2016 Corporate Energy Consumption Report

City of London

July 2017

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London
CANADA

Contents

1. Background

London's Corporate Energy Conservation and Demand Management (CDM) Plan was approved by Council in July 2014. The scope of the CDM Plan covers all forms of energy used by the Corporation of the City of London (referred to as "the Corporation" in the rest of the document). The CDM Plan established a goal to reduce total corporate energy use by ten percent from 2014 levels by 2020.

In August 2011, the provincial government introduced Ontario Regulation 397/11 under the *Green Energy Act*, which requires municipalities, municipal service boards, schools boards, universities, colleges and hospitals to report on facility energy consumption and associated greenhouse gas (GHG) emissions annually beginning in 2013. The scope of this mandatory report was limited to those facilities that:

- are heated or cooled and the public agency is responsible for paying the utility bills; or
- are related to the treatment or pumping of water or sewage and the public agency is responsible for paying the utility bills.

The Ontario Regulation 397/11 reporting requirement does not include significant corporate energy users such as streetlighting and corporate fleet fuel use, nor other needs such as sports field lighting. However, these energy needs are included within the scope of this Corporate Energy Consumption Report as it is imperative that all energy uses and impacts within the Corporation's control are continuously examined for reduction opportunities.

The current report is a follow up to the 2015 Corporate Energy Consumption Report. The total energy consumption in 2016 is compared with two baseline periods, 2007 and 2014. The tracking and monitoring of the Corporation's utility data started in 2007 through the use of EnergyCap software, and 2014 is the baseline year for the CDM Plan submitted to the Province.

Similar to the 2015 report, this information does not include energy use by London's agencies, boards and commissions. Energy use by these agencies is handled by these individual organizations and City staff provides assistance when requested.

2. Corporate Energy Consumption Overview

The 2016 Corporate Energy Consumption Report provides a summary of the Corporation's 2016 annual energy consumption and GHG emissions for all operations. The document summarizes all significant energy costs associated with the Corporation's operations. In addition to the report requirements mandated by the *Green Energy Act and Ontario Regulation 397/11,* information on all energy-consuming infrastructure (e.g., street lighting, sports fields) as well as fleet fuel has been included to provide a complete picture of energy needs for municipal operations. Report highlights include:

- **The Corporation consumed approximately 177 million "equivalent" kilowatt-hours (ekWh) of energy in 2016, a decrease of seven percent from 2014.** This is on track with the CDM Plan goal for a ten percent reduction from 2014 levels by 2020. Over the longer term, total energy use is now 11 percent lower than it was in 2007.

- **In terms of service delivery to Londoners, corporate energy use per person dropped by 18 percent from 2007 levels**. This reduction can be attributed to recent energy conservation measures and facility upgrades:

    - Wastewater treatment energy use per person has decreased by 26 percent
    - Water pumping energy use per person has decreased by 24 percent
    - Building energy use per person has decreased by 16 percent
    - Streetlights energy use per person decreased by 15 percent due to recent LED upgrades in 2015 and 2016
    - Vehicle Fleet energy use per person decreased by one percent

- **Total energy cost in 2016 increased to almost $21 million** with the increase primarily due to rising electricity prices. Total electricity costs have risen by 84 percent since 2007 (unadjusted for inflation) even though total electricity use actually dropped by two percent over that period. It is important to note that:

    - Energy costs would have been $2.1 million higher in 2016 if the energy efficiencies noted above were not in place.
    - In 2016, the Corporation spent approximately $7 million in capital investments related to energy–efficiency projects. These investments create energy savings every year over the life of the investment.

- **Energy cost per person was $54 in 2016**. Dividing the Corporation's total energy cost by London's population provides an indication of the relative contribution of energy costs associated with service delivery. Energy cost per person has been increasing each year. From 2015 to 2016 alone it increased to $54 from $50 (6 percent increase). Therefore, sustained energy reductions become more important each year as each unit of energy consumed becomes more expensive with rising energy prices.

- **Energy-related greenhouse gas emissions in 2016 were 60 percent lower than 2007.** The Corporation's improvement in energy efficiency accounts for about 25 percent of this reduction. In particular, the new centrifugal sludge dewatering system at the Greenway Wastewater Treatment Plant's sludge incinerator, installed in 2014-2015, resulted in a significant reduction in natural gas at that facility. The remaining 75 percent of the reduction comes from Ontario's actions to replace coal-fired power plants with cleaner forms of power generation. About 90 percent of Ontario's electricity is now generated from emissions-free sources, such as nuclear, hydro-electric generating stations, wind and solar. In 2016, every 1,000 kilowatt-hours of electricity generated in Ontario produced about 30 kilograms of carbon dioxide emissions. This is significantly better than it was in 2007, when 1,000 kilowatt-hours of electricity produced around 240 kilograms of carbon dioxide emissions.

2.1 Methods of Measurement

The Corporation procured EnergyCap software in 2007 to log monthly utility bills for municipally-owned and administered buildings and facilities. This software has the capability to track, monitor and capture data to assist the Corporation with reporting consumption and providing historical data. EnergyCap tracks data in the following Municipal Service Categories: Buildings; Traffic Signals & Streetlights; Wastewater & Treatment and Water Pumping.

Fleet data is provided from its software system PetroVend which is used for tracking vehicle fuelling at Operation Centers.

2.2 Limitations of Measurement

The annual energy consumption and greenhouse gas emissions for the Corporation does not include energy consumed in leased office space where the utility costs are incorporated in the leasing agreements.

Annual transportation fuel consumption and GHG emissions for the Corporation do not include fuel consumption and emissions produced from the use of personal vehicles, railway or air travel for work related tasks by staff or by contracted services by the Corporation.

3. Conservation and Demand Management (CDM) Goal Update

The introduction of CDM Plan provided the Corporation with an opportunity to review its energy management program initiatives and proposed energy targets. The Plan was developed according to Ministry of Energy's direction to provide the Corporation's annual energy consumption information to the public and set goals and actions for conserving energy and reducing GHG emissions from 2014 to 2020.

A series of past energy activities, programs, utility consumption and documents were analyzed to understand the Corporation's standing in energy management and to set a CDM target. The approach was to set a target achievable by continuing to implement short term initiatives, adopt energy conservation resources into existing capital investments already assigned, explore incentive opportunities towards energy project initiatives, review long term initiatives that have significant impacts on energy consumption and GHG emissions, and deepen the culture of conservation within the Corporation's operations.

The Corporation's proposed CDM goal is to achieve a ten percent reduction in overall annual energy by 2020. The baseline year is 2014. Tied to this goal are:

- A total energy use reduction of 30 million ekWh below 2020 Business-As-Usual (BAU) projections.
- A 15 percent (76 ekWh/person) improvement in energy efficiency based on the projected population in 2020.
- A total GHG emission reduction of 3,900 tonnes per year below 2020 BAU projections.
- An energy cost avoidance of $4 million below 2020 BAU projections.

In order to achieve this goal of a ten percent reduction by 2020, 35 technical and non-technical actions were prioritized to contribute to overall reductions. All actions were identified under four prescribed categories as follows:

- Tracking and Monitoring Measures
- Technical Measures
- Organizational Measures
- Behavioral Measures

Identified in Table 1 is the Corporation's progress towards the CDM goals.

Table 1 - CDM Plan Target Tracking

	2014 (Baseline)	2020 Business-As-Usual (BAU) Projection	2020 Reduction Target	Progress as of end of 2016	Notes
Primary CDM Plan Goal					
Reduction in total energy use from 2014 baseline	-	Up by 4.5%	Down by 10%	Down by 7%	• Corporation more than half way towards the CDM 2020 target of 10% reduction.
Secondary Goals (as stated in the CDM Plan)					
Influenced by City's actions					
Total Energy use (million ekWh)	191.5	200.1	170.1 (30 million ekWh reduced compared to 2020 BAU)	177.1	• A reduction of 23 million ekWh in 2016 compared to 2020 BAU (on track).
Energy Performance (ekWh/person)	511	508	432 (76 ekWh reduced compared to 2020 BAU)	462	• Reduction of 46 ekWh/person in 2016 to 2020 BAU (on track). • Overall 9% improvement in energy efficiency compared to 2014 baseline year.
Influenced by external factors					
Energy-related GHG emissions (tonnes)	26,000	28,400	24,500 (3,900 tonnes reduced compared to 2020 BAU)	18,000	• GHG reduction has exceeded CDM Plan target. • 75% of this reduction is due to Ontario electricity grid going green (see section 6 of this report)
Total Energy Costs (millions)	$18.75	$26.70	$22.70 ($4 million in energy cost avoidance to 2020 BAU)	$20.58	• 2016 cost are $6.1 million below 2020 BAU projection. • The 2020 BAU projections have not been adjusted to reflect the dramatic decrease in petroleum fuel prices in 2015 and 2016. • Annual increase in electricity costs make it challenging to reduce overall energy costs. • The increase in energy cost would be significantly higher without the implementation of efficiency measures. • There was a total of 24% increase in electricity cost from 2014 to 2016, but the overall energy cost increase for the Corporation is just over 10%.

Overall, The Corporation's performance in 2016 is on track with the CDM goal. A complete update of all actions (complete or in progress) will be provided as part of the 2016 Corporate Energy Management Activities Update report.

4. Corporate Energy Annual Summary

In 2016, the Corporation's energy use is categorized by consumption and the total cost of annual energy procured by commodity. Currently the Corporation is capable of tracking annual electricity, natural gas, steam, chilled water, diesel and gasoline consumptions and costs. This allows the Corporation to show the variances in costs associated with consumption.

The Corporation has averaged the 2016 energy consumptions and cost data in comparison to London's population. This allows the Corporation to demonstrate and relay to Londoners the energy consumed in relationship to service delivery provided by the Corporation.

As noted in section 1, total energy consumption in 2016 is compared with two reporting periods, 2007 and 2014. The tracking and monitoring of utility data was made possible in 2007 through EnergyCap software and is used here for comparison, and 2014 is the baseline year for the CDM Plan.

4.1 Total Corporate Energy Consumption

With the use of the EnergyCap software, the Corporation has ability to breakdown and report annual energy consumption by the commodity and by municipal service category.

4.1.1 Energy Consumption by Commodity

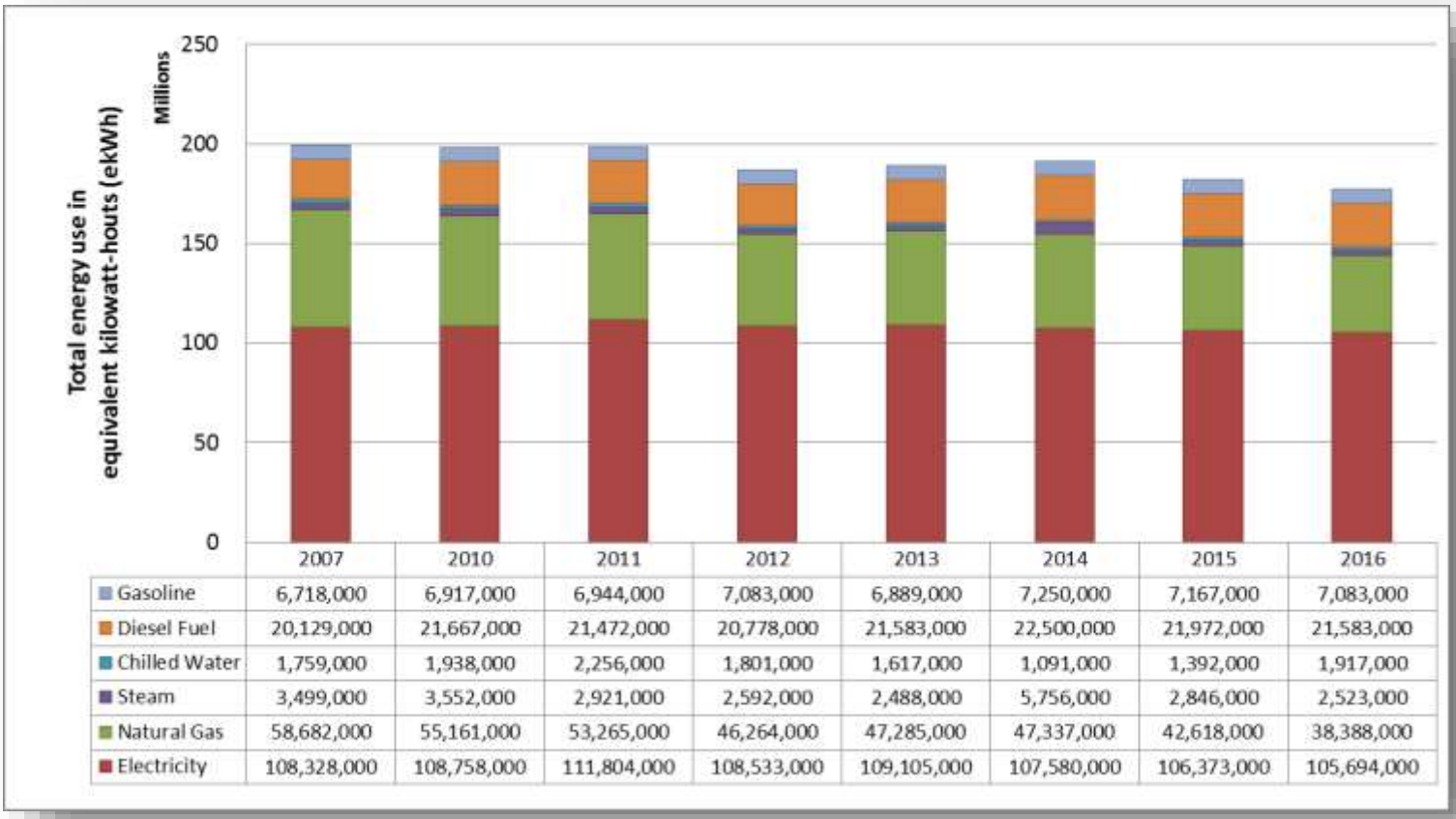
Table 2 – Consumption by Commodity Comparison 2014 – 2016 (CDM baseline tracking)

Energy Consumption (ekWh)	2014	2016	Variance	% Change
Electricity	107,580,000	105,694,000	(1,886,000)	-2%
Natural Gas	47,337,000	38,388,000	(8,949,000)	-19%
Steam	5,756,000	2,523,000	(3,233,000)	-56%
Chilled Water	1,091,000	1,917,000	826,000	76%
Diesel Fuel	22,500,000	21,583,000	(917,000)	-4%
Gasoline	7,250,000	7,083,000	(167,000)	-2%
Total	**191,514,000**	**177,188,000**	**(10,826,000)**	**-7%**

In comparison to 2014, the Corporation's total energy consumption and percentage of usage by commodity has shown a seven percent reduction in 2016 as shown in Table 2. It is important to note that there was a significant decrease in steam usage in this period as the Colborne Building was idled and there was also a drop in steam usage measurement associated with a meter issue at the J. Allen Taylor building.

Furthermore, 2016 summer being the warmest in past five years, chilled water consumption has also increased significantly.

Figure 1 – Total Energy Consumption by Commodity



	2007	2010	2011	2012	2013	2014	2015	2016
Gasoline	6,718,000	6,917,000	6,944,000	7,083,000	6,889,000	7,250,000	7,167,000	7,083,000
Diesel Fuel	20,129,000	21,667,000	21,472,000	20,778,000	21,583,000	22,500,000	21,972,000	21,583,000
Chilled Water	1,759,000	1,938,000	2,256,000	1,801,000	1,617,000	1,091,000	1,392,000	1,917,000
Steam	3,499,000	3,552,000	2,921,000	2,592,000	2,488,000	5,756,000	2,846,000	2,523,000
Natural Gas	58,682,000	55,161,000	53,265,000	46,264,000	47,285,000	47,337,000	42,618,000	38,388,000
Electricity	108,328,000	108,758,000	111,804,000	108,533,000	109,105,000	107,580,000	106,373,000	105,694,000

Figure 1 is a representation of energy consumption (ekWh) for the overall commodity usage since 2007.

The commodity consumption trend indicates that consumption remained relatively unchanged for the Corporation until 2012. In 2012, the Corporation reduced consumptions across all commodities. Further from 2012 to 2016, there is a four percent decrease in total consumption. Since 2007, London's population has increased by about eight percent, which means that corporate energy efficiency (in terms of energy used per person in London) improved by 18 percent over the ten year period. Compared to the CDM baseline year 2014, the results indicate an overall ten percent improvement in energy efficiency.

It is also important to note that differences in annual weather conditions will impact energy needs, as this will impact building air conditioning and space heating needs as well as pumping and treatment requirements for water supply and wastewater. In 2014, the natural gas and steam consumption were high due to extreme cold winter that year (i.e., the "Polar Vortex"). In comparison, 2016 was warmer than normal, which resulted in relatively lower natural gas and steam use and higher chilled water usage.

In Table 3, energy consumption by commodity are compared to 2007 values, along with the percentage of changes.

Table 3 – Energy Consumption by Commodity 2007-2016

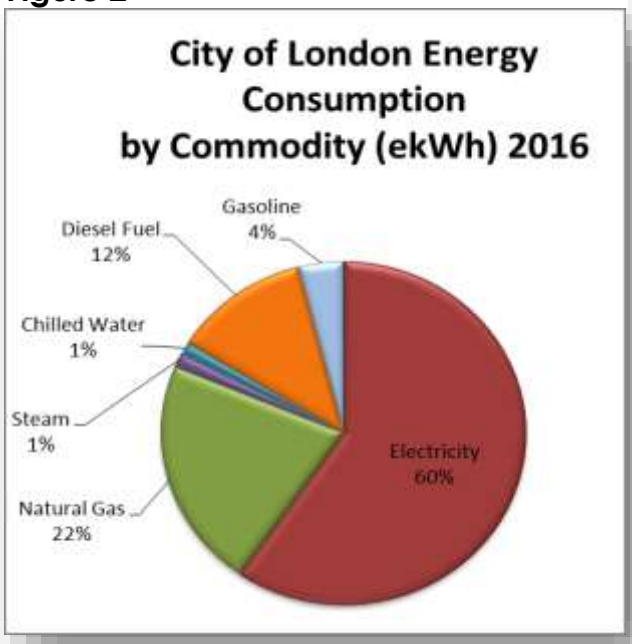
Energy Consumption (ekWh)	2007	2016	Variance	% Change
Electricity	108,328,000	105,694,000	(2,634,000)	-2%
Natural Gas	58,682,000	38,388,000	(20,294,000)	-35%
Steam	3,499,000	2,523,000	(976,000)	-28%
Chilled Water	1,759,000	1,917,000	158,000	9%
Diesel Fuel	20,129,000	21,583,000	1,454,000	7%
Gasoline	6,718,000	7,083,000	365,000	5%
Total	**199,115,000**	**177,188,000**	**(21,927,000)**	**-11%**

Table 3 illustrates that electricity, natural gas and steam energy consumption has been decreasing, whereas transportation fuel consumption has been growing at a pace consistent with London's growth. In 2016 due to warmer weather, chilled water consumption has also increased to nine percent. As noted previously, a steam meter issue at the J. Allen Taylor building resulted in lower than actual steam usage being recorded for the facility.

In summary:

- Electricity represents the majority of the corporation's energy consumption, accounting for 60% of overall needs.
- Natural gas consumption accounts for 22% overall energy needs.
- Diesel remains the most prominent fuel used within the Corporation's vehicle fleet, given the large number of heavy-duty vehicles in operation. The total fleet units also tend to increase year over year with London's expansion.

Figure 2



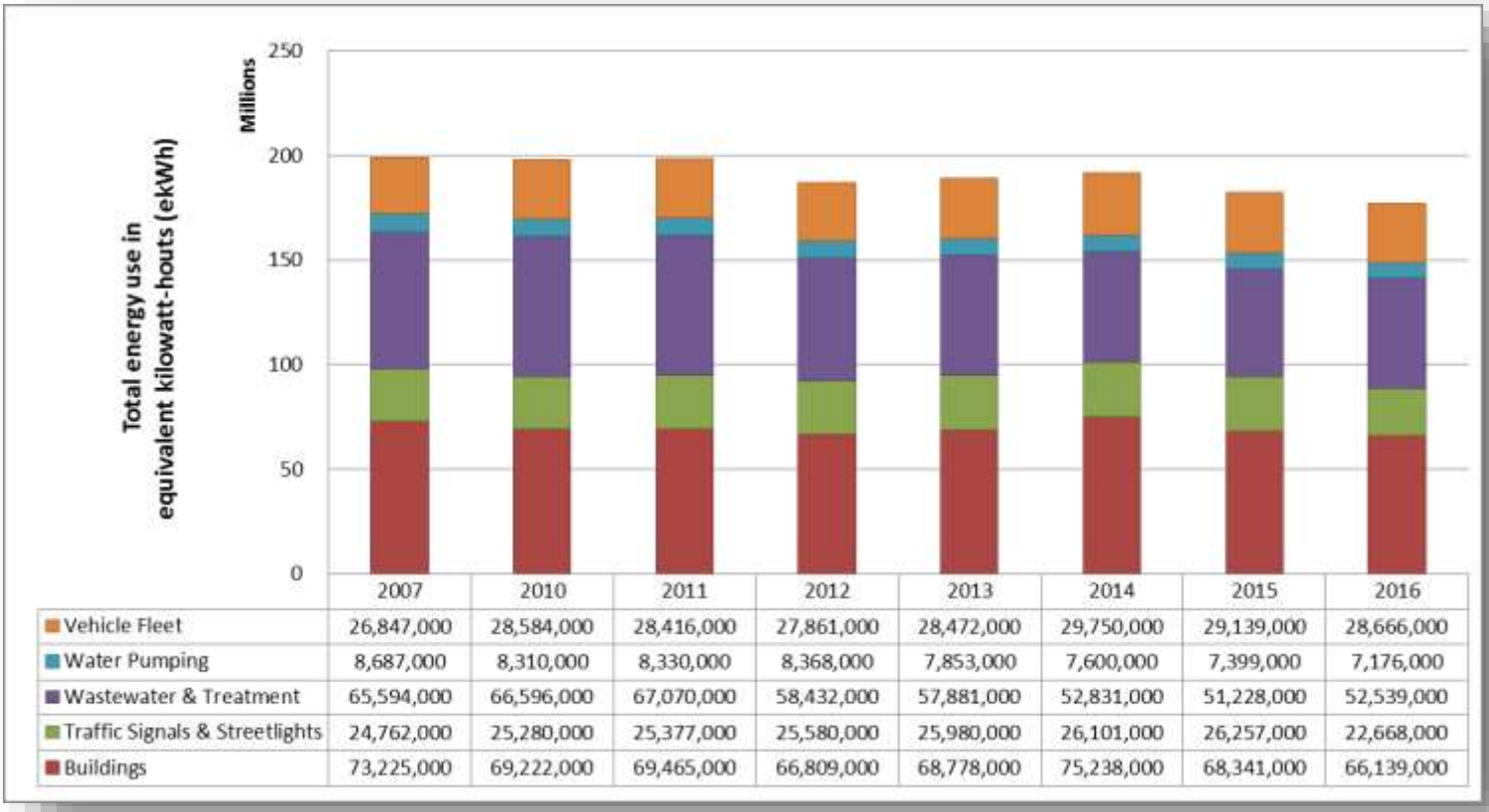
4.1.2 Energy Consumption by Municipal Service Categories

Table 4 – Consumption by Municipal Service Categories Comparison 2014 – 2016 (CDM baseline tracking)

Energy Consumption (ekWh)	2014	2016	Variance	% Change
Buildings	75,238,000	66,139,000	(9,099,000)	-12%
Traffic Signals & Streetlights	26,101,000	22,668,000	(3,433,000)	-13%
Wastewater & Treatment	52,831,000	52,539,000	(292,000)	-1%
Water Pumping	7,600,000	7,176,000	(424,000)	-6%
Vehicle Fleet	29,750,000	28,666,000	(1,084,000)	-4%
Total	**191,520,000**	**177,188,000**	**(18,427,000)**	**-6%**

Table 4 shows the Corporation's total energy consumption by municipal service categories in 2016 compared to the CDM Plan's baseline year of 2014. By separating the municipal service categories, this gives the Corporation the ability to see areas where progress is being made and the opportunity to target areas for future improvements.

Figure 3 – Total Energy Consumption by Municipal Service Categories



	2007	2010	2011	2012	2013	2014	2015	2016
Vehicle Fleet	26,847,000	28,584,000	28,416,000	27,861,000	28,472,000	29,750,000	29,139,000	28,666,000
Water Pumping	8,687,000	8,310,000	8,330,000	8,368,000	7,853,000	7,600,000	7,399,000	7,176,000
Wastewater & Treatment	65,594,000	66,596,000	67,070,000	58,432,000	57,881,000	52,831,000	51,228,000	52,539,000
Traffic Signals & Streetlights	24,762,000	25,280,000	25,377,000	25,580,000	25,980,000	26,101,000	26,257,000	22,668,000
Buildings	73,225,000	69,222,000	69,465,000	66,809,000	68,778,000	75,238,000	68,341,000	66,139,000

Figure 3 represents the overall energy consumption (ekWh) by the municipal service categories since 2007.

In Table 5 below, further detailed energy consumption by municipal service categories in comparison to 2007 values is shown, along with the percentage of change.

Table 5 – Energy Consumption by Municipal Service Categories 2007 – 2016

Energy Consumption (ekWh)	2007	2016	Variance	% Change
Buildings	73,225,000	66,139,000	(7,086,000)	-10%
Traffic Signals & Streetlights	24,762,000	22,668,000	(2,094,000)	-8%
Wastewater & Treatment	65,594,000	52,539,000	(13,055,000)	-20%
Water Pumping	8,687,000	7,176,000	(1,511,000)	-17%
Vehicle Fleet	26,847,000	28,666,000	1,819,000	7%
Total	**199,115,000**	**177,188,000**	**(21,927,000)**	**-11%**

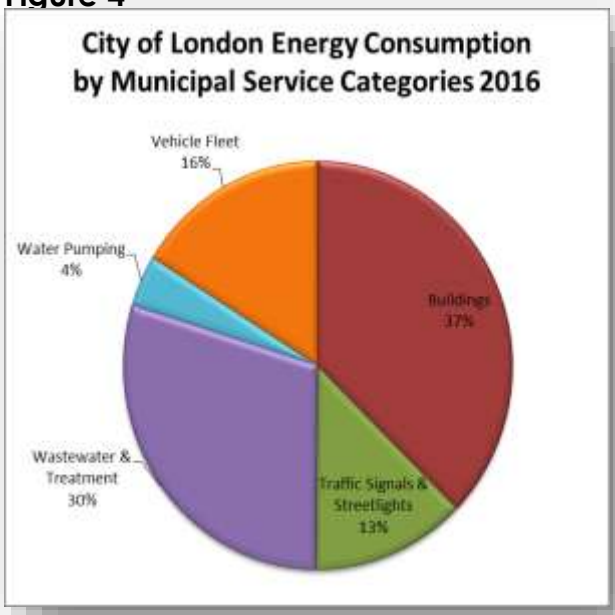
In terms of municipal service categories, there has been significant reduction in energy use within wastewater and treatment. Process retrofit actions undertaken by Wastewater Treatment Operations include the sludge dewatering at the Greenway Wastewater Treatment Plant sludge incinerator, as well as the replacement of aeration blowers at a number of wastewater treatment plants. Water Supply has also made improvements to water pumping infrastructure. The impact of building retrofits undertaken by Facilities is also evident. Also, in 2016, for the first time a reduction of eight percent occurred in traffic signals and streetlights due to LED lighting upgrades in fall 2015 and winter 2016.

Vehicle fleet fuel use tends to grow as London has grown.

In summary:

- Buildings (37%) and wastewater & treatment (30%) hold the highest percentage of demand for energy consumption for the Corporation.
- Combined, Vehicle fleet (16%) and traffic signals & streetlights (13%) result in about one third of energy consumptions.
- Water pumping (4%) remains the lowest end user contributor in energy consumption demands.

Figure 4



4.1.3 Total Corporate Energy Consumption Per Capita by Municipal Service Categories

The Corporation's energy consumption is a direct function of serving the public, businesses and visitors to London. The trends in consumption reported is significant to the services provided to the community. London continues to grow in population and increased services are generally required to support that growth. It is important to capture energy usage per capita to demonstrate the Corporation's achievements in energy reductions while continued growth occurs in London.

Table 6 – Energy Consumption Per Capita 2014 – 2016 (CDM baseline tracking)

Energy Consumption (ekWh) by Municipal Service Categories	2014	2016	Change from 2014 Variance	% Change
Buildings	75,238,000	66,139,000	(9,099,000)	-12%
Traffic Signals & Streetlights	26,101,000	22,668,000	(3,433,000)	-13%
Wastewater & Treatment	52,831,000	52,539,000	(292,000)	-1%
Water Pumping	7,600,000	7,176,000	(424,000)	-6%
Vehicle Fleet	29,750,000	28,666,000	(1,084,000	-4%
Total	**191,520,000**	**177,188,000**	**(10,832,000)**	**-7%**
London's Population	**375,000**	**383,822**	**8,822**	**2.3%**
Energy Use (ekWh) per person	**511**	**462**	**(49)**	**-9%**

In 2016, the Corporation improved energy efficiency by over nine percent illustrated in Table 6 above. Decreases in commodity use suggests that corporate initiatives and programs currently in place to reduce consumption act as a counterbalance to the additional increases of demand for energy due to London's growth. London's population increased by two percent in 2016 from 2014, while corporate energy use decreased by over seven percent from 2014.

Table 7 – Energy Consumption Per Capita 2007 – 2016

Energy Consumption (ekWh) by Municipal Service Categories	2007	2016	Change since 2007 Variance	% Change
Buildings	73,225,000	66,139,000	(7,086,000)	-10%
Traffic Signals & Streetlights	24,762,000	22,668,000	(2,094,000)	-8%
Wastewater & Treatment	65,594,000	52,539,000	(13,055,000)	-20%
Water Pumping	8,687,000	7,176,000	(1,511,000)	-17%
Vehicle Fleet	26,847,000	28,666,000	1,819,000	7%
Total	**199,115,000**	**177,188,000**	**(21,927,000)**	**-11%**
London's Population	**355,000**	**383,000**	**28,000**	**8%**
Energy Use (ekWh) per person	**561**	**462**	**(99)**	**-18%**

Table 7 above indicates the corporate energy consumption per capita by municipal service categories in comparison to 2007. London's population has grown by almost eight percent (28,000 people) since 2007. Ten years of data shows continued improvement of corporate energy use per capita with an overall reduction of 18 percent in 2016 compared to 2007.

4.1.4 Total Corporate Energy Consumption Summary

Overall, the Corporation reduced its energy consumption by 11 percent from 2007 levels. This reduction suggests that corporate initiatives currently in place to decrease consumption on existing and new infrastructure act as a counterbalance to the additional increases of demand for energy due to London's growth.

4.2 Total Corporate Energy Costs

With the use of the EnergyCap software, the Corporation has the ability to breakdown and report annual energy costs by the commodity and by municipal service category.

In 2016 the Corporation (not including Agencies, Boards & Commissions) spent approximately $20,580,000 on energy. This represents about two percent of the Corporation's operating budget for 2016.

4.2.1 Energy Costs by Commodity

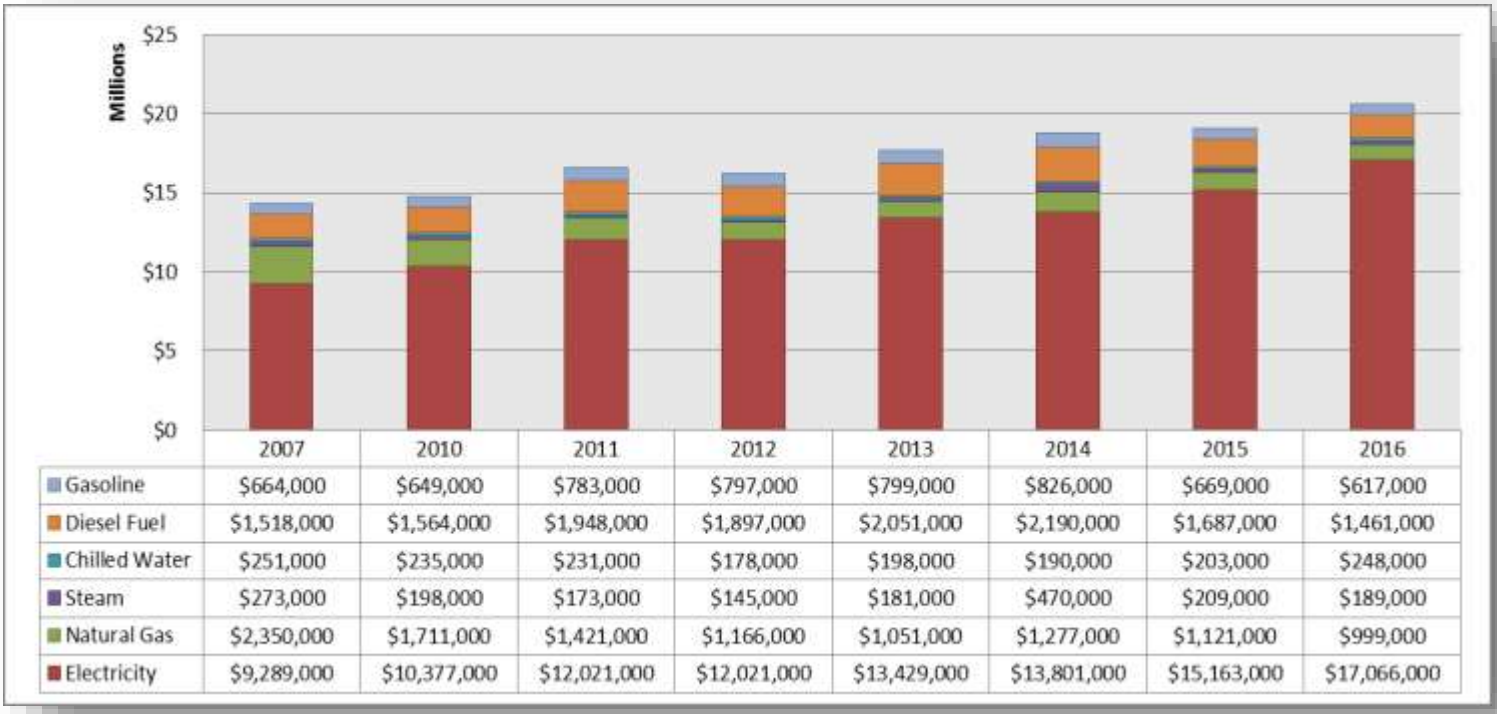
Table 8 – Energy Costs by Commodity Comparison 2014 – 2016

Energy Cost by Commodity	2014	2016	Change Since 2014 Variance	% Change
Electricity	$ 13,801,000	$ 17,066,000	$ 3,265,000	24%
Natural Gas	$ 1,277,000	$ 999,000	$ (278,000)	-22%
Steam	$ 470,000	$ 189,000	$ (281,000)	-60%
Chilled Water	$ 190,000	$ 248,000	$ 58,000	31%
Diesel Fuel	$ 2,190,000	$ 1,461,000	$ (729,000)	-33%
Gasoline	$ 826,000	$ 617,000	$ (209,000)	-25%
Total	**$ 18,754,000**	**$ 20,580,000**	**$ 1,826,000**	**10%**

In 2016, the Corporation's energy cost by commodity results indicate an approximate increase by ten percent from 2014 as illustrated in Table 8. Electricity prices have been rising year over year. Electricity

costs in total have risen by 24 percent even though total electrical consumption dropped by two percent.

Figure 5 – Total Energy Costs by Commodity



	2007	2010	2011	2012	2013	2014	2015	2016
Gasoline	$664,000	$649,000	$783,000	$797,000	$799,000	$826,000	$669,000	$617,000
Diesel Fuel	$1,518,000	$1,564,000	$1,948,000	$1,897,000	$2,051,000	$2,190,000	$1,687,000	$1,461,000
Chilled Water	$251,000	$235,000	$231,000	$178,000	$198,000	$190,000	$203,000	$248,000
Steam	$273,000	$198,000	$173,000	$145,000	$181,000	$470,000	$209,000	$189,000
Natural Gas	$2,350,000	$1,711,000	$1,421,000	$1,166,000	$1,051,000	$1,277,000	$1,121,000	$999,000
Electricity	$9,289,000	$10,377,000	$12,021,000	$12,021,000	$13,429,000	$13,801,000	$15,163,000	$17,066,000

The total energy cost by commodity illustrated in Figure 5 is a representation of the energy overall cost by commodity per year since 2007.

The cost by commodity trend indicates the costs for energy continue to rise for the Corporation. In 2016, the Corporation's total commodity costs increased significantly over the past two years. There was significant price changes in energy commodities in 2016, with a 24 percent increase in electricity costs, this was offset by a 22 percent decrease in natural gas costs and a 33 percent decrease in diesel fuel costs due to the global decline in oil prices. This resulted in an overall ten percent increase in energy costs for the Corporation.

In Table 9, further detailed energy consumption by commodity to 2007 values are shown, along with the percentage of changes.

Table 9 – Energy Costs by Commodity 2007 – 2016

			Change Since 2007	
Energy Cost by Commodity	**2007**	**2016**	**Variance**	**% Change**
Electricity	$ 9,289,000	$ 17,066,000	$ 7,777,000	84%
Natural Gas	$ 2,350,000	$ 999,000	$ (1,351,000)	-57%
Steam	$ 273,000	$ 189,000	$ (84,000)	-31%
Chilled Water	$ 251,000	$ 248,000	$ (3,000)	-1%
Diesel Fuel	$ 1,518,000	$ 1,461,000	$ (57,000)	-4%
Gasoline	$ 664,000	$ 617,000	$ (47,000)	-7%
Total	**$ 14,345,000**	**$ 20,580,000**	**$ 6,235,000**	**43%**

Over this longer period (Table 9), the dramatic changes in corporate energy costs are evident:

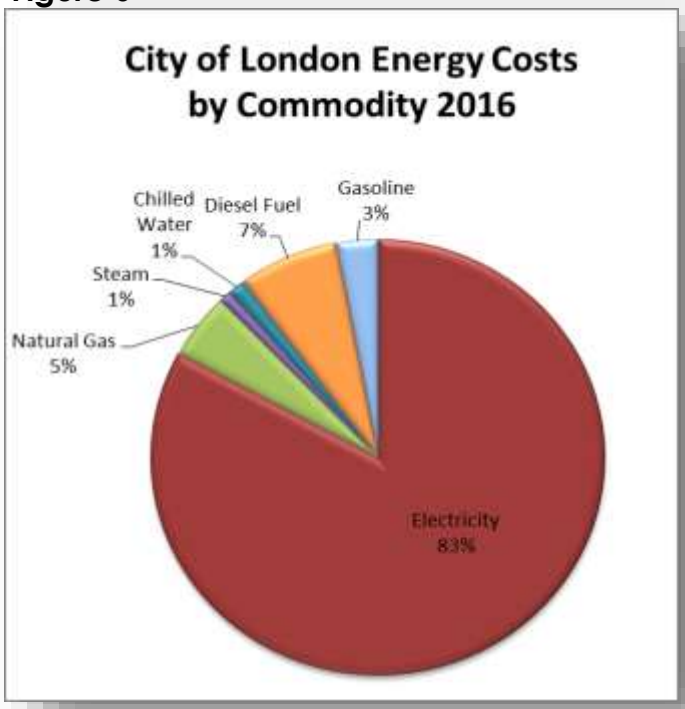
- Reduced natural gas costs due to the combination of lower use and lower natural gas prices
- Increased electricity costs driven solely by electricity prices since corporate electricity use has actually dropped by two percent

Given that electricity is the biggest source of energy the Corporation uses, the total combined costs are noticeably higher today (by 43 percent) compared to 2007.

In summary:

- Electricity represents the majority of the Corporation's energy costs, accounting for 83% in 2016.
- Natural gas consumption accounts for 5% of overall energy costs in 2016.
- Diesel is the largest fuel type used within the City's vehicle fleet, given the large number of heavy-duty vehicles the Corporation operates.

Figure 6



4.2.2 Energy Costs by Municipal Service Categories

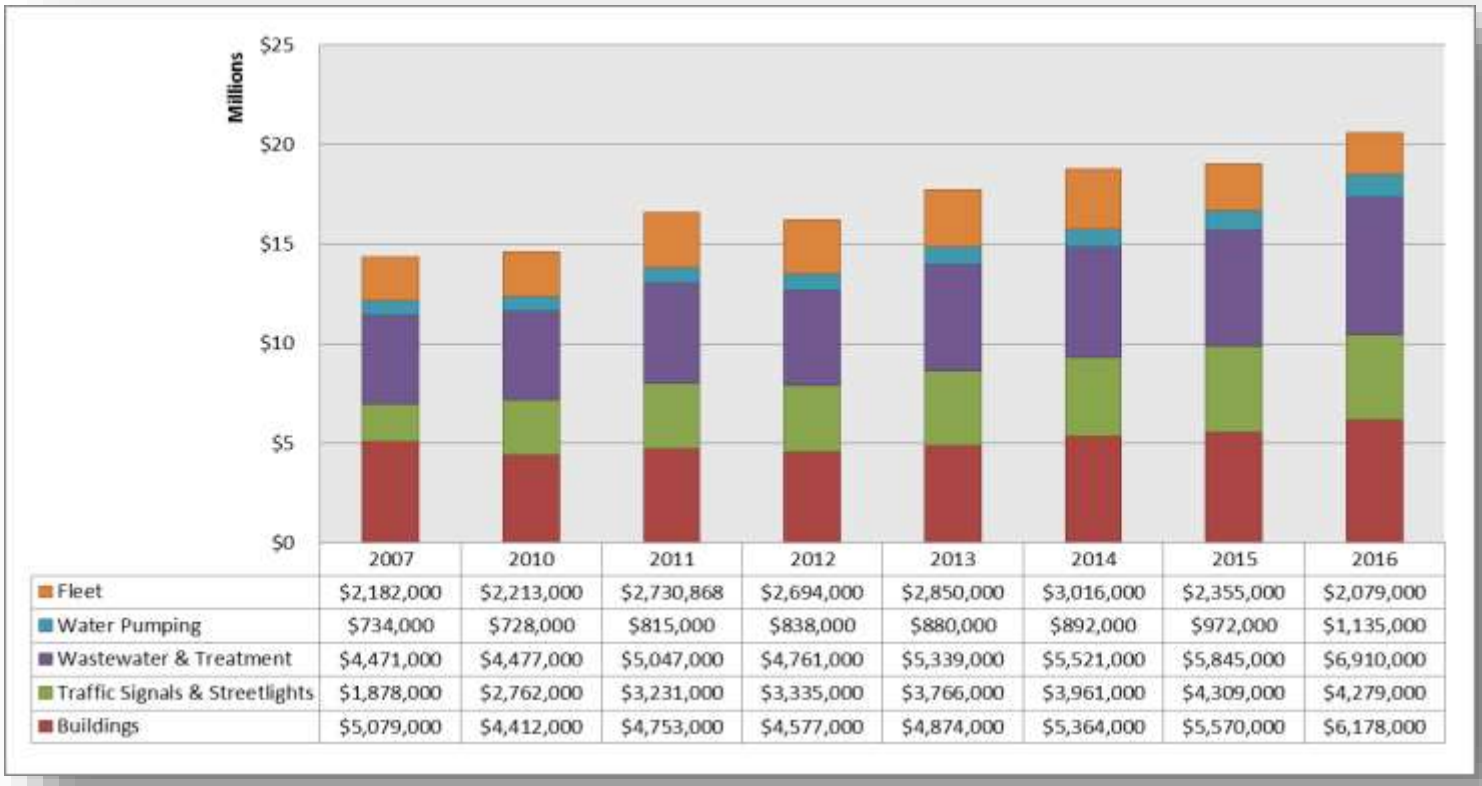
Though there was an increase in electricity prices in 2016 as noted in Table 8, the decrease in natural gas and diesel fuel costs by 22 percent and 33 percent resulted in overall commodity cost increase of only ten percent in 2016 (Table 10). This would be even higher if there was no change in diesel costs and consumption. Diesel and gasoline market prices have dropped to the lowest level in 2015 compared to last nine years.

Table 10 – Energy Costs by Municipal Service Categories Comparison 2014 – 2016

Energy Cost by Municipal Service Categories	2014	2016	Change since 2014 Variance	Change since 2014 % Change
Buildings	$ 5,364,000	$ 6,178,000	$ 814,000	15%
Traffic Signals & Streetlights	$ 3,961,000	$ 4,279,000	$ 318,000	8%
Wastewater & Treatment	$ 5,521,000	$ 6,910,000	$ 1,389,000	25%
Water Pumping	$ 892,000	$ 1,135,000	$ 243,000	27%
Vehicle Fleet	$ 3,016,000	$ 2,079,000	$ (937,000)	-31%
Total	**$ 18,754,000**	**$ 20,581,000**	**$ 1,827,000**	**10%**

Figure 7 is a representation of the energy overall cost by municipal service categories per year since 2007.

Figure 7 – Total Energy Cost by Municipal Service Categories



	2007	2010	2011	2012	2013	2014	2015	2016
Fleet	$2,182,000	$2,213,000	$2,730,868	$2,694,000	$2,850,000	$3,016,000	$2,355,000	$2,079,000
Water Pumping	$734,000	$728,000	$815,000	$838,000	$880,000	$892,000	$972,000	$1,135,000
Wastewater & Treatment	$4,471,000	$4,477,000	$5,047,000	$4,761,000	$5,339,000	$5,521,000	$5,845,000	$6,910,000
Traffic Signals & Streetlights	$1,878,000	$2,762,000	$3,231,000	$3,335,000	$3,766,000	$3,961,000	$4,309,000	$4,279,000
Buildings	$5,079,000	$4,412,000	$4,753,000	$4,577,000	$4,874,000	$5,364,000	$5,570,000	$6,178,000

The trend in cost by municipal service categories indicate that there is a steady increase in energy costs since 2010. Fleet fuel costs are largely a factor of global prices for transportation fuels, which has seen significant price volatility in the last couple of years.

The new Organic Rankine Cycle (ORC) project proposed at the Greenway Wastewater Treatment Plant (WWTP) to generate electricity using waste heat and the LED lighting project for street lights which are planned to be completed in next year should contribute towards avoided costs in the coming years.

In Table 11, further detailed energy costs by municipal service categories in comparison to 2007 values is shown, along with the percentage of changes.

Table 11 – Energy Costs by Municipal Service Categories 2007 – 2016

Energy Cost by Municipal Service Categories	2007	2016	Change since 2007 Variance	Change since 2007 % Change
Buildings	$ 5,079,000	$ 6,178,000	$ 1,099,000	22%
Traffic Signals & Streetlights	$ 1,878,000	$ 4,279,000	$ 2,401,000	128%
Wastewater & Treatment	$ 4,471,000	$ 6,910,000	$ 2,439,000	55%
Water Pumping	$ 734,000	$ 1,135,000	$ 401,000	55%
Vehicle Fleet	$ 2,182,000	$ 2,079,000	$ (103,000)	-5%
Total	**$ 14,344,000**	**$ 20,581,000**	**$ 6,237,000**	**43%**

Those municipal service categories that rely on electricity have seen the highest increases in costs:

- Increased water pumping and wastewater treatment energy costs by 55% each compared to 2007.

- Increased traffic signals & streetlight costs by 128% compared to 2007.

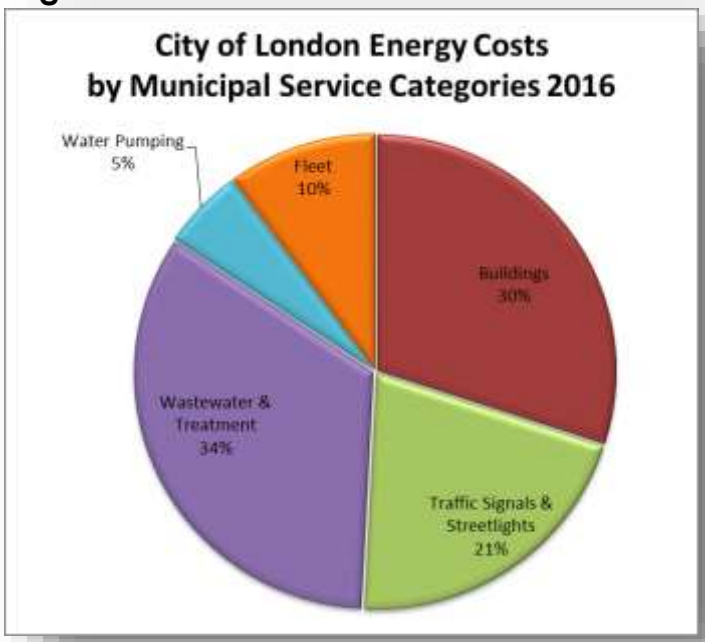
In summary:

- Wastewater & treatment represents majority of the Corporation's energy cost by service area, accounting to 34% in 2016.

- Buildings continue to account for 30% of overall end user energy costs.

- Street lighting & traffic signals are the third highest contributor in energy consumed by end user at 21%.

Figure 8



4.2.3 Energy Costs Per Capita

The operation, maintenance and services provided by the Corporation contribute to the overall corporate energy costs associated with serving the public, businesses and visitors of London.

Table 12 – Energy Costs Per Capita 2014 – 2016

Energy Costs by Municipal Service Categories	2014	2016	Change from 2014 Variance	% Change
Buildings	$ 5,364,000	$ 6,178,000	$ 814,000	15%
Traffic Signals & Streetlights	$ 3,961,000	$ 4,279,000	$ 318,000	8%
Wastewater & Treatment	$ 5,521,000	$ 6,910,000	$ 1,389,000	25%
Water Pumping	$ 892,000	$ 1,135,000	$ 243,000	27%
Fleet	$ 3,016,000	$ 2,079,000	$ (937,000)	-31%
Total	**$ 18,754,000**	**$ 20,581,000**	**$ 2,130,000**	**10%**
London's Population	**375,000**	**383,000**	**8,000**	**2.1%**
Energy costs per person	**$ 50**	**$ 54**	**$ 4**	**8%**

Table 12 reflects the corporate energy costs per capita by municipal service categories for the Corporation.

The total energy costs for the Corporation has increased by ten percent, but given that energy use was actually six percent lower in 2016 versus 2014, this shows that Corporate energy initiatives are helping to reduce the impact of rising electricity prices.

Table 13 – Energy Costs per Capita by Municipal Service Categories 2007 – 2016

Energy Costs by End User	2007	2016	Change since 2007 Variance	Change since 2007 % Change
Buildings	$ 5,079,000	$ 6,178,000	$ 1,099,000	22%
Traffic Signals & Streetlights	$ 1,878,000	$ 4,279,000	$ 2,401,000	128%
Wastewater & Treatment	$ 4,471,000	$ 6,910,000	$ 2,439,000	55%
Water Pumping	$ 734,000	$ 1,135,000	$ 401,000	55%
Fleet	$ 2,182,000	$ 2,079,000	$ (103,000)	-5%
Total Corporation	**$ 14,344,000**	**$ 20,581,000**	**$ 6,237,000**	**43%**
London's Population	**355,000**	**383,000**	**28,000**	**8%**
Energy costs per person	**$ 40**	**$ 54**	**$ 14**	**35%**

London's population has grown by eight percent (28,000 people) since 2007. Table 13 above indicates the corporate energy costs per capita by municipal service categories in comparison to 2007. Ten years of commodity data shows continued energy cost increases for corporate energy with an overall increase of 35 percent in corporate energy cost per capita from 2007.

4.2.4 Total Corporate Energy Costs Summary

Total corporate energy costs continue to increase - with the price of electricity in Ontario being the major contributor. However, corporate energy management practices by the Corporation including cost avoidance measures through procurement, building retrofits, and other conservation measures assist in continued efforts to reduce amounts of energy used to help reduce the effect of the market cost increase.

It is prudent for the Corporation to continue to implement a multipronged approach to help contain and/or reduce energy costs. The energy efficiency improvements and cost avoidance measures being implemented serve to insulate the Corporation from the market changes and inflationary costs associated with energy procurement.

However, despite the efforts to manage consumption, the 2016 electricity prices varied significantly month-to-month relative to what has been observed over the past ten years. A key driver of this volatility is the Global Adjustment (GA) portion of utility bill which made up more than 60 percent of the typical electricity bill in 2016. The GA portion of the electricity bill pays for the province's electricity supplier contracts (e.g., natural gas plants, Bruce Power, regulated nuclear, hydroelectric, wind and solar power projects) and conservation activities. In 2017, the Government of Ontario announced a refinancing plan where some of the GA cost components associated with the supplier contract term length will be paid over longer term (i.e., similar to refinancing a loan with a longer amortization period to reduce monthly loan repayment costs). These changes in the coming years will bring some short-term relief from the recent jump in electricity prices, but will result in higher overall electricity costs over the longer term due to this longer repayment term. Nevertheless, it is not clear at this point of time whether these changes will apply only to residential customers or will include some of the municipally operated building.

5. Corporate Energy Cost Avoidance

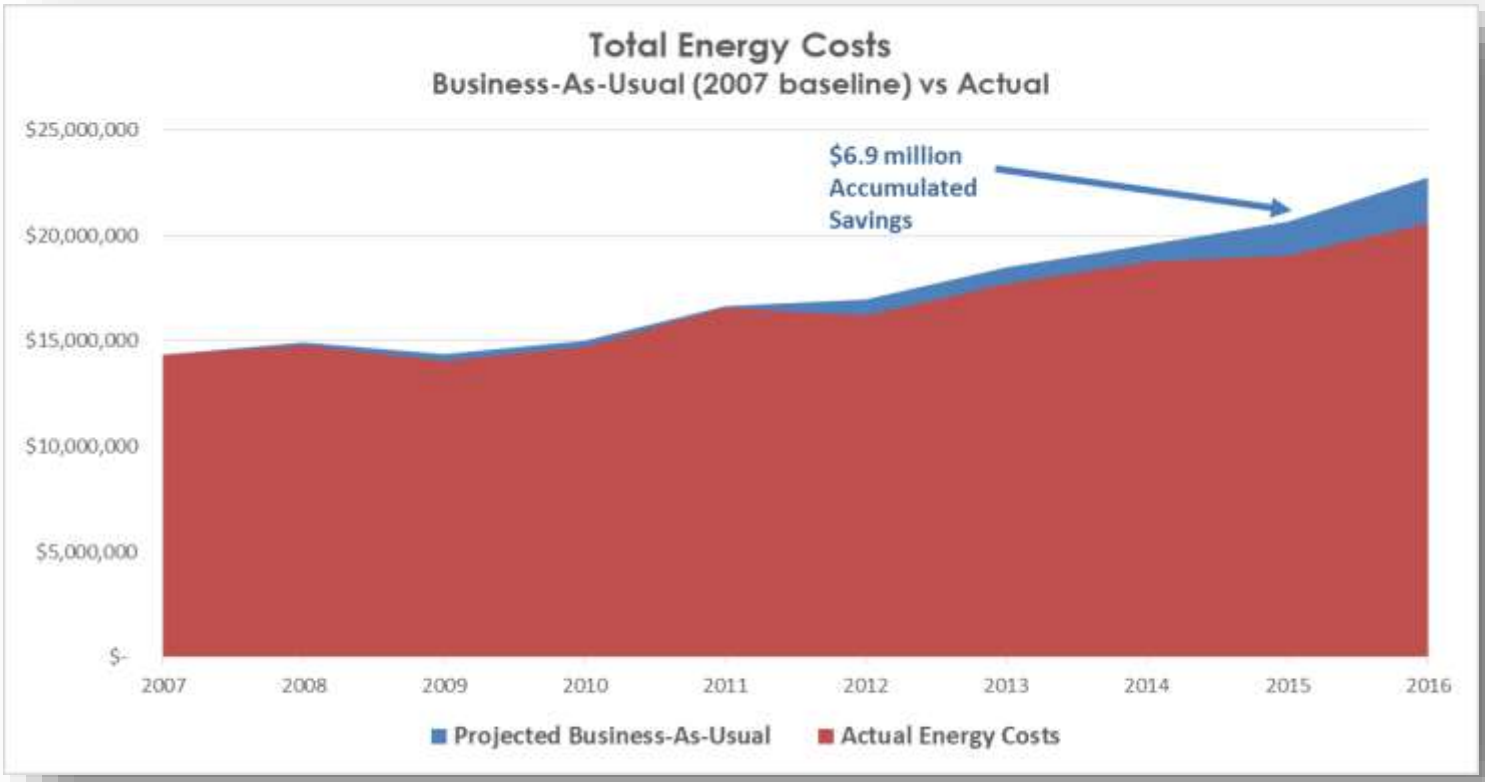
In terms of service delivery to Londoners, energy use per person has dropped by 16 percent since 2007 levels. This energy reduction can be attributed to recent energy conservation measures and facility upgrades.

Table 14 – Energy Costs Per Capita by Commodity 2007 – 2016

Energy Consumption (ekWh) by Commodity per person	2007	2016	Change since 2007 Variance	Change since 2007 % Change	2007 compared to 2016 Avoided Costs
Electricity	305	275	(30)	-10%	$ (1,665,000)
Natural Gas	165	100	(65)	-39%	$ (395,000)
Steam	10	7	(3)	-33%	$ (63,000)
Chilled Water	5	5	0	1%	$ 2000
Diesel Fuel	57	56	(1)	-1%	$ (20,000)
Gasoline	19	18	(1)	-3%	$ (18,000)
Total	**561**	**462**	**(99)**	**-18%**	**$ (2,159,000)**

Approximately $2.1 million in energy costs were avoided in 2016 compared to 2007 levels and more than $6.9 million in avoided energy costs have been accumulated since 2007 (Figure 9).

Figure 9 – Avoided Energy Costs (Accumulated)



6. Corporate Energy-related Greenhouse Gas Emissions

In 2016, the Corporation's energy-related GHG emissions can be summarized by commodity and by municipal service categories. Based on the Corporation's current use of electricity, natural gas, steam, chilled water, diesel and gasoline consumptions and costs, GHG emissions can be calculated.

The total GHG reflects the municipal operations and can be measured annually back to 2007. This allows the Corporation to show trends in energy-related GHG emissions over the last nine years.

6.1 Total Corporate Greenhouse Gas Emissions

Overall, since 2007 the Corporation has reduced its annual energy-related carbon footprint by over 60 percent.

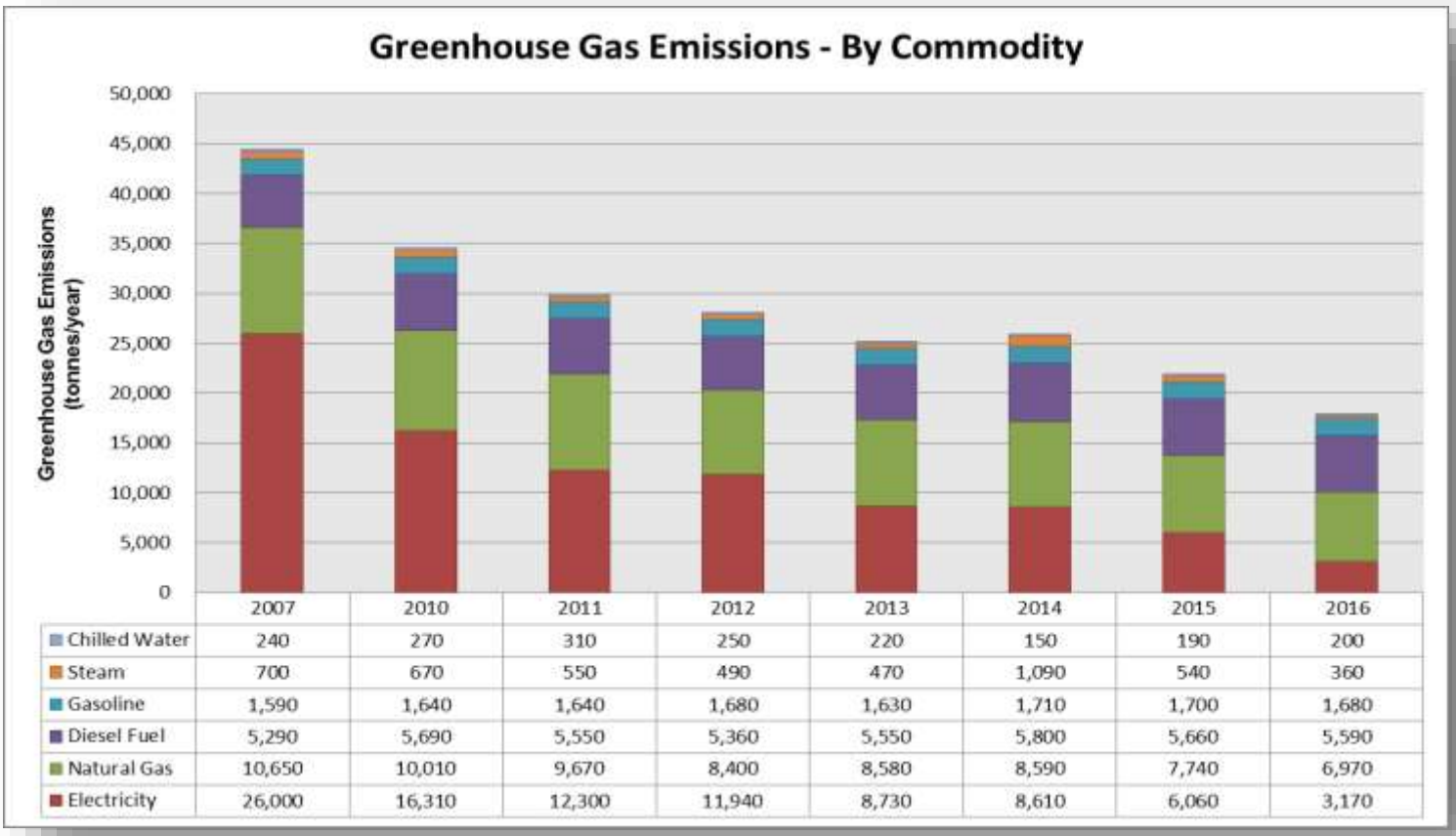
Table 15 – Greenhouse Gas Emissions by Commodity 2007 – 2017

GHG Emissions – By Commodity (tonnes/year)	2007	2016	Change since 2007 Variance (tonnes)	% Change
Electricity	26,000	3,170	(22,830)	-88%
Natural Gas	10,650	6,970	(3,680)	-35%
Diesel Fuel	5,290	5,590	300	6%
Gasoline	1,590	1,680	90	6%
Steam	700	360	(340)	-49%
Chilled Water	240	200	(40)	-17%
Total	**44,500**	**18,000**	**(26,500)**	**-60%**

Most of the recent progress in reducing energy-related corporate greenhouse gas emissions is due to provincial action to replace coal-power plants with cleaner electricity generation.

The total GHG emissions by commodity, illustrated in Figure ten, is a representation of the GHG emission reductions since 2007.

Figure 10 – Greenhouse Gas Emissions – By Energy Commodity



6.2 Total Corporate Greenhouse Gas Emissions by Municipal Service Categories

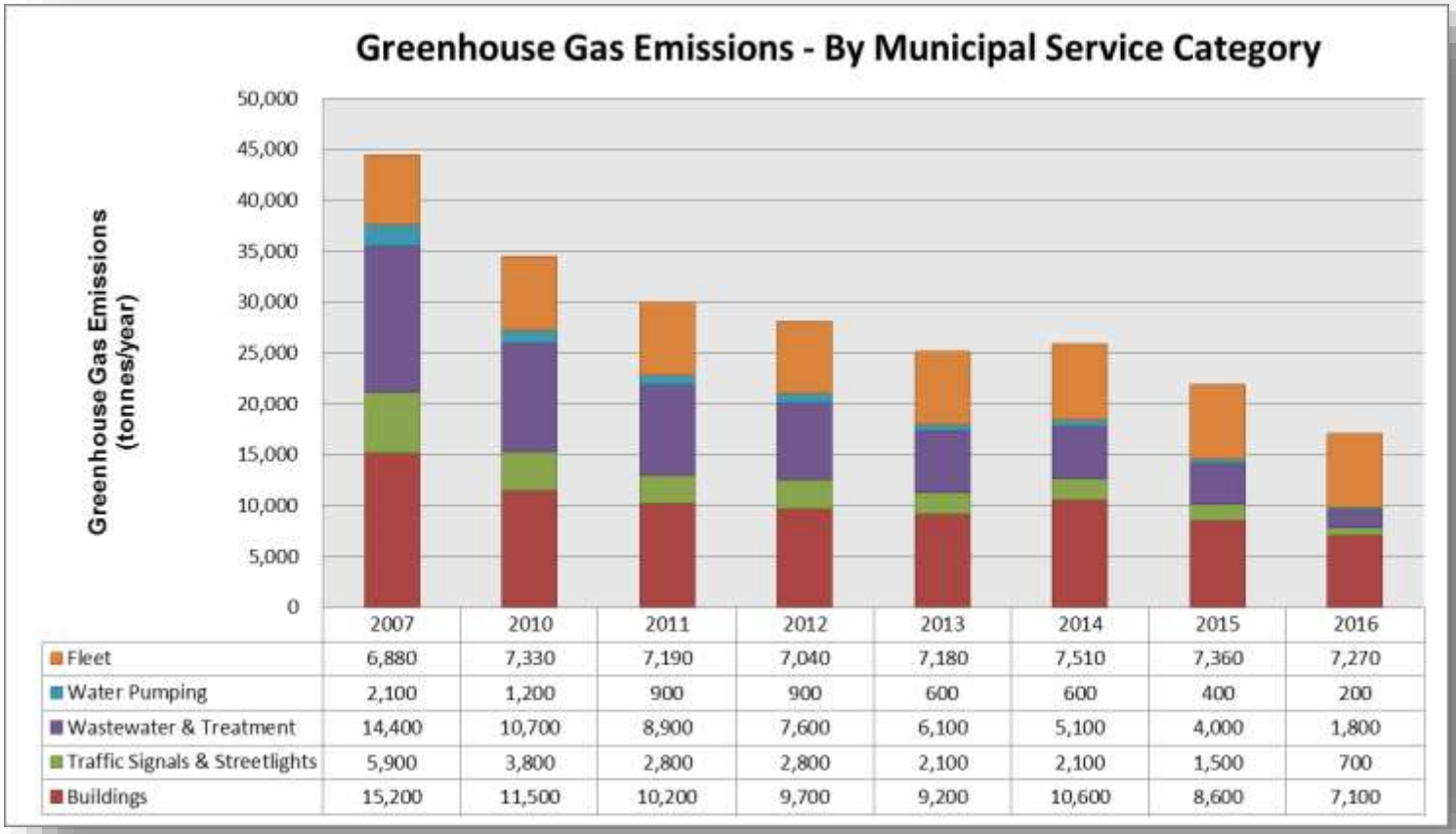
Table 16 represents trends for all municipal service categories for the Corporation since the baseline year of 2007. (It should be noted that the total does not include non-energy related greenhouse gases such as methane in landfill gas and nitrous oxides from sewage sludge incineration. These are discussed in Section 6.3 in more detail.)

Table 16 – Greenhouse Gas Emissions by Municipal Service Categories 2007-2016

GHG Emissions – By Municipal Service Categories (tonnes/year)	2007	2016	Change since 2007 Variance (tonnes)	% Change
Buildings	15,200	7,100	(8,100)	-53%
Traffic Signals & Streetlights	5,900	700	(5,200)	-88%
Wastewater & Treatment	14,400	1,800	(12,600)	-88%
Water Pumping	2,100	200	(1,900)	-90%
Fleet	6,880	7,270	390	6%
Total Corporation	**44,500**	**17,100**	**(27,400)**	**-62%**

The total GHG emissions by municipal service categories illustrated in Figure 11 below is a representation of the GHG emission reductions by commodity since 2007.

Figure 11 – Energy Related Greenhouse Gas Emissions by Municipal Service Categories



Overall, since 2007 the Corporation has reduced its annual energy-related carbon footprint by over 60 percent (not including landfills). Compared to 2014 CDM baseline year, this has been reduced by 31 percent. This is more than the CDM target.

Those municipal service categories powered by electricity have seen the benefits associated with the phase-out of coal-fired power generation. The sludge dewaterer at Greenway WWTP has also contributed significantly to GHG emissions reductions through the reduced use of natural gas. In fact, had this action had not taken place, it is likely that the Greenway WWTP would have been considered a Large Emitter (i.e., a facility emitting more than 25,000 tonnes of GHGs per year) under Ontario's new Cap & Trade program.

The only municipal service category that has seen increased emissions has been fleet fuel use. Fleet greening efforts are in place, but the increasing size of London's population and urban land area places demands on City vehicles providing services to Londoners. This will the subject of the upcoming Green Fleet Strategy to be completed in Fall 2017.

The Corporation continues to search for innovative and collective ways to reduce GHG emissions from energy use.

6.3 Non Energy-related Greenhouse Gas Emissions

The Corporation also has direct control over two major sources of greenhouse gas emissions not associated with energy use:

- Methane emissions from the W12A Landfill as well as closed landfills; and
- Nitrous oxide (N2O) emissions from the incineration of sewage sludge at the Greenway Wastewater Treatment Plant.

In fact, methane emissions from landfill sites are significantly larger in magnitude than energy-related greenhouse gas emissions. With the installation and ongoing expansion of the landfill gas collection and flaring system at the W12A landfill, the Corporation has made significant reductions in greenhouse gas emissions as seen in Table 17.

Table 17 – Summary of Landfill Gas Flaring at W12A Landfill

Year	Methane Flared (tonnes)	Equivalent CO_2 Reduced (tonnes)	Cumulative Methane Flared (tonnes)	Cumulative CO_2e Reduced (tonnes)
2004	852	21,000	852	21,000
2005	1,975	49,000	2,827	70,000
2006	1,800	45,000	4,627	115,000
2007	1,441	36,000	6,068	151,000
2008	1,845	46,000	7,914	197,000
2009	2,282	57,000	10,196	254,000
2010	2,324	58,000	12,520	312,000
2011	2,658	66,000	15,177	378,000

Year	Methane Flared (tonnes)	Equivalent CO_2 Reduced (tonnes)	Cumulative Methane Flared (tonnes)	Cumulative CO_2e Reduced (tonnes)
2012	3,237	81,000	18,415	459,000
2013	4,516	113,000	22,931	572,000
2014	4,165	104,000	27,096	676,000
2015	4,299	107,000	31,395	783,000
2016	5,989	149,700	37,384	932,700

As a result of London having joined the Compact of Mayors in 2015, nitrous oxide (N_2O) emissions from sewage treatment is now included within London's energy and GHG emissions inventory as per the Global Protocol for Community-Scale GHG Emission Inventories. Nitrous oxide, a potent greenhouse gas with 310 times the global warming potential of carbon dioxide, is a combustion by-product from the incineration of sewage sludge and its formation is influenced by incinerator operating conditions (i.e., combustion temperature).

Since 2008, annual stack testing at the Greenway Wastewater Treatment Plant sludge incinerator has included the measurement to nitrous oxide alongside other air pollutants. Table 18 summarizes the nitrous oxide stack test results.

Table 18: Summary of 2008 – 2016 Stack Test Results for N_2O Emissions from the Greenway WWTP Sewage Sludge Incinerator

Year	N_2O emissions				Sewage sludge burn rate during stack testing (tonnes/h)	Estimated CO_2e emissions per tonne sludge
	Measured average emissions g/s	Measured average emissions kg/h	Estimated annual emissions tonnes/y	Estimated annual CO2e tonnes/y		
2008	0.1	0.4	4	1,200	10.4	0.01
2009	1.1	3.9	34	10,700	9.5	0.13
2010	1.1	3.9	34	10,600	9.9	0.12
2011	1.2	4.4	39	12,000	9.0	0.15
2012	1.0	3.5	31	9,600	10.6	0.10
2013	0.2	0.6	5	1,700	no data	
2014	1.1	4.1	36	11,000	7.3	0.17
2015	1.0	3.7	32	10,000	7.2	0.16
2016	0.3	1.1	9	2,900	6.8	0.05

As can be seen from the table above, measured emissions of nitrous oxides can vary from year to year. As Environment and Climate Change Canada considers reducing the reporting threshold for facility emissions to 10,000 tonnes per year of carbon dioxide equivalent emissions for the 2017 reporting year, it is possible that the Greenway WWTP may be required to report its emissions in future years.

Figure 12 – Non-Energy Related Greenhouse Gas Emissions by Municipal Source