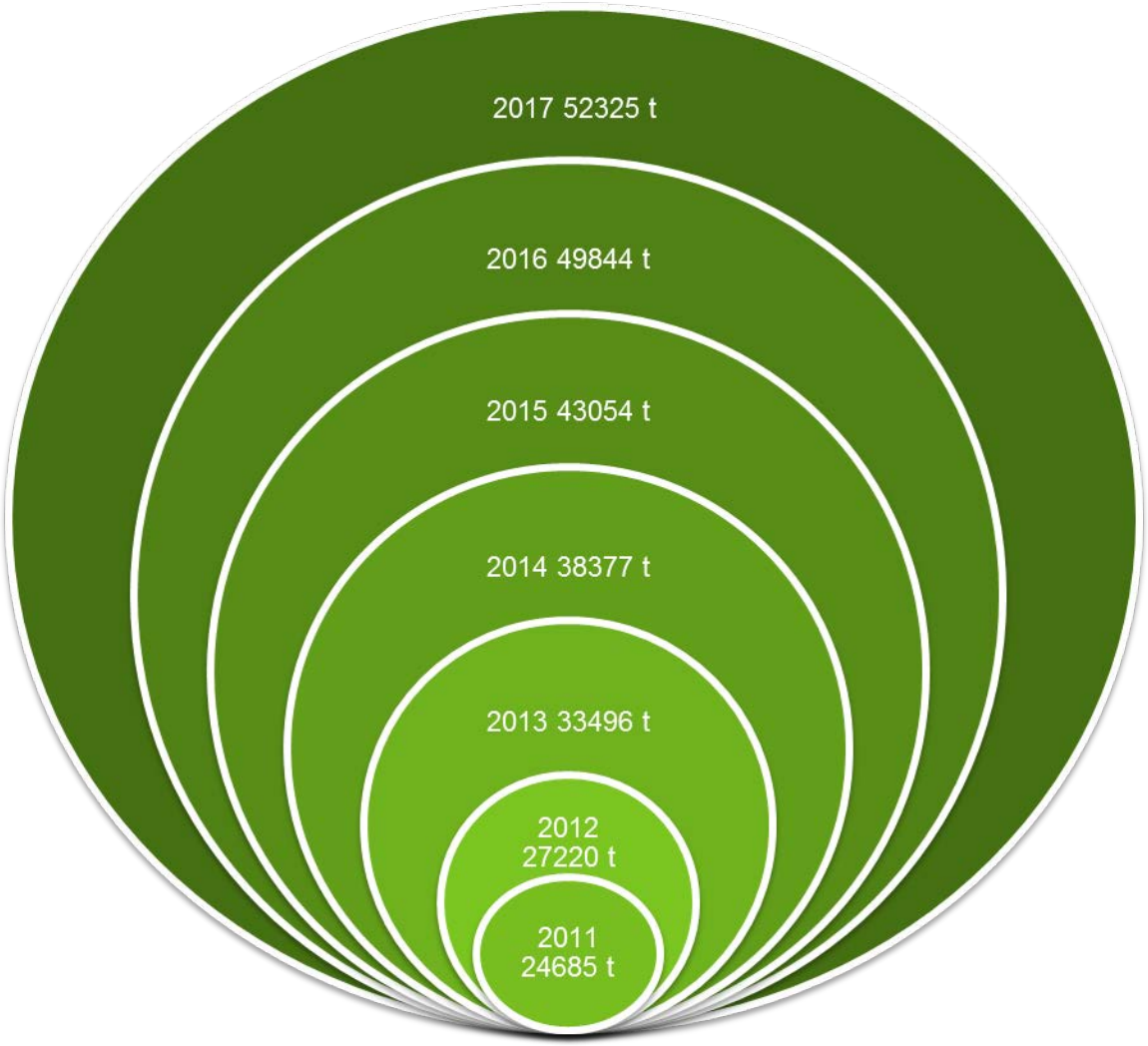
Upgrade to LED in administration offices, industrial spaces, tunnels and exterior and roadway lighting. There is a projected operational savings of $100,000.

Mountain Transfer Station LED Lighting Upgrade

This project proposes to upgrade inefficient lighting sources such as metal hallide and high pressure sodium lighting to more efficient LED.

The benefits of energy conservation projects include reducing energy efficiency, lowering operating costs and improving processes. In addition, there are GHG reductions that are associated with energy efficiency projects. The diagram below shows the cumulative GHG reductions that have occurred as a result of energy conservation efforts.

Figure 12: Cumulative GHG Reductions from Energy Conservation Initiatives in Tonnes of CO_2e (2011 to 2017)



Greenhouse Gas Emissions 2016 Report

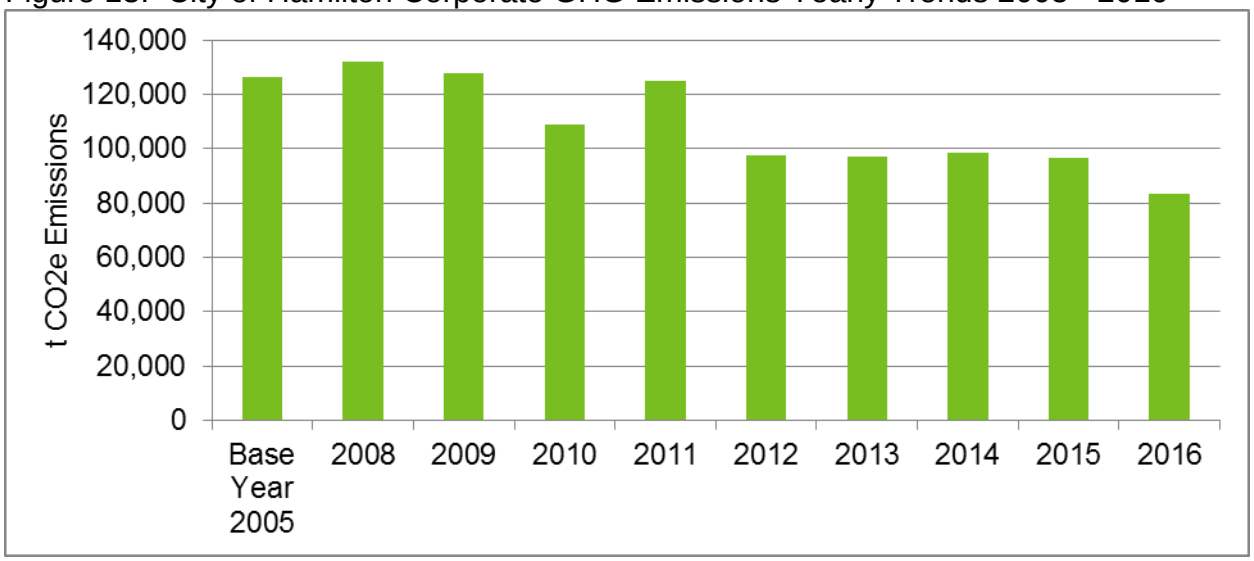
GHG emissions related to Corporate operations have been inventoried and reported annually since adoption of the Corporate Air Quality and Climate Change Strategic Plan (PED06336(a)) in 2008. Originally, the plan established Hamilton's Corporate emission targets at a 10% reduction of 2005 GHG's levels by 2012, followed by a further 20% reduction of 2005 GHG's levels by 2020. The City reached its target for 20% reduction ahead of schedule, in 2012. New, more aggressive GHG emission reduction targets were then established and aligned with City's Corporate Energy Policy and the Board of

Health Climate Change Actions 2012 report (BOH13024). Both call for 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 Corporate Energy Policy of 50% reduction by 2030.

Data for the GHG report is one year behind, therefore the data shown is for the 2016 calendar year.

In the 2016 reporting year, the GHG emissions inventory was 83,519 tonnes CO_2e (Carbon Dioxide equivalence). The inventory does not include HRPI operations. This represents a 34% reduction (43,048 t CO_2e) from the base reporting year of 2005.

Figure 13: City of Hamilton Corporate GHG Emissions Yearly Trends 2005 - 2016

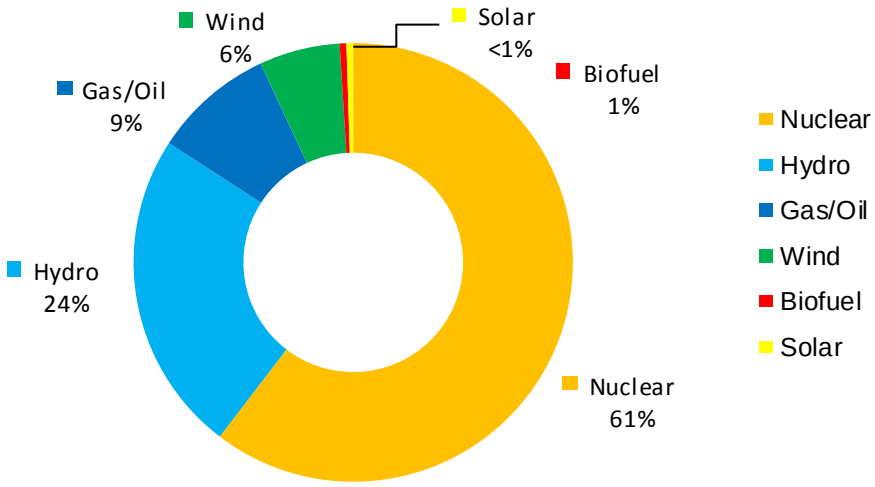


Note: Does not include HRPI operations

Overall, there has been a general trend of decreasing emissions in the Corporate GHG inventory since the base year. Energy efficiency initiatives, such as energy efficient equipment upgrades which result in a reduction of energy use, or fuel conversion from diesel to natural gas have made an impact on the reduction of the City's GHG inventory. However, the Ontario electricity emission factor, which is a measurement of the CO_2e intensity of electricity generation, has had a significant impact on the measurement of GHGs. The emission factor reflects the system-wide change in the electricity supply mix in Ontario, which has been steadily decreasing as Ontario moves to greener and cleaner power sources.

The graph below, with data reported from the Independent Electricity System Operator (IESO) shows the energy output by fuel type for 2016 for transmission-connected generation. The annual data varies, depending on real-time data output. It does not include embedded generation.

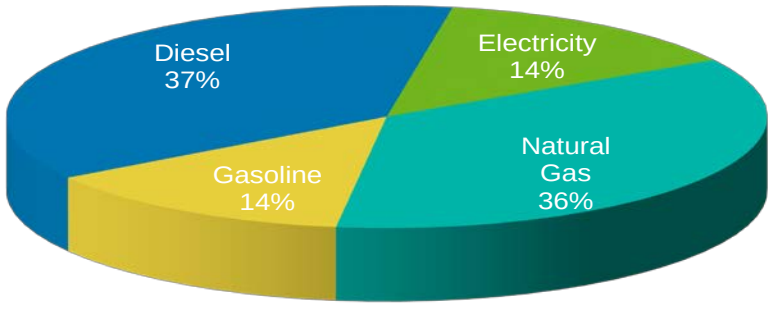
Figure 14: 2016 Energy Output by Fuel Type



Source: Transmission-Connected Generation - IESO Mix 2016 Output

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

Figure 15: 2016 Percentage tCO_2e Emissions Contribution by Fuel Source



The figure below shows a breakdown of the percentage of emissions by tonnes CO_2e that each reported sector has contributed to in 2016. The two largest emitters of GHG's are the City's Vehicle Fleet (38,040 t CO_2e, 46%) and Corporate Buildings (24,356 t CO_2e, 29%). Hamilton Water is third (8,990 t CO_2e, 11%). The remainder of the sectors contribute 5% or less. This is a similar trend to past years.

Figure 16: 2016 Percent Tonnes CO_2e of Total by Sector

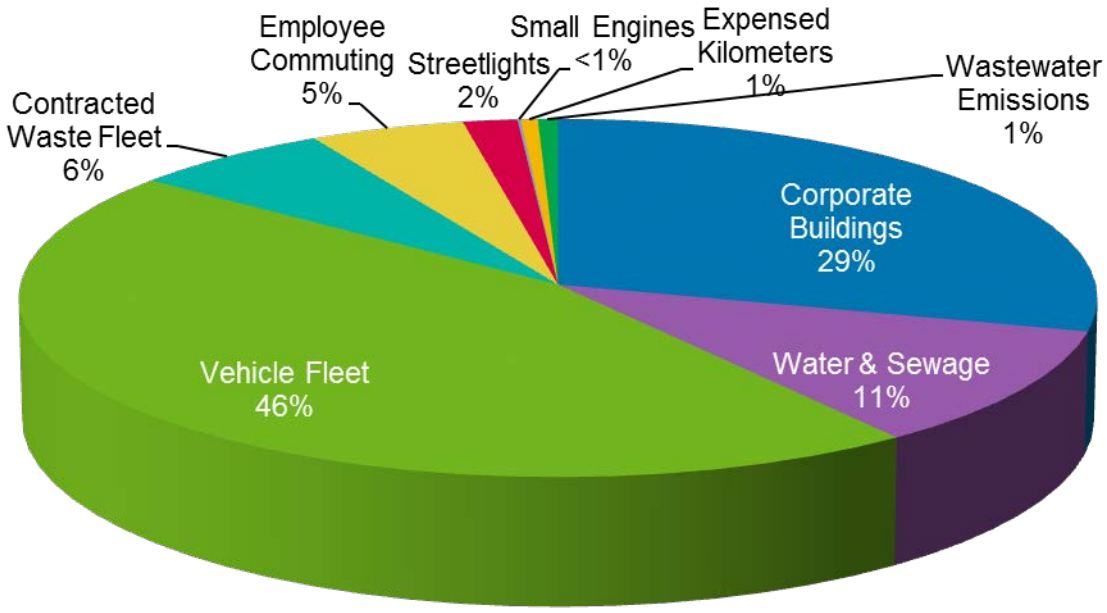
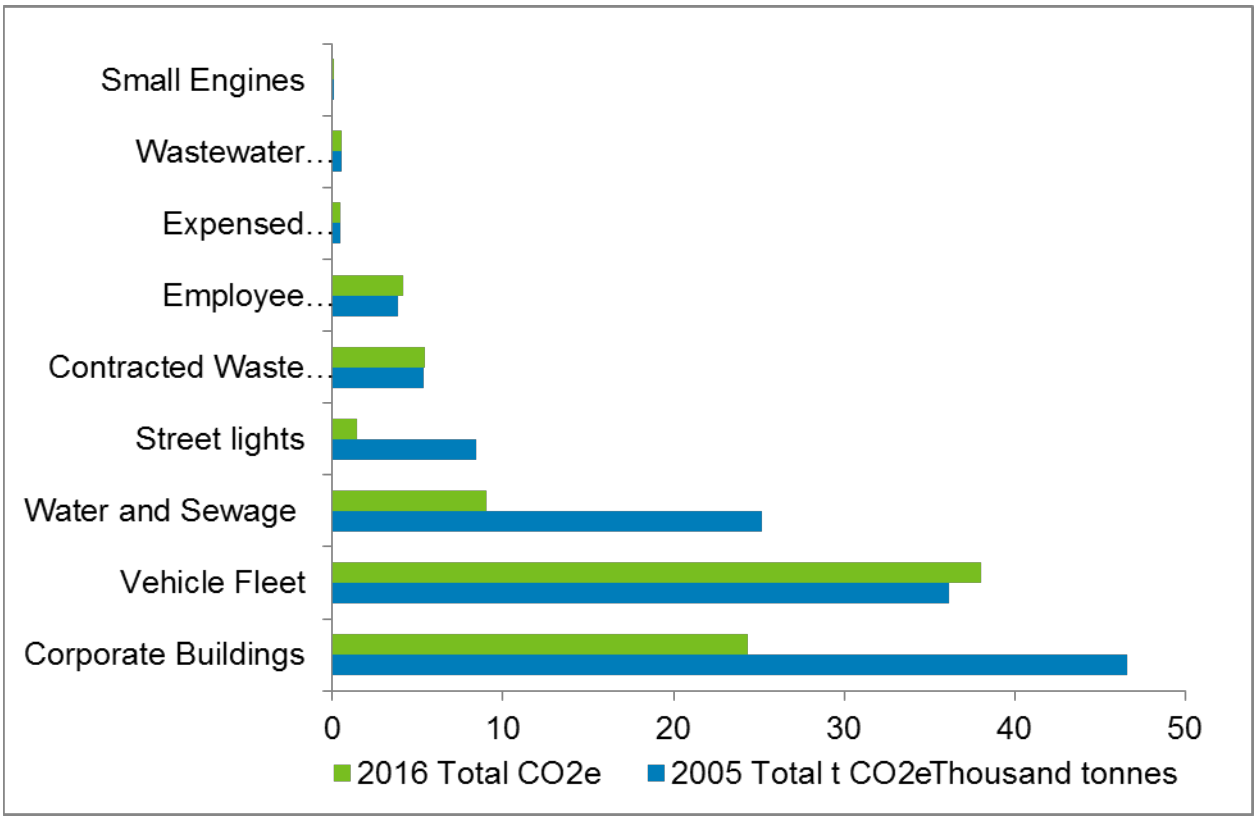


Figure 17: 2016 to 2005 Base Year Comparison by Sector



As shown in Figure 17 above, most sectors show a downward trend in GHG inventory which is due to a combination of Ontario's changing emission factor, and a variety of efficiency measures undertaken by the City. However, Vehicle Fleet including Transit has increased CO2e emissions by 5% over the base year 2005. Although the efficiency of vehicles may have improved since 2005, and Transit has replaced a large number of diesel-run buses with natural gas fueled buses, a lower GHG emitter, the overall fuel consumption has risen as a result of increased fleet size.

Final Comments

Each year the City strives to reach its long term goals, while operating within an evolving energy industry. With each regulatory, provincial or federal initiative related to reducing energy use and GHG emissions, come new challenges and new opportunities to achieve those objectives.

The City has made great strides, from our existing policy framework, to making "Clean and Green" a strategic priority, but it is important now, more than ever, to reduce our consumption, choose renewable technologies and become more efficient. As the City aims to mitigate rising energy costs and reduce energy consumption to improve energy intensity and GHG targets, the Climate Change Action Plan was introduced to address provincial goals.

The Cap & Trade program, introduced in 2017, was designed to influence large carbon emitters to reduce emissions overall. All consumers pay for the price of carbon within fuel costs (i.e. natural gas and diesel), and in turn the province is expected to use that revenue generation for funding green, GHG-reducing projects as indicated in the Climate Change Action Plan.

Measuring and reporting on our performance continues to be an essential tool for the City to assess it progress and focus its efforts on meeting corporate targets and identifying areas of continuous improvement.

Appendix A

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

Energy Strategies and Programs KPI's

Figure A-1: Cumulative Results of Energy Programs and Strategies (2006 – 2017)

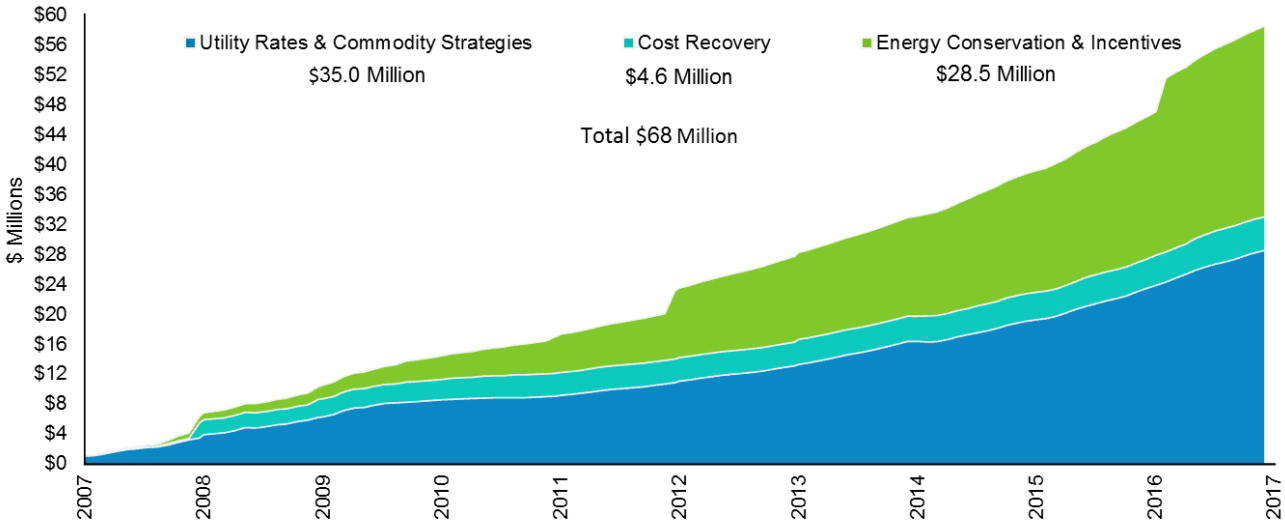


Figure A-2: Three Year Comparison Energy Programs and Strategies

Category	Past 3 Years			2006-2017
	2015	2016	2017	Cumulative
Levy RPP/Interval Change	$ -	$ -	$ -	$ 2,886,651
Rate RPP/Interval Change	$ -	$ -	$ -	$ 2,873,163
Levy Global Adjustment	$ 994,677	$ 1,279,622	$ 1,344,340	$ 5,138,464
Rate Global Adjustment	$ 2,916,622	$ 3,402,587	$ 4,631,762	$ 16,951,113
Levy Natural Gas	$ 352,603	$ 365,430	$ 446,304	$ 6,059,687
Rate Natural Gas	$ 59,040	$ 63,111	$ 66,946	$ 1,072,607
Energy Conservation Levy	$ 1,947,669	$ 2,008,166	$ 2,286,392	$ 16,580,539
Energy Conservation Rate	$ 513,415	$ 513,415	$ 616,098	$ 3,095,959
Incentives	$ 465,362	$ 3,948,039	$ 147,841	$ 8,816,185
Cash Recovery Levy	$ 221,993	$ 593,832	$ 118,099	$ 4,364,031
Cash Recovery Rate	$ -	$ -	$ -	$ 235,375
Totals	$ 7,471,381	$ 12,174,201	$ 9,657,781	$ 68,073,774

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

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

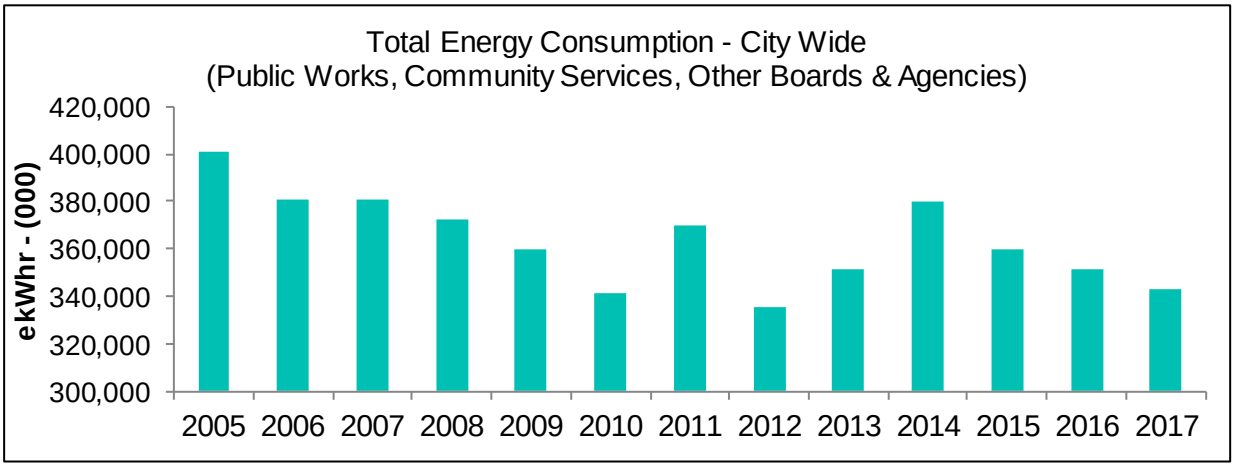


Figure A-4: Total Annual Reported Costs Electricity and Natural Gas (Facilities)

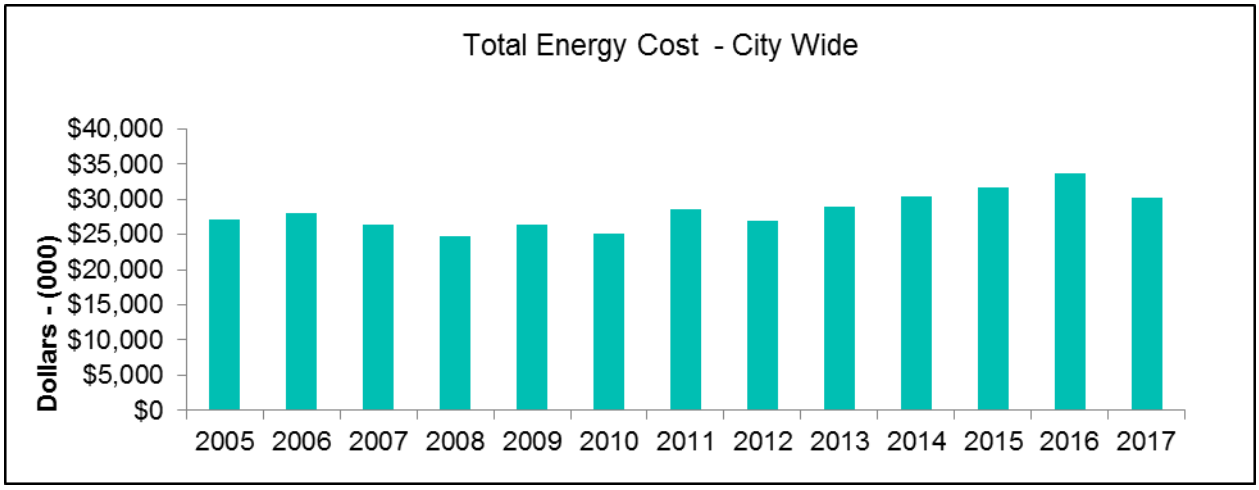


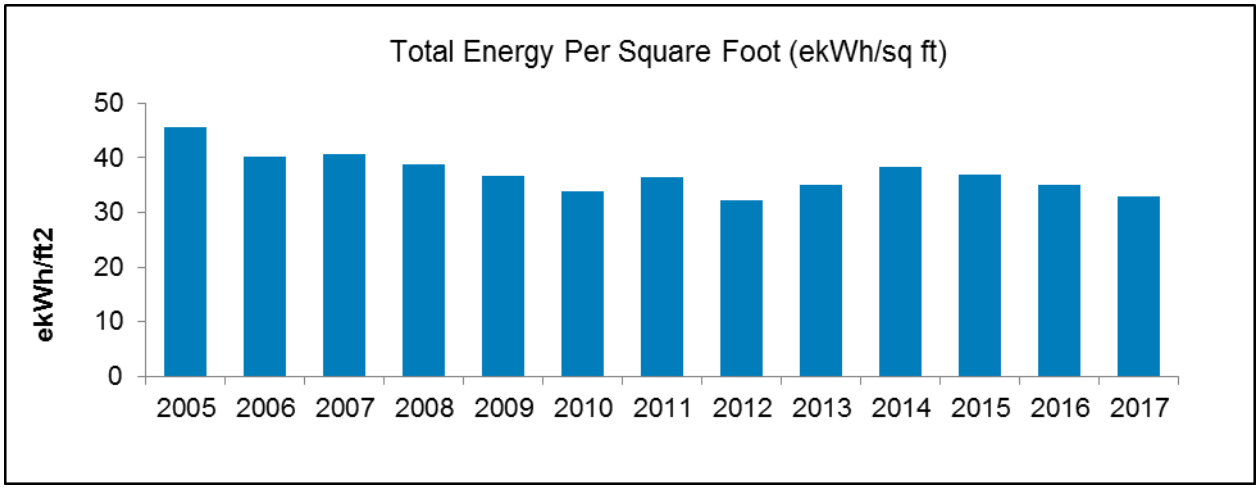
Figure A-5: Total Consumption Comparison by Portfolio Category

Total Energy	in 000's of ekWhs			Comparisons	
Consumption	2005	2016	2017	2017 vs 2005	2017 vs 2016
City/Town Halls	13,775	8,242	8,271	-40%	0%
Corporate Facilities	17,188	8,147	6,394	-63%	-22%
Street Lighting	33,603	26,775	26,920	-20%	1%
Traffic Lighting	5,688	2,022	2,067	-64%	2%
Other City Operations	5,618	5,687	4,689	-17%	-18%
Hamilton Water	121,040	122,873	124,461	3%	1%
Yards	39,589	28,068	25,104	-37%	-11%
Arenas	39,904	34,656	34,204	-14%	-1%
Community/Senior Centers	3,834	3,452	3,337	-13%	-3%
Rec Centres/Pools	26,789	27,221	26,986	1%	-1%
Tim Horton's Field	0	8,248	7,424	0%	-10%
Rec Parks/Stadiums/Golf	8,332	5,993	4,666	-44%	-22%
Lodges (Macassa, Wentworth)	24,938	16,097	15,672	-37%	-3%
Culture	5,383	4,643	4,728	-12%	2%
Fire/ EMS	10,698	12,538	12,346	15%	-2%
Hamilton Public Libraries	9,343	10,559	10,479	12%	-1%
First Ontario Centre	10,122	9,840	9,160	-10%	-7%
Hamilton Convention Centre	4,656	3,541	3,712	-20%	5%
First Ontario Concert Hall	5,466	4,363	4,658	-15%	7%
Hamilton Police Services	14,757	8,688	8,067	-45%	-7%
City Wide Total	**400,722**	**351,654**	**343,345**	**-14%**	**-2%**

Figure A-6: Total Cost Comparison by Portfolio Category

Total Energy-$	in 000's of $			Comparisons	
Cost	2005	2016	2017	2017 vs 2005	2017 vs 2016
City/Town Halls	$860	$710	$690	-20%	-3%
Corporate Facilities	$866	$732	$554	-36%	-24%
Street Lighting	$2,895	$5,302	$5,010	73%	-6%
Traffic Lighting	$462	$381	$358	-23%	-6%
Other City Operations	$534	$916	$700	31%	-24%
Hamilton Water	$9,590	$11,892	$10,488	9%	-12%
Yards	$2,205	$2,057	$1,636	-26%	-20%
Arenas	$2,455	$2,950	$2,896	18%	-2%
Community/Senior Centers	$224	$269	$248	11%	-8%
Rec Centres/Pools	$1,192	$1,556	$1,468	23%	-6%
Tim Horton's Field	$0	$917	$704	0%	-23%
Rec Parks/Stadiums/Golf	$564	$362	$401	-29%	11%
Lodges (Macassa, Wentworth)	$1,087	$1,109	$877	-19%	-21%
Culture	$338	$281	$281	-17%	0%
Fire/ EMS	$614	$983	$896	46%	-9%
Hamilton Public Libraries	$827	$909	$851	3%	-6%
First Ontario Centre	$840	$979	$880	5%	-10%
Hamilton Convention Centre	$387	$254	$268	-31%	6%
First Ontario Concert Hall	$454	$304	$324	-29%	6%
Hamilton Police Services	$783	$804	$749	-4%	-7%
City Wide Total	**$27,177**	**$33,667**	**$30,277**	**11%**	**-10%**

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



The following series of graphs break down the energy intensity results per site for 2017 within their specific portfolio category. 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 were removed from the energy intensity graphs below, but have been included in all cost and consumption data. Also note that the energy intensity access may be adjusted depending on grouping. (i.e. maximum 50 up to maximum 200).

Figure A-8: Corporate Facilities Energy Intensity

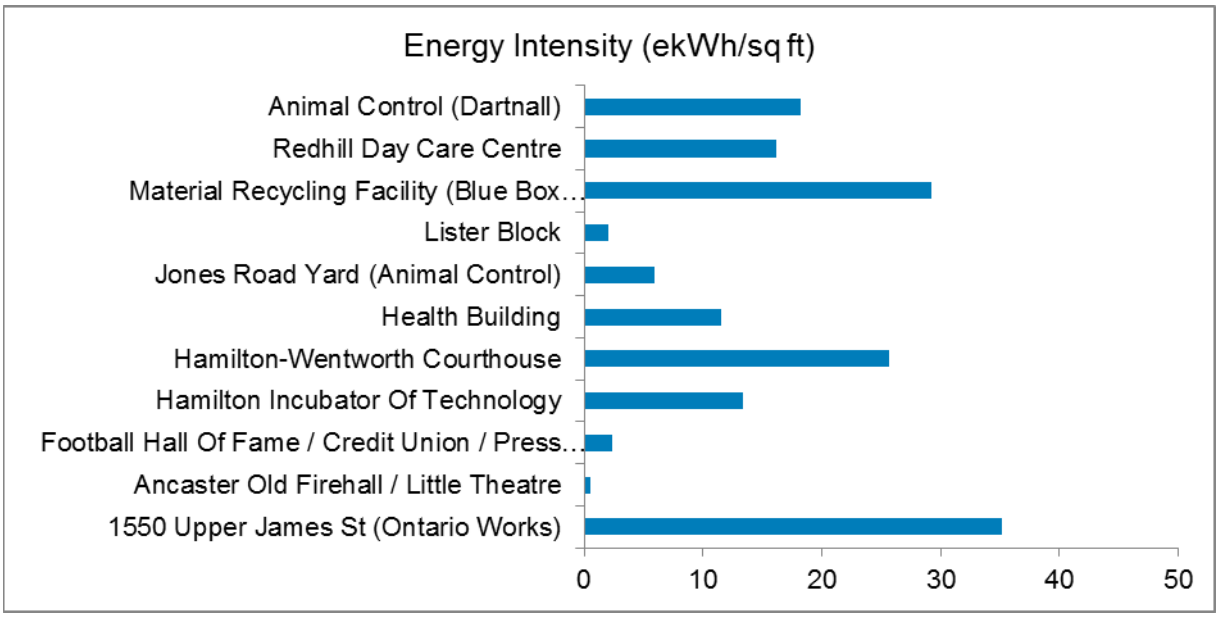


Figure A-9: City and Town Halls Energy Intensity

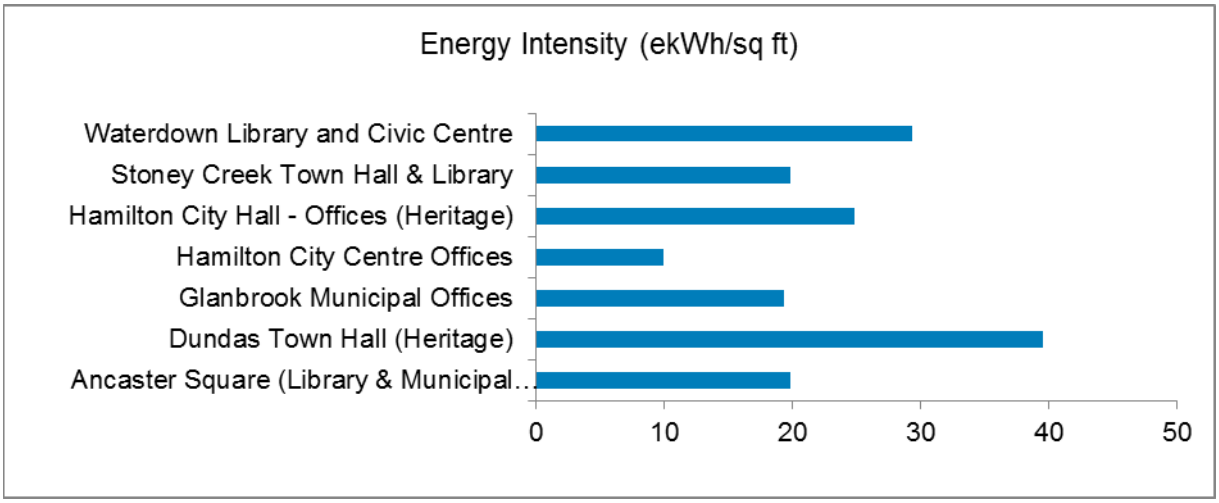


Figure A-10: Arenas Energy Intensity

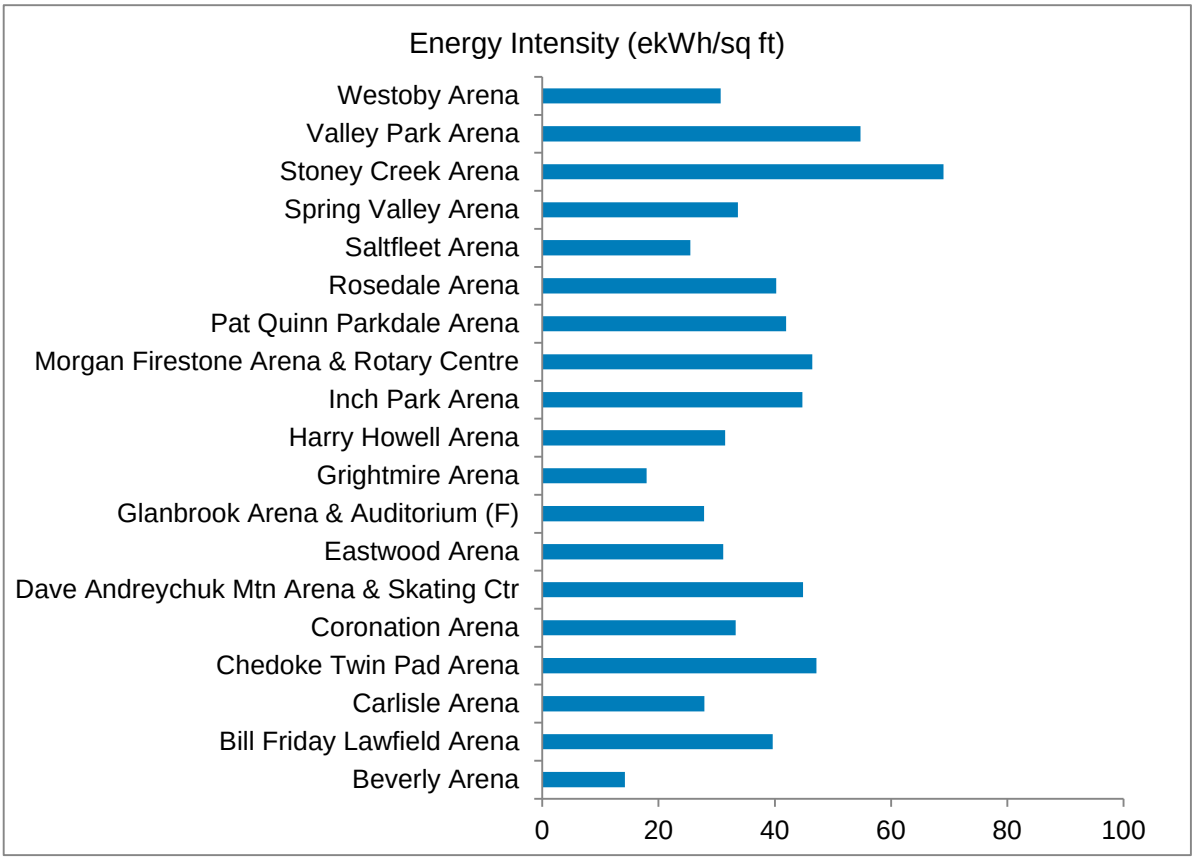
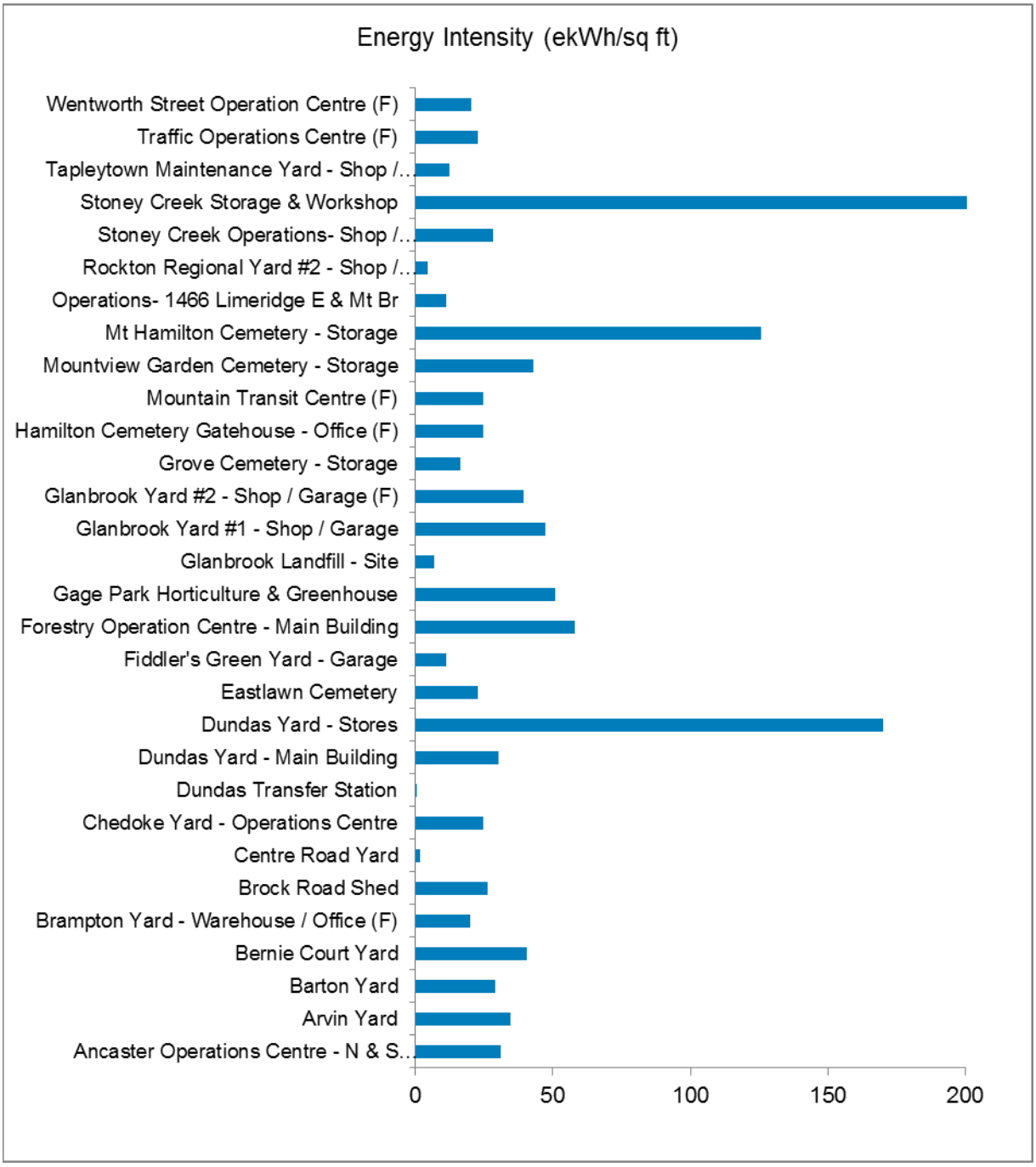


Figure A-11: Yards Energy Intensity



(F) = City fueling station,
Stoney Creek Storage & Workshop has an energy intensity of 480.

Figure A-12: Community Centres Energy Intensity

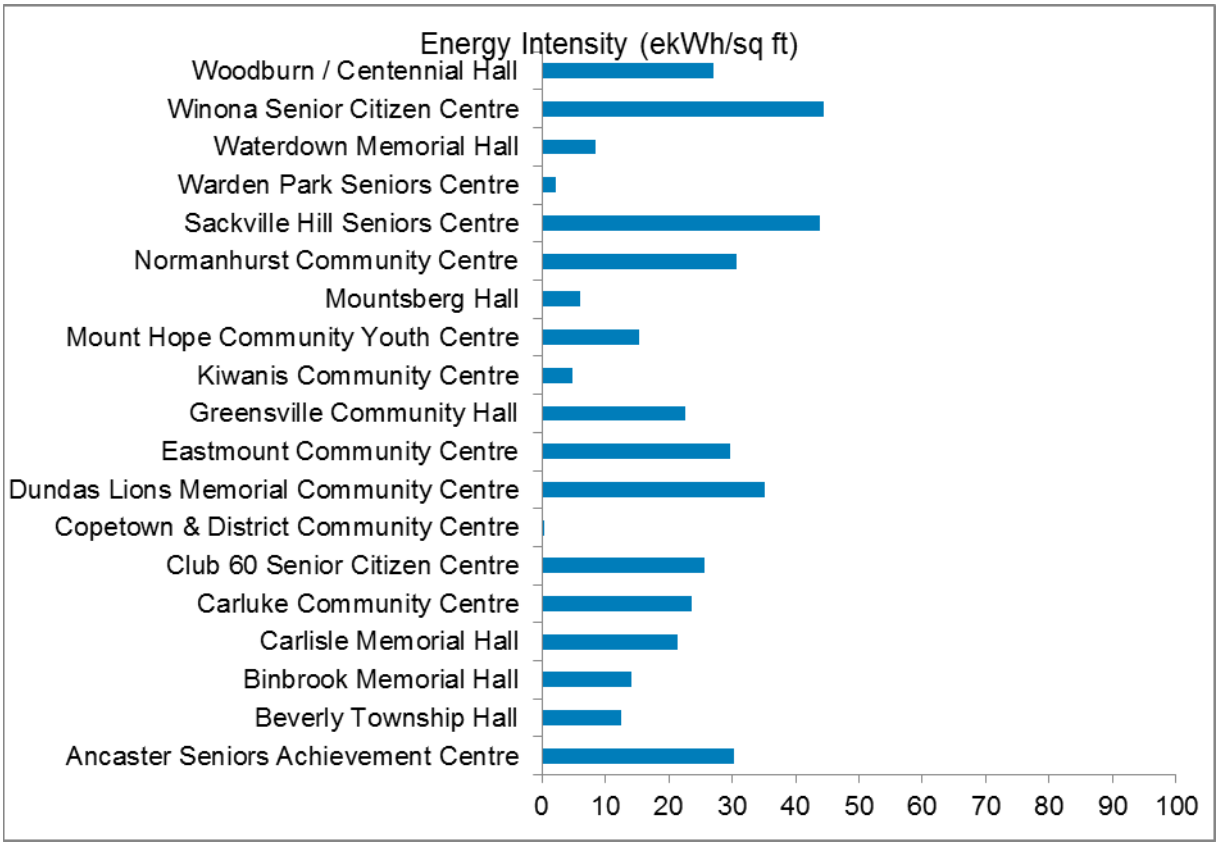


Figure A-13: Lodges Energy Intensity

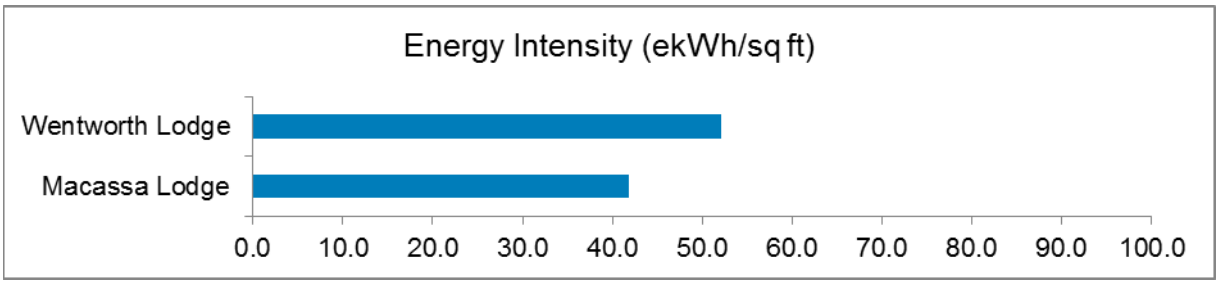
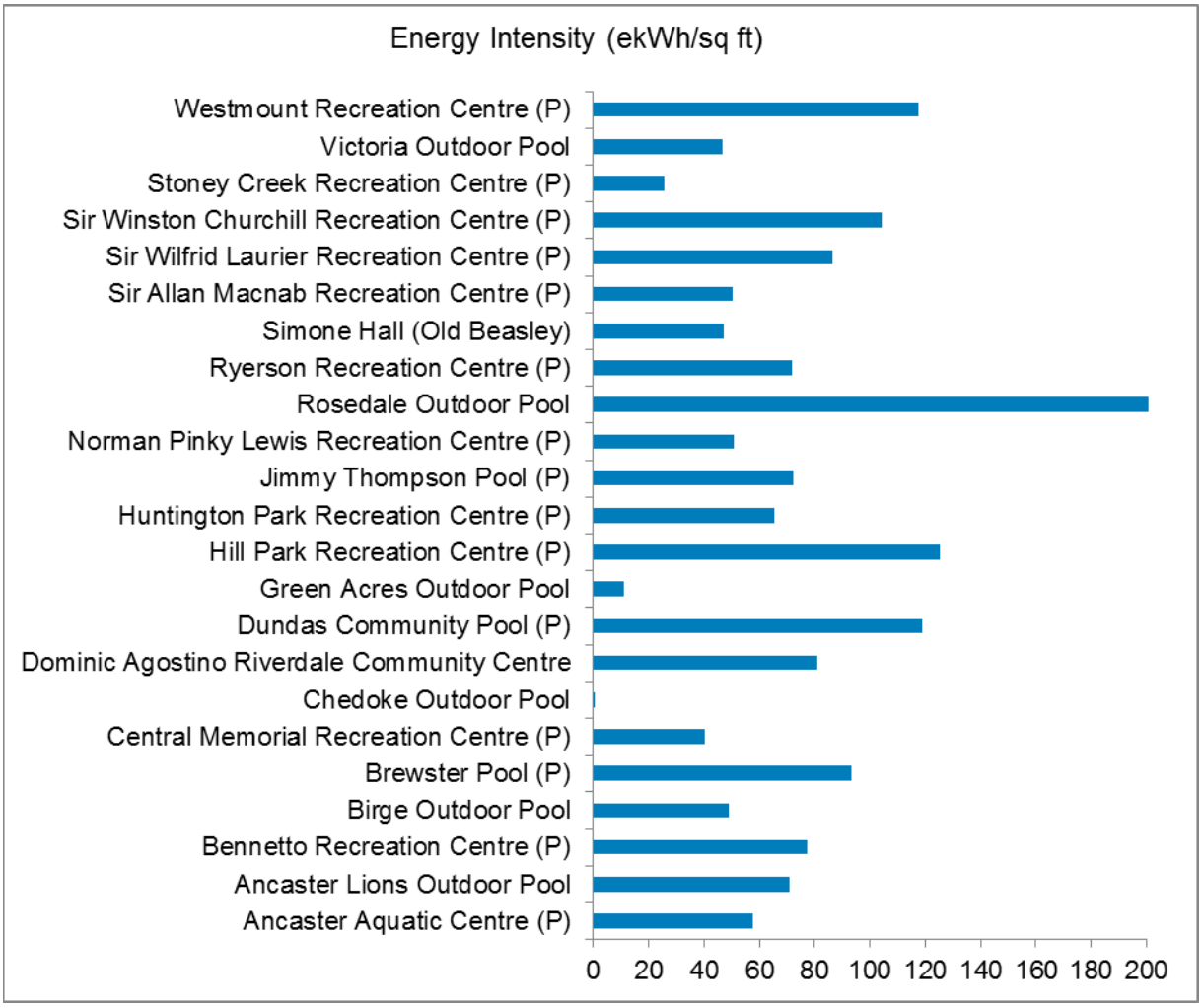
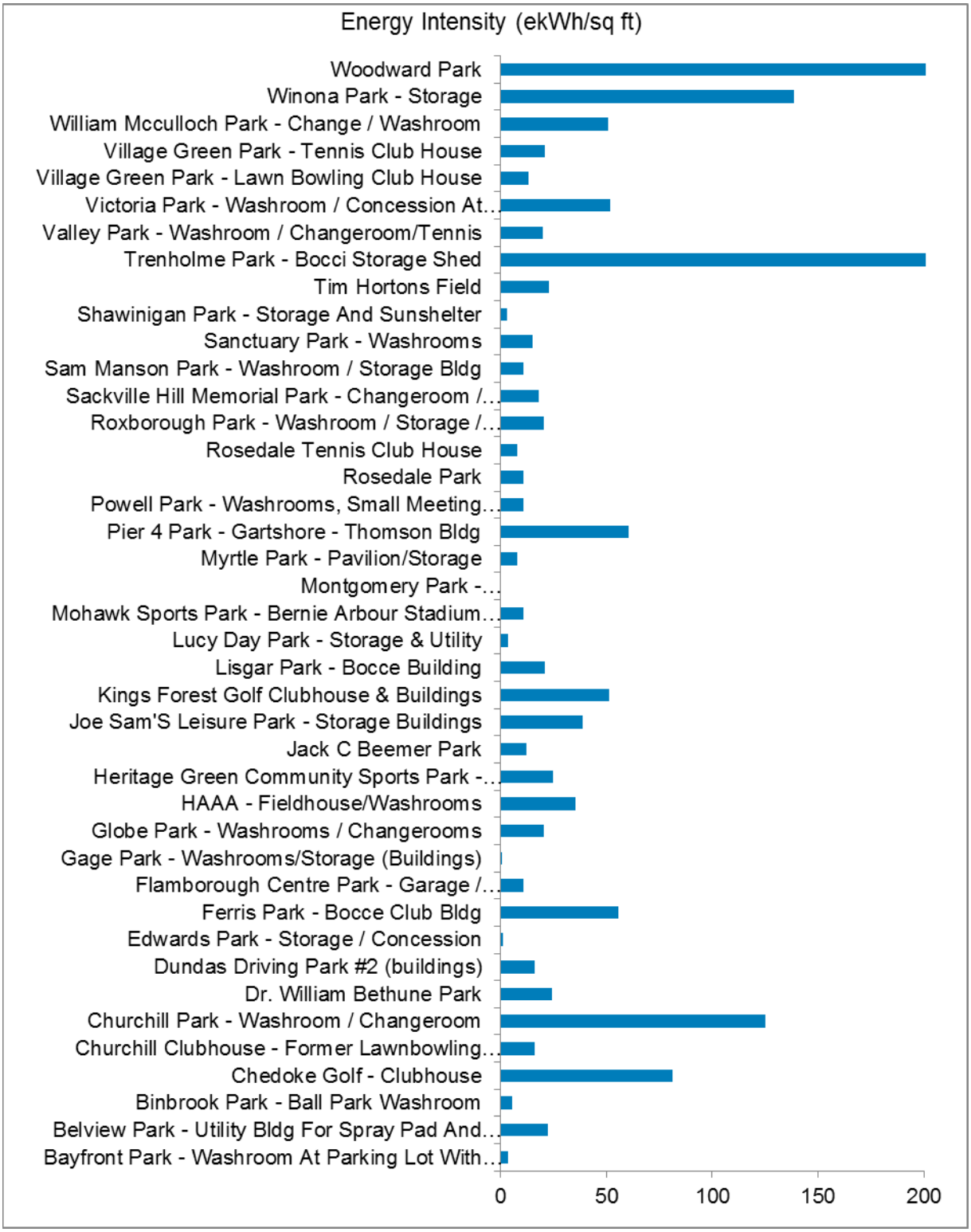


Figure A-14: Recreation Centres and Pools Energy Intensity



(P) = Pool
Rosedale Outdoor Pool has an energy intensity of 302.

Figure A-15: Stadiums, Recreation Park Buildings and Golf Energy Intensity



Trenholme Park has an energy intensity of 499. Woodward Park has an energy intensity of 631.

Figure A-16: Libraries Energy Intensity

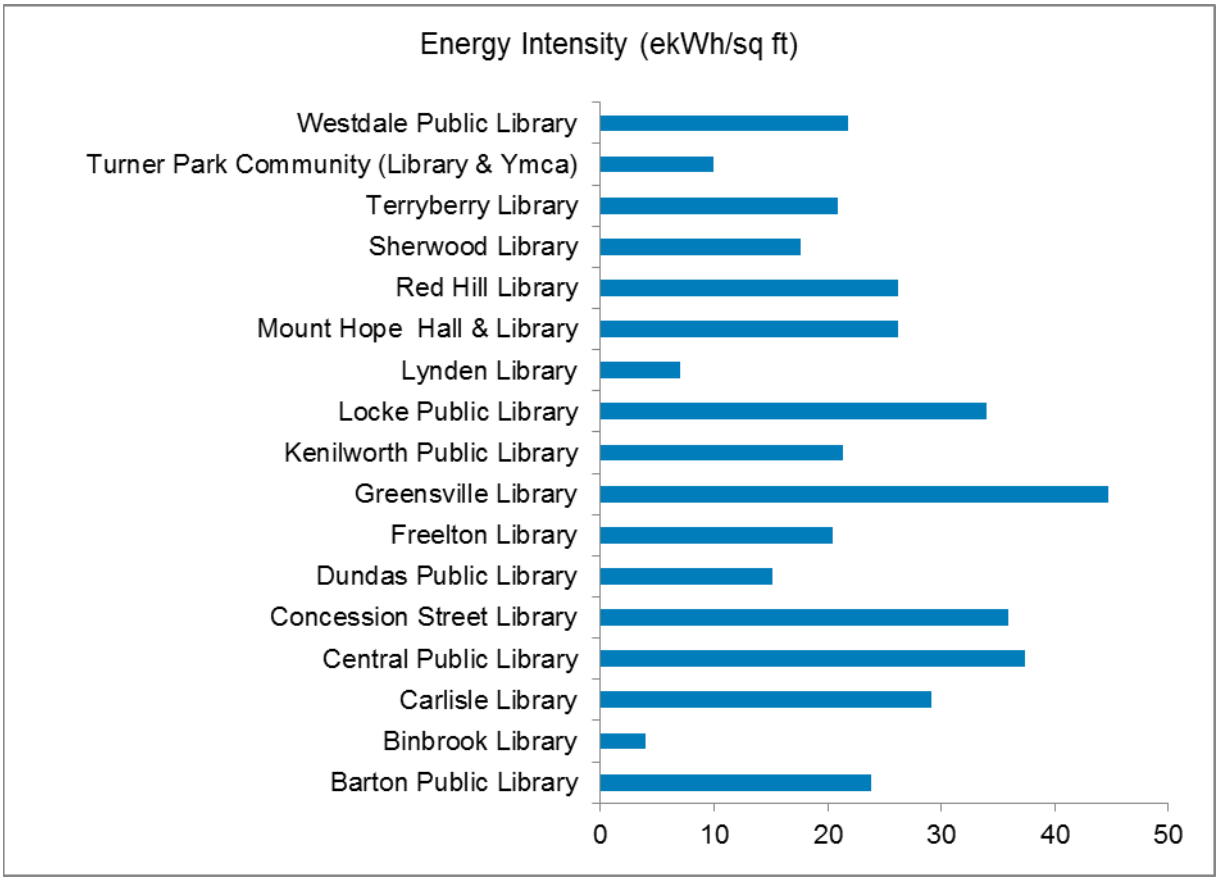


Figure A-17: Culture and Historical Energy Intensity

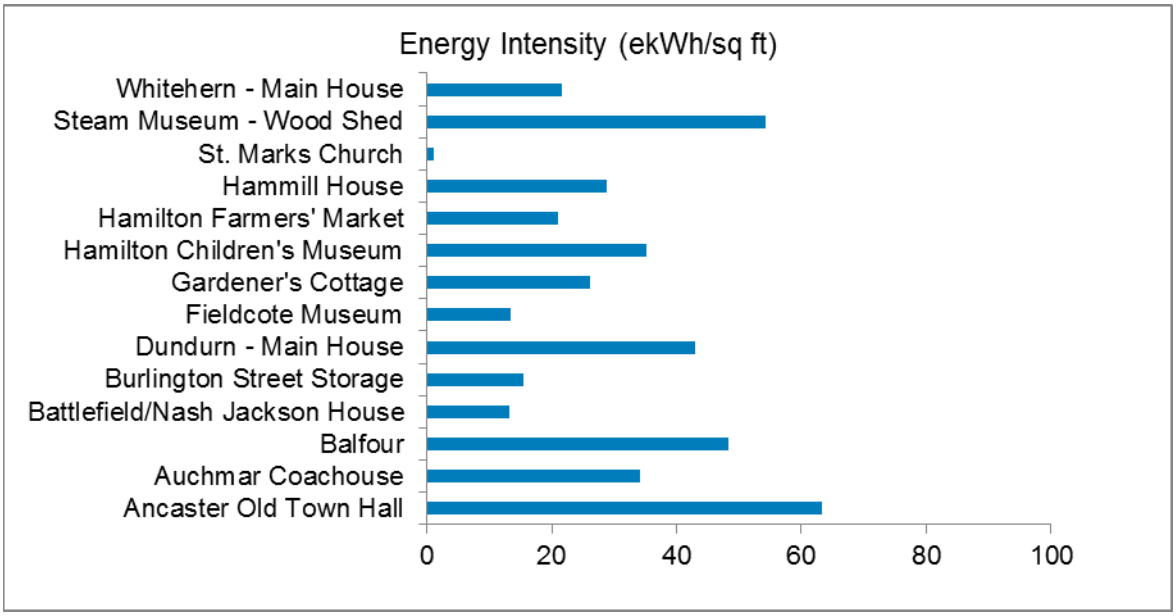


Figure A-18: EMS and Fire Energy Intensity

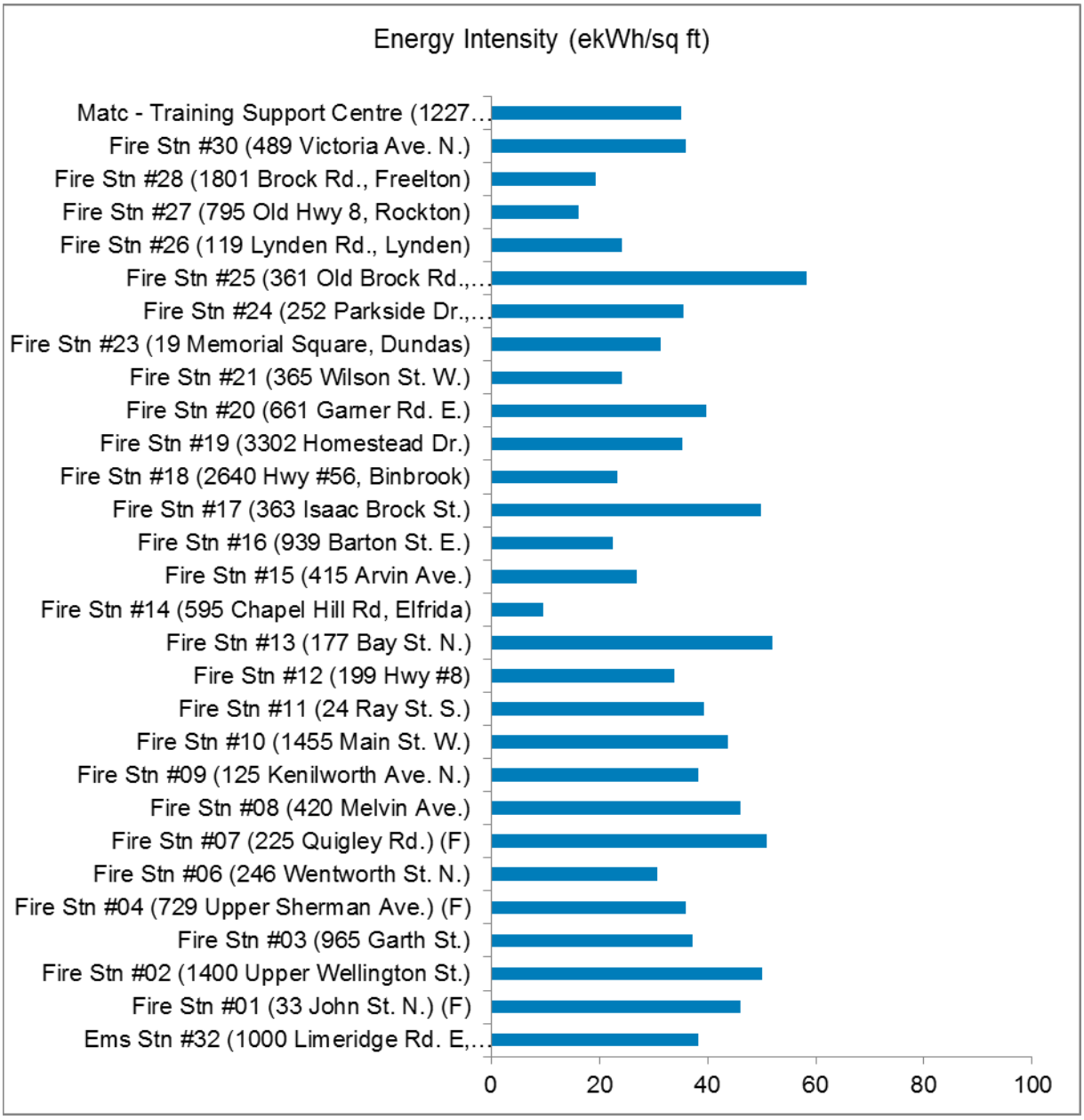
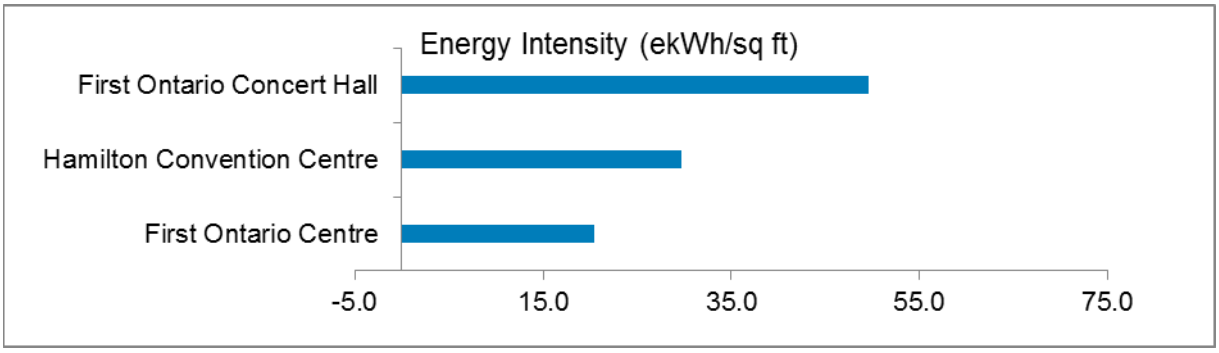


Figure A-19: Entertainment Energy Intensity



Weather Data

Weather and temperature can impact consumption of electricity, natural gas and fuel. Refering to cooling degree days and heating degree days can help to identify one reason why consumption could be up or down year over year. Cooling degree days (CDD) are a measure of how much (in degrees), and for how long (in days), outside air temperature was higher than a specific base temperature. Heating degree days (HDD) are a measure of how much, and for how long the outside air temperature was lower than a specific base temperature. The City tracks degree day data from Environment Canada.

Figure A-20: 2017 Weather Data from Environment Canada for Hamilton: (Weather Station: YHM)

Month	Mean Temp (◦C)	HDD	CDD	2017 vs 2016 HDD	2017 vs 2016 CDD
Jan-17	-2.2	625.4	0	-9%	
Feb-17	-0.1	505.3	0	-16%	
Mar-17	-0.8	582	0	23%	
Apr-17	8.6	281.6	0	-32%	
May-17	11.6	200.3	6.7	28%	-75%
Jun-17	18.6	33.1	50.6	-9%	1%
Jul-17	20.5	0.7	76.7	-50%	-39%
Aug-17	18.7	22.2	42.5	100%	-70%
Sep-17	17.3	67.8	47.3	65%	13%
Oct-17	12.7	171.4	5.4	-21%	15%
Nov-17	2.8	424.4	0	19%	
Dec-17	6	694.7	0	10%	
2017 Annual Total		3608.9	229.2	0%	-41%

Figure A-21: Heating Degree Days (2014-2017)

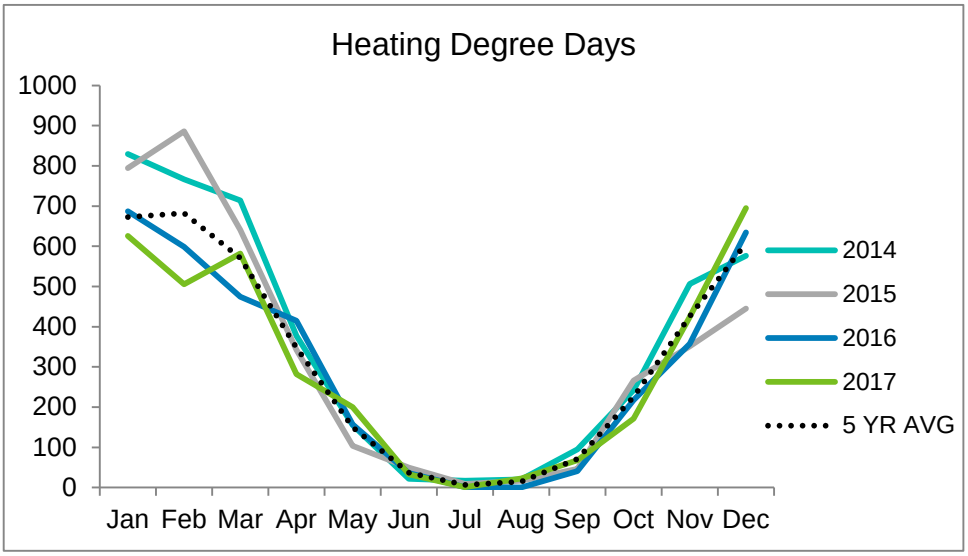
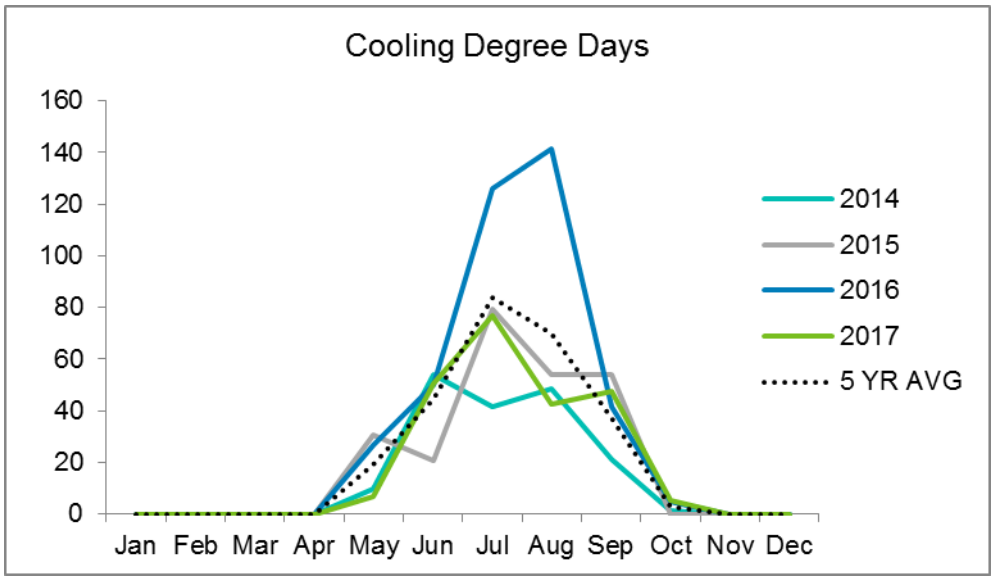


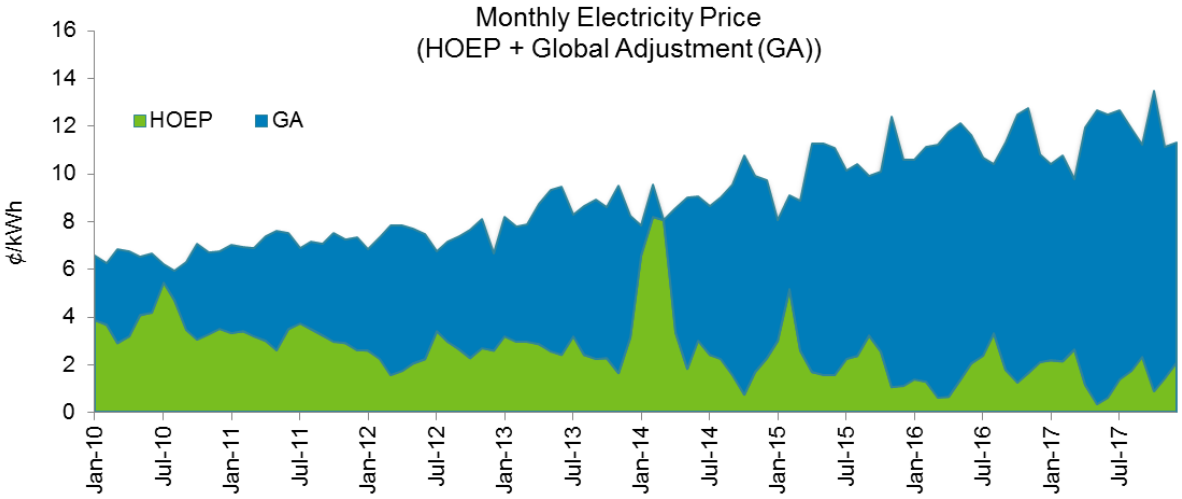
Figure A-22: Cooling Degree Days (2014-2017)



Global Adjustment

Electricity commodity has two components, the Hourly Ontario Energy Price (HOEP) and the Global Adjustment (GA).

Figure A-23: Electricity Monthly Prices (HOEP and GA)



The majority of consumers are class B, but larger high-demand sites may qualify for class A. Class A sites within the City include 900 Woodward; 850 Greenhill; 111 Kenilworth; 1579 Burlington St.; FirstOntario Centre; CUP Operations; and Tim Hortons Field.

Figure A-24: 2017 Class A Global Adjustment Results

2017	Standard Global Adjustment Charge	Actual Global Adjustment Charge	Cost Benefit
Jan	$ 640,173	$ 340,821	$ 299,352
Feb	$ 619,196	$ 314,009	$ 305,187
Mar	$ 602,778	$ 284,424	$ 318,354
Apr	$ 898,794	$ 356,674	$ 542,120
May	$ 1,046,579	$ 423,326	$ 623,253
Jun	$ 981,185	$ 446,490	$ 534,696
Jul	$ 1,036,511	$ 380,390	$ 656,122
Aug	$ 919,910	$ 357,246	$ 562,663
Sep	$ 780,642	$ 284,960	$ 495,682
Oct	$ 1,069,211	$ 381,466	$ 687,745
Nov	$ 803,816	$ 317,483	$ 486,333
Dec	$ 819,712	$ 355,117	$ 464,595
Total	$ 10,218,507	$ 4,242,405	$ 5,976,103

Figure A-25: Global Adjustment Class A Results (2011-2017)

Year	Standard Global Adjustment Charge	Actual Global Adjustment Charge	Cost Benefit
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
2017	$ 10,218,507	$ 4,242,405	$ 5,976,103
Total	$ 45,134,173	$ 23,056,237	$ 22,077,936

Peak Days – 2017

Peak day tracking is extremely important for Class A assets. Class A GA charges are calculated based on a percentage of usage during peak hours during the peak setting period. Public Works personnel work collaboratively to manage peak events. The Office of Energy Initiatives use tools to predict peak times and notify front line staff such as Hamilton Water operations staff and Corporate operations staff to shift processes to off peak times and/or minimize usage during these peak periods.

Figure A-26: Top 10 Ontario Demand Peaks from (May 1, 2017 to April 30, 2018)

Rank	Date	Hour Ending (EST)	Adjusted AQEW (MW)
1	25-Sep-17	17	21,171
2	26-Sep-17	17	21,039
3	12-Jun-17	17	20,702
4	05-Jan-18	18	20,238
5	19-Jul-17	18	20,123
6	06-Jan-18	18	20,046
7	24-Sep-17	17	19,898
8	03-Jan-18	18	19,887
9	06-Jul-17	18	19,869
10	13-Dec-17	18	19,860

AQEW = Adjusted Allocated Quantity of Energy Withdrawn**.** . These values are published 20 business days after the trade date and only the highest demand hour of the day is used.
Source Data: IESO/Peak Tracker for Global Adjustment Class A (as of 5 April 2018)

Fuel

Figure A-27: Fuel Usage by User Group

Group	Diesel Litres	Unleaded Litres	CNG DLE	Total (DLE)
Energy, Fleet & Facilities	43,219	111,286	-	154,504
Engineering Services	-	39,419	-	39,419
Environmental Services	1,060,757	406,579	-	1,467,336
Hamilton Water	179,777	198,903	-	378,680
Operations	1,278,134	276,077	-	1,554,210
Transportation	88,406	49,140	-	137,546
Other	336,341	963,037	-	1,299,378
Transit	6,417,774	94,007	4,195,759	10,707,540
Totals	9,404,408	2,138,446	4,195,759	15,738,613

Notes for Clarification on above table:

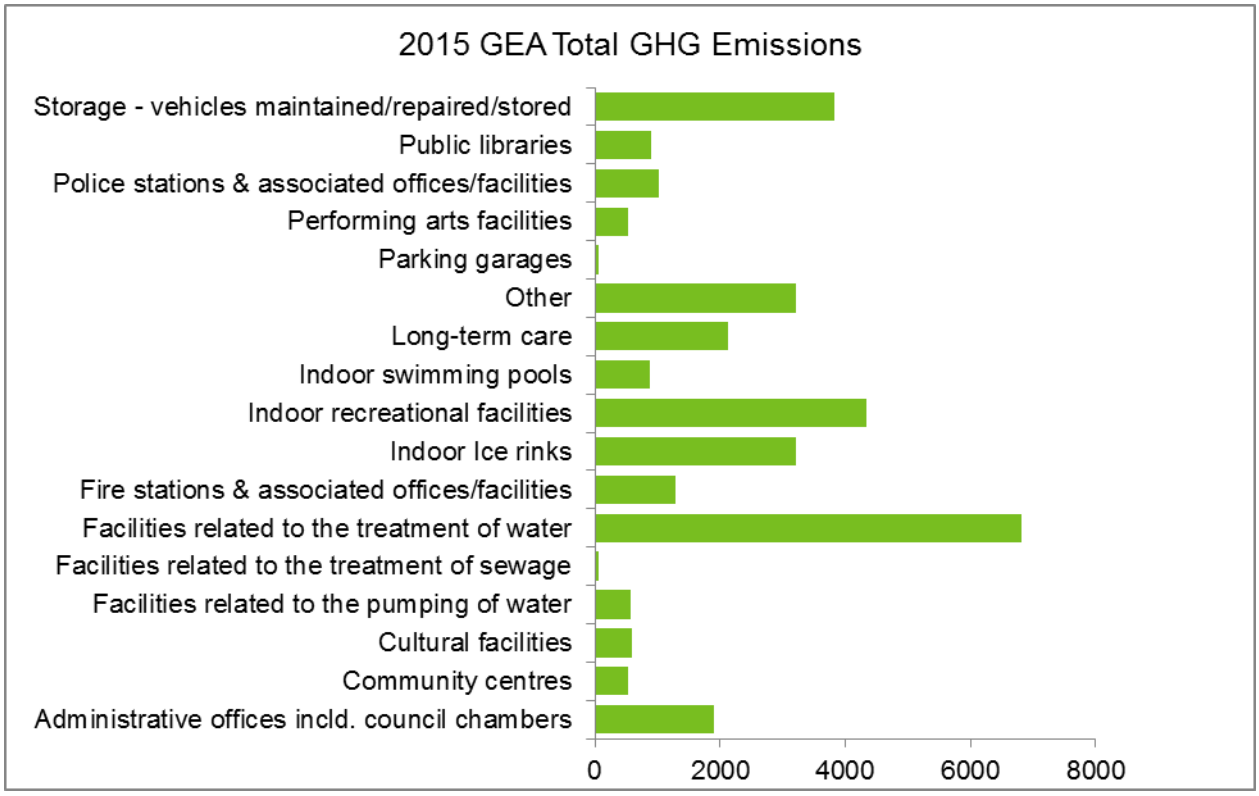
1) Transit Includes Transit Operations, Route Planning and Transit Yard Support.
2) Operations includes Waste Management, Landfill, Roads and Support Services
3) The “Other” group includes Fire and EMS, Public Health, Recreation, Tourism and Culture, Library, By-Law Services, Mayor’s Office, City Clerk’s Office and Information Services.
4) Does not include Police.

Green Energy Act (GEA) Reporting

The City is 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 2015 calendar year, According to the GEA’s reporting formula, the City-owned corporate facilities are responsible for omitting 31,887 tonnes of Carbon dioxide (CO_2e). It should be noted that the GEA facility type reporting categories are pre-set and do vary from the City’s internal reporting categories. However, they do continue to represent corporately-owned assets only.

Figure A-28 below shows the data that was submitted for the 2015 reporting year in the GEA facility categories.

Figure A-28: 2015 GEA Total GHG Emissions Tonnes



For additional information on City of Hamilton energy policies and the relevant reports referenced herein, see: www.Hamilton.ca/energy.

Glossary

Common Acronyms used throughout the report:

CAFE = corporate average fuel economy

CDD = cooling degree days

CNG = compressed natural gas

CO_2 = carbon dioxide

CO_2e = carbon dioxide equivalent

DLE = diesel litre equivalent

ekWh = equivalent kilowatt-hours

GA = Global Adjustment

GEA = Green Energy Act

GHG = greenhouse gas

GJ = gigajoule

HDD = heating degree days

HOEP = Hourly Ontario Energy Price

HRPI = Hamilton Renewable Power Inc.

IESO = Independent Electricity System Operator

KPI = key performance indicator

kW = kilowatt

kWh = kilowatt-hour

LED = light emitting diode

M^3 = cubic metres

OEB = Ontario Energy Board

tCO_2e = tonnes carbon dioxide equivalent

Common concepts used throughout the report:

Energy Performance is the collection of performance measurements including consumption, cost and energy intensity as compared against baseline and year over year.

Energy Intensity is the measurement of energy used per square foot of facility space.

Avoided Cost/Cost Avoidance refers to the costs not incurred as a result of some action taken which is outside of status quo.

Utility Rates refers to the rate classes identified by utility providers.

Rate Optimization refers to ensuring that utility accounts are assigned to the appropriate rate class to result in best cost benefit.

Cost Recovery is the value collected by identifying billing errors, billing anomalies or rates corrections that result in a financial adjustment to costs.

Incentives are monies received from a recognized program including from utility providers, the IESO, Federal or Provincial grant programs where incentives are tied to energy conservation measures.

Energy Conservation is the collection of energy efficient measures, equipment or processes that lead to lower consumption.

Commodity Hedging is the process of fixing prices for specific terms for natural gas, fuels or electricity (commodities).

Unit Cost is the total price of variable and fixed costs per unit. In this report it refers to unit costs of electricity, natural gas and fuels.