



2016 Corporate Energy Management Activities City of London

July 2017

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1 Corporate Energy Management – Update

Energy management is a key component in managing facilities and infrastructure in today's economy. The Corporation of the City of London (referred to as "the Corporation" or "the City" within this document) has been a leader in energy conservation and sustainable energy for more than 16 years and as part of its commitment to Building a Sustainable City as part of the 2015-2019 - Strategic Plan, the Corporation has been actively involved in energy conservation projects in every operational area.

In compliance with the Green Energy Act and the Ontario Regulation 397/11, the City was required to report on their energy consumption and greenhouse gas emissions annually starting early 2013 and develop a Conservation and Demand Management (CDM) plans starting 2014. In the development of these reports, the City has recognized the importance of capturing annual energy consumption and activities to track our progress towards the CDM Plan. This led to the development of series of reports inter-related to the development and support of future CDM plans. This current report is a follow up to the 2013-2015 Corporate Energy Management Activities Report and captures all the energy efficient activities and projects undertaken by the City in 2016.

1.1 CDM Plan Update

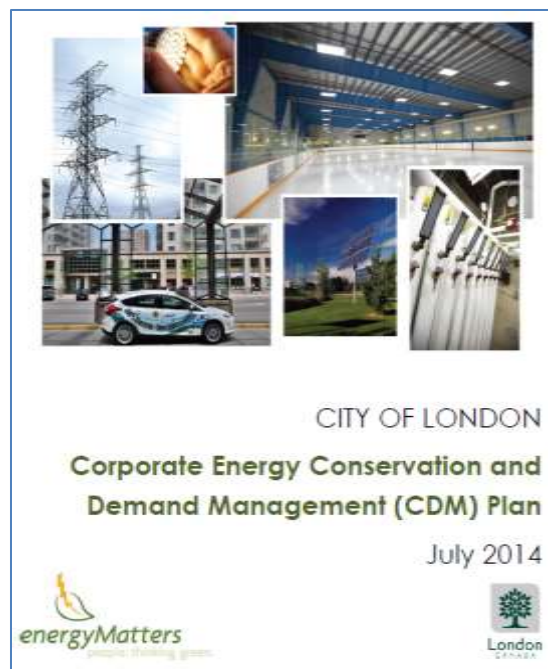
The introduction of the CDM Plan provided the City with an opportunity to review its energy program initiatives and proposed energy targets. The CDM Plan was developed according to Ministry of Energy's direction to provide the City's annual energy consumption information to the public and set goals and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

A series of past energy activities, programs, utility consumption and documents were analyzed to understand the City'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 solutions into existing capital investments already assigned, explore incentive opportunities towards energy project initiatives and review long term initiatives that have significant impacts on energy consumption and GHG emissions.

The Corporation's CDM goal is to achieve a 10 percent reduction (from 2014 levels) in overall annual energy use by 2020. Achieving this goal represents:

- A total energy use reduction of 30 million equivalent kilowatt-hours (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 business-as-usual projection.
- An energy cost avoidance of \$4 million below 2020 business-as-usual 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

Overall, the Corporation’s performance in 2016 is on track with the CDM goal (see 2016 Corporate Energy Consumption Report).

2 2016 Energy Management Activities

The Corporation leads by example when it comes to sustainable energy investments and initiatives. London’s future sustainability depends on the implementation of best practices in energy management today.

The current report summarizes a selection of the significant energy management projects and supporting initiatives which are in progress, planned and completed in 2016 which has resulted in efficient municipal building and infrastructure stock.

2.1 Funding and Incentive Sources

Incentives offered for energy conservation projects from Union Gas, London Hydro and the Federation of Canadian Municipalities have encouraged various municipal operations to undertake energy conservation projects. The incentive programs offer funding for controlling and reducing energy demand by replacing energy-wasting equipment, or to pursue new construction(s) that exceed provincial building codes and standards which in turn assist the Corporation to reduce annual energy costs and associated greenhouse gas (GHG) emissions. Additionally, these incentives support in developing stronger business cases to help save money and energy. The table below shows the total amount of incentives received for projects undertaken in 2016.

Organization	Total Incentives received in 2016
Union Gas	\$30,000
London Hydro	\$164,000

2.2 Current Activities

Updates on Current Activities in this report are identified according to the six key focus areas of the Corporate Energy Management Program:

- Tracking & monitoring energy consumption
- Renewable energy and feasibility projects
- Leadership in Energy and Environmental Design (LEED) buildings and new energy efficient buildings
- Energy conservation and demand management projects
- Energy procurement
- Creating a corporate “Culture of Conservation”

3 Tracking & Monitoring Energy Consumption

Tracking energy usage is an important first step to understanding how an organization uses energy which is necessary before any efforts to reduce energy costs and usage can be made. As described in 2013-2015 Corporate Energy Management Activities report, the Corporation continues to use EnergyCAP software and London Hydro's Green Button data to track and monitor its utility consumption.



All the functions performed by EnergyCAP are listed in the Past and Current Activities report published in September 2013. Since its procurement, EnergyCAP has been continuously updated to accommodate various reporting requirements.

In 2016, EnergyCAP has been testing its web version with the Corporation to migrate from its enterprise or the desktop version. The updated software is comprehensive and much easier to use.

London Hydro's Green Button program defines a particular data format and secure mechanism whereby the data can be accessed by third party applications for analysis, dashboard population, and other purposes with the data owner's approval. Green Button data enables us to access and analyze electricity consumption for every five minute interval.

4 Renewable Energy Projects

In terms of an overall approach for supporting renewable energy, City staff continue to recommend making direct investment in renewable energy projects at municipal facilities rather than the procurement of "green energy" from energy retailers (e.g., purchase offset credits).

The following are updates to renewable energy projects in 2016.

4.1 Landfill Gas as a Potential Resource

The City's past efforts to explore landfill gas utilization for electricity generation were hampered by factors beyond the control of the Corporation. In September 2016, the Independent Electricity System Operator (IESO) suspended the second round of Large Renewables Procurement (LRP2) in an effort to reduce future electricity costs, due in part to surplus power generating capacity in Ontario. Combined with the information from July 2016 indicating a lack of transmission capacity for projects above 500 kilowatt capacity at the Wonderland Transmission Station, this eliminates any potential for large scale use of landfill gas for power generation.

In November 2016, an application was submitted to the IESO for a 500 kilowatt landfill gas power plant to the fifth round of the Feed-In-Tariff (FIT5) program. FIT5 will be the last round of applications. The Corporation's FIT5 application was the only one submitted using landfill gas as the renewable energy source, out of 1,120 applications submitted. As of April 2017, this application has moved on to the next stage of review by the IESO. However, it is important to note that the Municipal or Public Sector Entity

contract capacity set aside is oversubscribed, with 108 applications totalling 41.2 megawatts of capacity competing for 33.3 megawatts of procurement target.

Upgrading landfill gas to pipeline quality renewable natural gas (RNG) is emerging to be the most likely option for large-scale landfill gas utilization. It is estimated that the 500 kilowatt power plant will use about 320 cubic metres per hour (200 cubic feet per minute, or cfm) of landfill gas – about 20 percent of currently available landfill gas. This would leave about 1,300 cubic metres per hour (800 cfm) of landfill gas for RNG production.



In June 2016, Ontario released its new Climate Change Action Plan that has proposed a new renewable natural gas content requirement for the province’s natural gas supply from sources such as landfills and municipal green bin collection. This provides new opportunities for the utilization of landfill gas from the W12A Landfill and the potential for utilization of biogas from a future organics management program in London. In January 2017, the province also proposed a new approach for the Renewable Fuel Standard for gasoline that would include the ability to use RNG to create a “credit” towards meeting the Renewable Fuel Standard. This would be a similar system used in California. A similar program is being contemplated at the federal level as part of Canada’s proposed Clean Fuel Standard.

Given this information, City staff are working on identifying recommended next steps to prepare for these upcoming options for producing renewable natural gas from landfill gas.

4.2 Waste Heat Recovery from Sewage Sludge Incineration

Greenway Wastewater Treatment Plant (WWTP), the Corporation’s largest wastewater treatment plant, presents an opportunity to conserve energy by installing an Organic Rankine Cycle (ORC) engine to recover waste heat from its Fluidized Bed Combustor (FBC) unit. Greenway WWTP’s FBC unit is used to incinerate cake sludge produced after wastewater treatment. Currently only a portion of energy generated and exhausted in this process is captured and used to pre-heat intake air to the FBC unit.

In April 2016, Greenway WWTP completed a preliminary study with a consultant, GHD Limited, to determine the feasibility of implementing energy recovery from the FBC unit. The GHD study concluded that energy recovery using an ORC power-generating engine is a viable option for the plant. The ORC system has two main components: the Turboden ORC unit and a thermal fluid heat exchanger. The low temperature heat can be transformed into electricity.

The results from the preliminary study have shown that the ORC engine has the potential to almost completely offset the electricity requirements of the solids handling process unit at current solids handling rates. This would reduce the Greenway WWTP’s annual electricity load by 16 percent and a four percent annual reduction in City corporate-wide electricity load. The ORC engine is expected to produce 3,675 megawatt-hours (MWh) annually running at 24 hours and 330 days per year. The study also showed a co-generation of almost 9,300 equivalent megawatt-hours of reusable heat energy from this system.



Energy recovery using the ORC unit also contributes to the London’s Community Energy Action Plan which has “Making use of free heat and free light” & “Use of renewable energy” as key guiding principles. This project has been approved for \$750,000 in incentives under the Industrial Accelerator Program (IAP) from London Hydro and the IESO. In May 2017, this project has also received a grant from Canadian Water and Wastewater Fund (CWWF) which covers 75% of the capital cost.

The table below shows annual GHG emissions saved by using the electricity generated by the ORC system. There are two ways to quantify the GHG reduction benefits – using the Ontario grid-average emission factor and using the Ontario

fossil-on-margin emissions factor. The first method assumed that the electricity savings are allocated evenly across all power generating sources such as nuclear, hydro, wind, and natural gas. The second method assumes that electricity savings are allocated to the natural gas power plants that operate on the margins of demand, ramping up and down in response to power demands. The GHG savings from this project typically contribute towards the second method (electricity generated by fossil fuels) as it directly reduces demand on the grid.

Estimation Method	Annual GHG Emission Reductions (tonnes)
Electricity GHG savings using the grid-average emissions factor	220
Electricity GHG savings using the fossil-on-margin emissions factor	2,100

Based on the economic and environmental benefits identified in the feasibility study, the Corporation has decided to go ahead with implementation of the ORC system as a capital project for the Greenway WWTP plant. This project was approved by Council in July 2016. The Preliminary Engineering Design followed by a Detailed Design was completed in October 2016. The timeline for project completion is estimated to be the end of 2018.

4.3 Bioenergy

London Waste to Resource Innovation Centre

In February 2015, London Municipal Council approved a concept referred to as the London Waste to Resources Innovation Centre. The primary goal of this Centre is to create a location(s) in or near London for the ongoing examination of innovative solutions for waste reduction, resource recovery, energy recovery, and/or waste conversion.

In 2016, City staff continued to support work with Green Shields Energy for further examination of a waste conversion technology known as Gas Phase Reduction. City staff also undertook a number of new

projects have been initiated under this banner, including signing a Memorandum of Understanding (MOU) with the University of Western Ontario (Institute of Chemicals and Fuels from Alternative Resources) undertake testing and research on the viability of a range of technologies and processes to create resources from waste that would normally be sent to disposal facilities

In early 2017, additional MOUs were signed for the following waste conversion technology research:

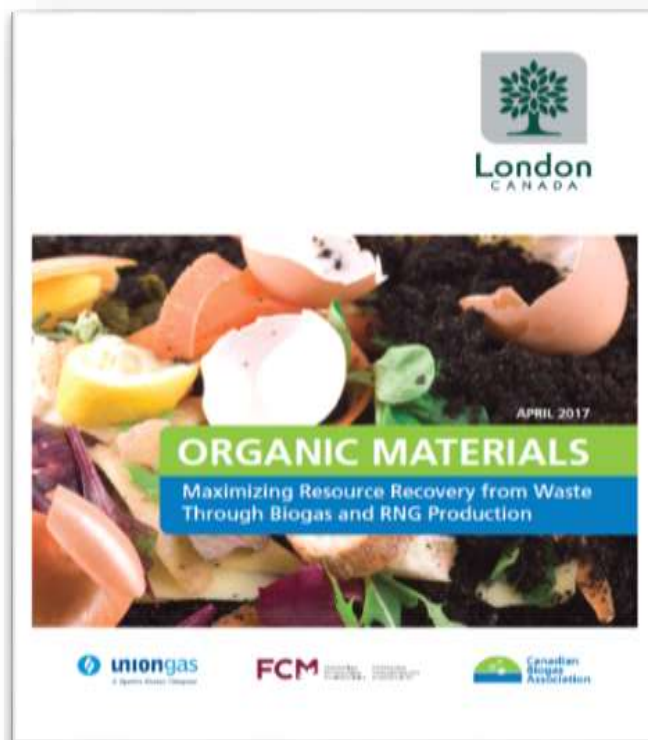
- Bio-Techfar Inc., to undertake testing and research on the viability of a proprietary pyrolysis technology and processes to create resources from a range of biomass materials that would normally be sent to recycling and/or disposal facilities.
- Hawthorne Green Key Group Inc., to undertake testing and research on the viability of a proprietary pyrolysis technology and processes to create resources from various fractions of municipal solid waste that would normally be sent to recycling and/or disposal facilities;

Canadian Biogas Association Preliminary Feasibility Study

Prior to the announcement of Ontario's Climate Change Action Plan, City staff started to work with the Canadian Biogas Association and Union Gas to research the potential for resource recovery from organic materials discarded by London residents by producing renewable natural gas (RNG) that could be used in compressed natural gas (CNG) vehicles. It has been estimated that the cost to fuel a vehicle with RNG is on par with the current market price of diesel fuel, and this study provided estimates specific for London. The Federation of Canadian Municipalities (FCM) provided funds to assist the Corporation in this research. The Corporation undertook this work as part of its investigation of various options for the management of the organic portion of its residential waste. This work provided the Corporation with information on using residential organics to produce RNG including performance, costs, and GHG reductions. This includes options such as biogas from "green bin" source-separated organics and "whole bag" facility-separated organics, as well as landfill gas. The feasibility study provided City staff with insight into the impact that the value of RNG could have a different organics management options.

For municipal governments, decisions associated with waste diversion are based on net system costs for waste collection, processing, and disposal. For both scenarios, it is assumed that any revenue from the scale of RNG as a fuel would be used to reduce these costs, as would any other revenue from the scale of GHG offsets from organics diversion.

For the purpose of this feasibility study, it was assumed that there was no provincial or national market for RNG and that the maximum price of RNG as a fuel for local fleets is the price at which the net cost of converting the fleets from diesel fuel to RNG is zero. Therefore, the maximum price of RNG is the cost of the diesel fuel supply minus the additional capital and operating costs of new CNG vehicles and fueling stations. In other words, the fleet operator is forgoing the cost savings from using CNG in exchange



for the GHG reductions associated with using RNG. The price of system gas within the Union Gas pipeline in 2016 was around \$3 per gigajoule (GJ).

For relatively small fleet such as the Corporation's waste collection fleet, this works out to \$4 per GJ. For relatively larger fleets such as the hypothetical use in London Transit's bus fleet, this works out to \$10 per GJ. This value is higher with carbon pricing, where a \$50 per tonne carbon price would increase the value of RNG by additional \$3.50 per GJ.

In terms of the impact on RNG value on organics management options, in the case of source-separated organics for London, RNG would need to have a value above \$15 per GJ in order for the anaerobic digesting of source-separated organics to have a clear cost advantage over aerobic composting. Between \$5 and \$15 per GJ for RNG, there is no significant cost advantage between anaerobic digestion and aerobic composting options. Below \$5 per GJ, traditional aerobic composting retains the cost advantage.

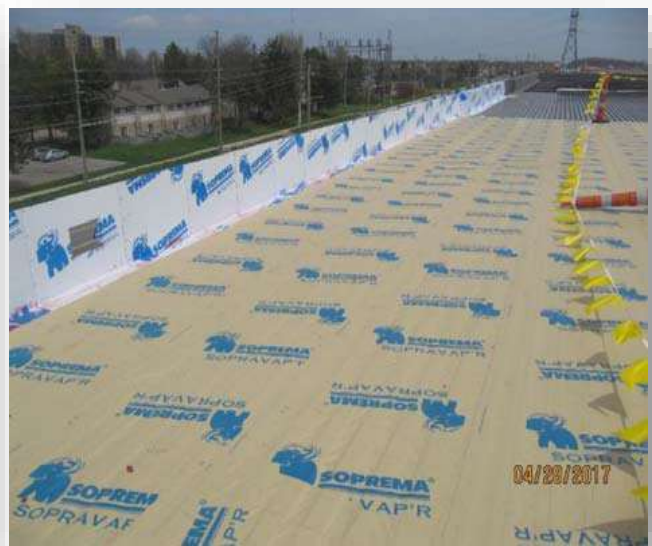
For London, RNG would need to have a value above \$15 per GJ in order for the anaerobic composting of facility-separated organics (FSO) to have a roughly comparable costs to the Corporation's existing landfill.

This report can be found on the City of London website –

<http://www.london.ca/residents/Environment/Energy/Documents/CBA-London-Report-v7.pdf>

4.4 Solar Rooftop Sections

Roof sections capable of supporting solar photovoltaic generating system (PV systems) continue to be included in new construction design criteria for flat roof areas that are suitably sized and oriented to host a PV System.



In addition to having a PV system-ready flat roof area at the Southwest Community Centre, the soon-to-be-tendered Southeast Community Centre project will include a 10 kilowatt net-metered solar PV system that will offset a portion of the facility's electrical load. This measure was part of the Facility Energy Management Budget Amendment (Case # 19) which was approved by Council in the fall of 2016.

5 LEED Buildings and New Energy Efficient Buildings

The Corporation makes use of the Canada Green Building Council's Leadership in Energy and Environmental Design (LEED) program to advance green building and sustainable community practices.

As part of its Corporate CDM plan, the City continues to pursue LEED design principles, which are incorporated within the scope of all new City facilities and infrastructure upgrade projects. This does not mean that every single building will seek formal LEED certification, as the cost and effort for obtaining third party certification does not always add significant value to a project – particularly smaller projects.

5.1 Southeast Reservoir Pumping Station

The new Southeast Reservoir Pumping Station is being constructed to meet the LEED Silver certification standard. As mentioned in 2013-2015 Corporate Energy Management Activities Report, in early 2013 this project was registered with the Canada Green Building Council. However, before completion of this building, an updated LEED program was released that rendered the Southeast Reservoir site ineligible for certification. This building is being built to consume at least 25 percent less energy than a similar building designed to the Building Code and is expected to be completed by end of 2017.



The energy efficient highlights of this building include:

- A green roof to reduce storm runoff,
- Lighting that does not contribute to light pollution,
- Water use reduction measures in plumbing fixtures for water,

- Use of building materials – certified woods, paints and carpets free of volatile organic compounds (VOCs),
- Public access to the site –walking trails, and
- The use of renewable materials made from agricultural products, and the use of regionally manufactured materials.

5.2 New Community Centres

The design consultant teams for the new Southwest Community Centre and the new East Community Centre were tasked with designing to the LEED Silver point target. LEED Silver means a facility design scores between 50 and 59 of a possible 110 points in the LEED scoring matrix. The designs for the each of the new centres are eligible for up to the following:

- Southwest Community Centre (*under construction*): 47 (+12 possible) points
 - Facility highlights:
 - Double pad arena
 - Library
 - Fitness center
 - Leisure center
- East Community Centre (*tender closing August 2017*): 50 (+24 possible) points
 - Facility highlights
 - Gymnasium
 - Multipurpose room
 - Leisure and lap room
 - Rooftop Solar PV

6 Energy Conservation and Demand Management Projects

The Corporation continues to examine energy management within every project. Energy conservation and demand management consists of corporate initiatives and projects that result in the reduction of energy consumption by proposing more efficient methods and technologies and/or technologies that shift power demand to off-peak periods.

The strengthening of our corporate energy management team has brought forward a number of conservation projects, and energy management staff also having the opportunity to weigh in and encourage energy-saving measures on upcoming designs and proposals throughout the Corporation has proven to be beneficial.

6.1 Roads and Transportation

6.1.1 LED Street Lights



With the successful pilot projects completed between 2010 and 2012 to evaluate LED street light effectiveness, the Corporation has decided to expand their use all across London. Results of the 2012 pilot project concluded that the installations of all LED fixtures appear to be operation as expected, with reduced maintenance and utility costs.



There are about 35,000 street lights in London. In an effort to convert all street lights to LEDs, the project scope was divided into three phases. In the first phase, completed between November 2015 and May 2016, 9,276 existing cobra-style High Pressure Sodium (HPS) fixtures were converted to LEDs. All the major arterial road street lights in London were covered in this phase. A total of 2,285 kilowatts of HPS lighting were replaced with 997 kilowatts of LED fixtures for a 56 percent reduction in electricity use. The

approximate cost avoidance expected in 2016 from this project is around \$690,000. This project was also eligible for a \$1.3 million incentive from London Hydro.

Currently, the second phase of the street light replacement project is in progress and the timeline for phase two installation is scheduled from July 2017 to October 2017. In this phase, all the city streets with cobra-style lights will be replaced with LEDs. A total of 1,332 kilowatts of HPS lighting are being replaced with 325,000 watts of LED fixtures for a total of 64 percent reduction in electricity use. This will result in about \$620,000 in electricity costs avoided. Phase two has also been approved for an approximate amount of \$500,000 in incentives from London Hydro.

A few of the highlights from LED Street lighting project progress so far are as follows:

- Electricity consumption for streetlighting was reduced for the very first time in 2016
- There was a 13 percent reduction in streetlight energy consumption in 2016 compared to the baseline year of 2014
- An 88 percent reduction in streetlights related GHG emissions (55 percent of this is due to Ontario electricity grid going green and the remaining is due to the LED project)

Phase three of the project will look at secondary roads with non-cobra style and post-top fixtures for which a reliable LED technology is still under review.

6.2 Wastewater Treatment

The Corporation operates six Wastewater Treatment Plants (WWTPs) and 36 pumping stations to assist wastewater flow to plants from gravity sewers or force mains. Wastewater Operations' primary focus is the treatment of incoming sewage to meet legislative requirements set out by the Ministry of Environment and Climate Change. As operating costs, energy demands and commodity costs continue to climb, the evaluation of operating efficiencies, energy conservation methods, and demand management projects and initiatives play a vital role in maintaining successful wastewater treatment facilities.

In 2016, Wastewater Operations continued to implement a number of projects that fit within best practices of energy conservation and demand management initiatives. Some of these projects are identified in the below sections.

6.2.1 Treatment Plants – Aeration Blower Upgrade

Blower power consumption represents the largest electrical energy consumption in the wastewater treatment process, sometimes up to 50 percent of total consumption. Older centrifugal blower installations throughout the city, while running effectively, are not as efficient as newer technology. In 2016, the Corporation completed replacing existing blowers at Adelaide WWTP (Section 2), Vauxhall WWTP (Sections 1 and 2) and Oxford WWTP (Section 2) with new turbo blowers.

Turbo blowers are typically 20 to 30 percent more efficient than standard centrifugal blowers, and utilize variable-frequency drive (VFD) control rather than throttling the blowers to better match actual process demands. Given the success of these installations, the City is currently replacing the Section 3 blowers at Greenway WWTP with new turbo blowers and is examining turbo blowers for Pottersburg WWTP.

Implementing these measures at Adelaide, Vauxhall, Oxford and Greenway resulted in:

- 6,340 megawatt-hours per year in electrical consumption or \$760,800 in utility cost avoidance
- 6% towards the Corporation's electricity reduction

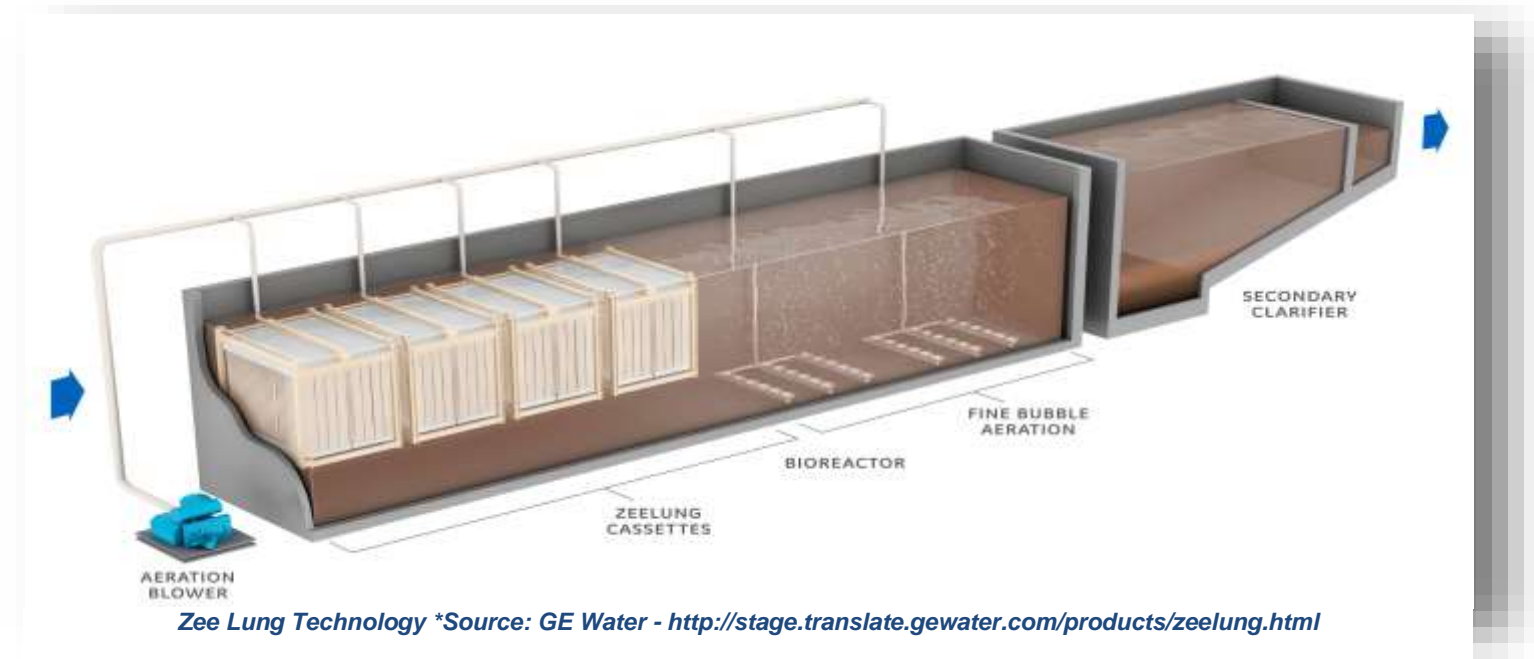
- \$2.1 million incentive from London Hydro

The Greenway WWTP aeration blower project also received 100 percent funding from the Canadian Water and Wastewater Fund (CWWF) in 2017.

6.2.2 ZeeLung Technology – Pilot Project

After upgrading aeration blowers to newer efficient turbo blowers, the Oxford and Adelaide WWTPs are looking to further improve their process efficiency by piloting the use of ZeeLung Membrane Aerated Biofilm Reactor (MABR) technology. ZeeLung MABR is trademark of General Electrical (GE) Company. This process enables simple, low-energy nutrient removal in a smaller footprint.

ZeeLung membranes can be installed directly into existing bioreactor tanks, minimizing the impact on equipment hydraulics and operations. Oxygen is delivered at an efficiency four times greater than fine bubble aeration. The system increases biomass inventory by supplementing a suspended growth system with attached growth enabling nutrient removal. The nutrient removal along with increased capacity in existing bio-reactor volumes avoids the need to construct new bio-reactor tanks and this contains the process to a smaller footprint.



The Adelaide WWTP started a pilot project to install this technology in 2016 and currently City staff are working with GE on the installation of a full-scale pilot at the Oxford WWTP. The pilot is expected to be in full operation by Fall 2017. As the Zeelung technology is proven and reaches full scale maturity it will be considered for future plant upgrades and expansions.

6.2.3 Other Efficient Lighting Projects

Apart from the process efficiency projects, the Corporation's WWTPs have been actively involved in upgrading their office and plant lighting to energy efficient LEDs.

Vauxhall and Adelaide plants have together replaced around 400 T8 lamps with LEDs for a total energy savings of 30 kilowatts per year. Vauxhall and Pottersburg plants have also replaced outside building lighting from CFLs to LEDs.

Greenway has successfully piloted replacing its lunch room and conference room lighting from T12 fixtures to LEDs, apart from energy savings this resulted in great improvement in lighting levels at these locations. Greenway is currently evaluating the feasibility of converting all of its office lighting to LED as part of the on-going office renovation project.

6.3 Water Engineering and Operations

The Corporation receives its treated water from both the Lake Huron Water Supply System (approximately 85 percent of the daily consumption) and the Elgin Area Water Supply System. A network of well fields, which remain inactive, are maintained in case an emergency situation arises.

The water treatment of London's two primary water sources fall under the jurisdiction of two Boards: the Lake Huron Primary Water Supply System Joint Board of Management and the Elgin Area Primary Water Supply System Joint Board of Management. Water is delivered from Lake Huron to the Arva Pumping Station, where the City of London's water distribution system begins. Similarly, Lake Erie water is also delivered to the Elgin-Middlesex Pumping Station, from which the Corporation assumes responsibility. These pumping stations contribute about four percent to City's overall energy consumption and are continuously monitored for efficiency upgrades. A few of the recent energy efficiency initiatives and projects taken by water operations are in the next four sections.

6.3.1 Elgin Middlesex Pumping Station (EMPS)

Currently, Water Engineering is undertaking upgrades at the EMPS for the replacement of Pumps 4 and 5 with more efficient water pumps that are better sized for the new pumping requirements. This will result in substantial reductions of energy consumption at this site. The anticipated replacement will change the two 600 horsepower (hp) pumps and motors with two 450 hp pumps and motors. Preliminary projections indicate an annual energy savings of 850,000 kWh/year (over \$100,000/year). Further savings will be realized by operating these pumps at off-peak times versus peak times. A custom retrofit application was



submitted to the IESO and an incentive amount of \$370,000 was approved. This project will be completed and in operation in Summer 2017.

6.3.2 Uplands and Wickerson Pumping Stations Upgrade

As a best practice, both the Uplands and Wickerson pumping station's pumps have been fitted with VFDs to optimize the process and make it more energy efficient. One of the new 40 horsepower (hp) pumps at Uplands has been installed with VFD and three previously installed pumps in 2016 were equipped with VFDs.

At the Wickerson station all the pumps are fitted with VFDs and two additional pumps installed in Fall 2016 have been equipped with VFDs as well.

6.3.3 Arva Pumping Station

6.3.3.1 Impeller Trimming

A process upgrade project was undertaken at the Arva Pumping Station to optimize its utility efficiency and meet the new pumping requirements for the plant. The impeller on one of the 700 hp pumps was trimmed from 0.6 meters to 0.5 meters to reduce power consumption and to better meet the new pumping needs. This project has been in operation since April 2017. SCADA data from before and after the project shows that energy consumption was reduced from 480 kilowatt to 310 kilowatt. Total project savings are identified to be 1,125 MWhs per year in electricity and the project has also been approved for \$18,000 in incentives by IESO.



6.3.3.2 Optimization and Energy Efficiency Study

In addition to its continuous best practices, city staff wants to improve its efficiency by identifying savings opportunities by conducting an energy efficiency study at the Arva pumping Station. In late 2016 and early 2017, the City put out a Request for Proposal (RFP) to seek interested and qualified consultants to complete an Optimization & Energy Efficiency Study.

The overall focus of the study is to:

- Undertake a comprehensive energy review and audit of the Arva Pumping Station to identify opportunities for energy efficiency and conservation savings;
- Undertake a comprehensive review of Arva's current energy procurement strategy and provide analysis of the facility's eligibility for participation in the IESO's Industrial Conservation Initiative Class A program and any cost benefit of participating;
- Investigate opportunities, the need, and cost of system improvements;
- Review strategies and recommendations of the previous pump optimization study to assess feasibility and implementation for the current operations; and

- Review the overall reliability of the Pumping Station, including the use of current on-site generator, power outages, and past issues with the pumps and/or any equipment.



In April 2017, City commissioned AECOM to complete the study. AECOM partnered with VIP Energy to conduct the study and the timeline for completing this initiative is from June 2017 to December 2017.

6.4 Facilities (Design & Construction)

The Facilities Division is responsible for the design, construction, energy management/life cycle renewal works and maintenance of facilities operated by the Corporation with the exception of street lighting, wastewater treatment and water supply operations. The Corporation maintains and operates over 95 sites, 279 buildings, 304 hectares (750 acres) of property and approximately 315,870 square meters (3,400,000 square feet) of owned and leased space.

Facilities is often requested to manage capital development projects for municipal organizations such as London Fire Services, London Police Service, London Public Library and Museum London.

In Appendix A, a list of all 2016 Facilities projects that have an energy conservation component associated with them. The projects identified in 2016 were not necessarily large stand-alone energy conservation projects, but rather contribute incrementally to the corporate energy conservation and demand management results. The following are highlights of a number of projects planned, in progress and completed by Facilities that contribute to energy conservation initiatives.

6.4.1 Canada Games Aquatic Centre

Recognition in 2016

In 2016, the Canada Games Aquatic Centre (CGAC) renovation project was recognised and awarded **2016 QUEST Smart Energy Communities Award – Real Estate Sector**. QUEST (Quality Urban Energy Systems of Tomorrow) is a leader developing Smart Energy Communities that improve energy efficiency,

enhance reliability, cut costs, and reduce greenhouse gas emissions. Every year it recognizes leadership and innovation in advancing Smart Energy Communities in Canada. It recognizes organizations, agencies, individuals or institutions who are advancing in Smart Energy Communities.

Co-Generation Unit

As noted in last year's report, Ameresco Canada completed a comprehensive lifecycle renewal and energy management project at the Canada Games Aquatic Centre (CGAC) that saw the facility shutdown from April 2014 to November 2014 while the project was completed. One of the measures associated with the project was a 53 kilowatt combined heat and power system (CHP).



New Combined Heat and Power System

A CHP is a system that converts the chemical energy stored in a fuel into a combination of electricity and useable heat. The electricity generation function of a CHP means that it ultimately interacts with the electrical distribution grid via the building's service connection. As a result

of this connection (although indirect), London Hydro's review, commissioning and acceptance of the system was required. London Hydro's acceptance was received after its commissioning on June 7, 2017. The connection agreement is in the process of being executed and the system is scheduled to be operational shortly.

The CHP at CGAC uses natural gas as its fuel source and is designed to displace a portion of the electrical base load of the facility while also offsetting a portion of the heating base load of the facility. Highlights of the CHP installed at the Canada Games Aquatic Centre include:

- Projected annual electricity generation: 465,000 kWh
- Projected annual thermal energy converted: 3,400 GJ (944,000 equivalent kWh)
- Projected annual cost avoidance: \$21,000 (*based on 2014 rates*)
- Approved saveONenergy incentive value \$93,000

6.4.2 Arena Desiccant Dehumidification

Facilities replaced the mechanical dehumidifiers with desiccant dehumidification at Earl Nichols Arena and Oakridge Arena. Desiccant dehumidifiers provide superior moisture removal performance at low temperatures which contributes to their energy efficiency improvement when compared to mechanical/direct expansion dehumidifiers.

6.4.3 High Efficiency Lighting

In 2016, the Corporation continued to explore LED technology for parking lots and for municipally owned facilities. The previous generation of energy efficient lighting – T5 fluorescent which replaced metal halide - at a number of arenas is reaching the point in its service life where a large scale re-lamping is coming due. This point in the fixtures' lifecycle presents an opportunity to replace the existing fixtures with high efficiency LED fixtures. Facilities is progressing on a multi-year replacement program to do this related to the 2016 Budget Amendment (Case #19).



In addition to the standalone energy retrofit measures like this arena lighting program, the Facilities Division continues to develop lifecycle renewal project scopes based upon renewal needs and energy efficiency opportunities.

All the lighting upgrades completed and in process in the past year are shown in Appendix A.

The continued quick payback and return on investment associated with lighting retrofit projects

proves their effectiveness as energy conservation projects. The Corporation continues to review capital assets to identify opportunities where lighting upgrades can be completed which will make the building inventory more efficient operationally.



7 Green Fleet

The Corporation's Fleet Services Division is responsible for over \$49 million in municipal fleet and equipment assets. Services include vehicle and equipment purchases and disposals, maintenance and service, asset management/administration and fuel management including refuelling stations. Fleet Services' vehicles and equipment support over 30 City of London service areas including Water, Sewer, Wastewater, Transportation, Solid Waste and Parks & Recreation. Fleet Services also provides various services to agencies, boards, and commissions including London Public Library, Tourism London, London Animal Care Centre, EMS, Fire and Police Services. The Corporation's equipment and fleet consists of over 1,300 units ranging from hand held equipment like string trimmers, to light passenger vehicles, to heavy off-road equipment like graders and backhoes. City of London services are a large consumer of

fuel and Fleet Services continues to research technology that helps end users reduce both energy consumption and their environmental impacts.

Fleet Services strives to help their end users understand and implement fuel savings opportunities and how to reduce their environmental impacts. Fleet Analysts electronically track and report fuel use in vehicles and equipment through an automated system called Petrovend. Additionally, they continue to invest in telematics systems that closely monitor usage patterns (utilization), idling, driver performance (speeding, rapid starts, harsh cornering) and route optimization (trip maps, Global Positioning System (GPS)).



7.1 Green Fleet Initiatives

The “Green Fleet” conservation initiatives currently underway include:

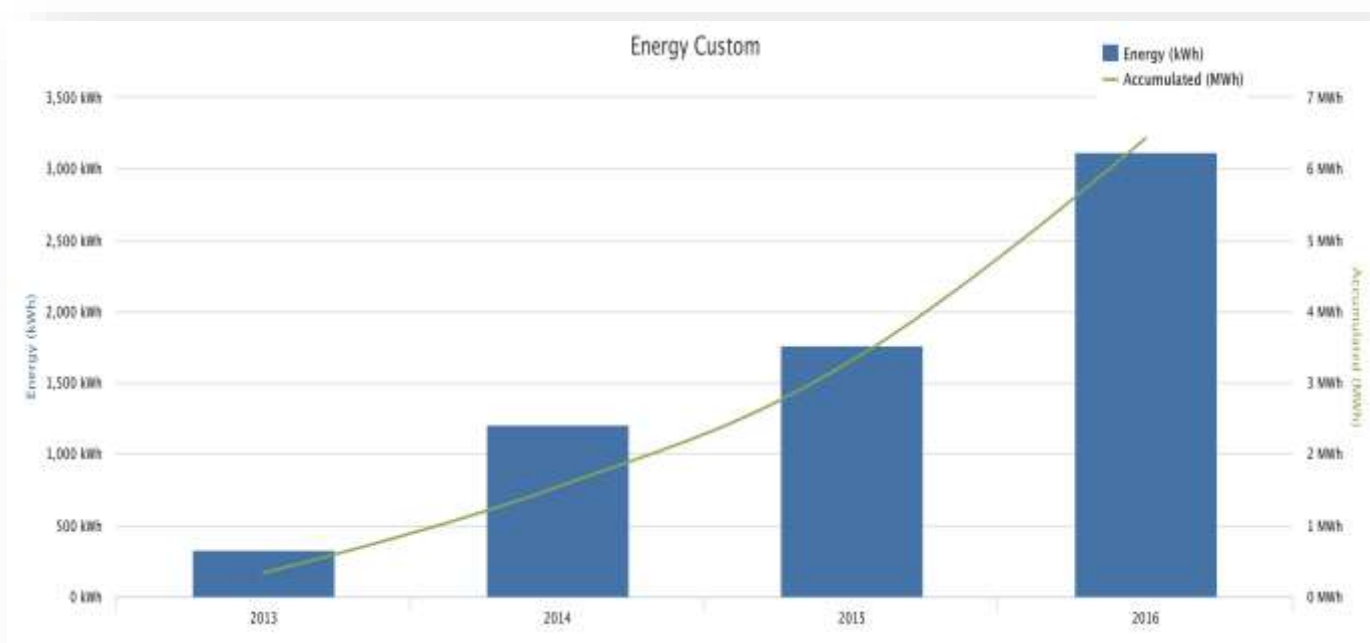
- Continued use and replacement of gas-electric hybrid vehicles where model types are available and add value.
- Move away from hybrid vehicles if suitable high-efficiency right-sized solutions provide better value without significant additional environmental impact.
- Replacement of full-size work vans with more-efficient Ford Transit vans and in some cases downsized even further to high-efficiency Ford Transit Connects.
- Continue to expand cab heating technology, where effective, to reduce the idle time necessary for warm up, engine controls and cab heat in the winter months.
- All gasoline used is ethanol blended to E10 (10% ethanol content).
- 38 medium and heavy units now include DEF (diesel exhaust fluid) selective catalytic reduction systems.
- 85 Automated Vehicle Locator (AVL) Units installed with plans for an additional 50 units by year end as part of the Computerized Maintenance Management System (CMMS) roll out.
- Preparing a formal Green Fleet Plan for direction and approval (fall 2017).
- Introduction of the “Service Area Fleet Champions” project to help facilitate changes to standard transportation solutions.
- Feasibility study work on alternative fuels particularly Compressed Natural Gas (CNG) for solid waste collection trucks.
- Engaging partners at E3 Fleet Challenge Ontario to continue to work toward best practices and sustainable strategies

Today, the current City of London “Green Fleet” Roster consists of:

City of London “Green Fleet” Roster Vehicles / Equipment Type	Number of units in service
Hybrid SUVs	20
Hybrid Cars – C-Max	8
Full Electric Vehicle (EV)	1
Selective Catalytic Reduction (SCR) Systems using Diesel Exhaust Fluid (DEF)	30
Vehicles using Ethanol blended Gasoline	221
Units using B5 biodiesel blend	50
Total Green Fleet (in rolling stock)	330 (55% of 600 rolling stock)

7.2 Electric Vehicle (EV) Charging Stations

The ChargePoint EV Charging Station at City Hall provides statistics on utilization and these statistics have shown an increase in the number of charging sessions year-over-year since installation in 2013. Since 2016, utilization has ranged between 90 and 100 percent during business hours.



Number of Charging Station Sessions per Year at City Hall

Realizing the demand increase for charging stations, the City conducted a survey in January 2017 of City employees to determine the interest in having long- term (Level-1) EV charging spots at major City-owned employment sites for City employees who routinely park for eight hours or more. This survey also included

an assessment of their willingness to pay for the use of these dedicated 120 volt (Level-1) standard wall outlets for EV charging spots as well as 240 volt Level 2 charging stations. Over an eight hour period, a dedicated 120 volt wall outlet is capable of providing enough charge (at 12 amps) to add about 50 to 65 kilometers of range depending upon the EV model. Compared to providing Level 2 charging (a 240 volt AC outlet – capable of adding about 25-35 kilometers of range per hour), Level 1 would be a lower-cost solution capable of providing enough range for most City employees to return home.

Reviewing the results of 2017 January survey, City has shortlisted locations as having major employee demand:

- City Hall
- AJ Tyler Operations Centre
- Fire Hall number 1,2,3,6,8,11 and 14
- South London Community Centre, CGAC, North London Optimists Community Centre and Kiwanis Seniors Centre (optional)

As a next step in the process of promoting EV charging stations, City has commissioned its energy service partner, Ameresco Canada, to complete the feasibility study for EV charging stations. The scope of work for the study has been divided into two parts:

Part 1 – EV Charging Employee Access: Includes detailed business case/study for Environmental Programs and Facilities Services detailing options and costs associated with providing EV charging at Corporate facilities for employees.

Part 2 – EV Charging Visitor Access: Includes complete feasibility and business case for installing one Level 2 charging station at South London Community Centre, CGAC, North London Optimists Community Centre and Kiwanis Seniors Centre (optional), including pros and cons of making these free for use versus “pay for use” (i.e., the number of utilization hours required to recoup the added costs associated with “pay for use” level 2 units).

The results of this study will enable City staff to provide Council with information to determine any further steps the City might want to take with respect to implementing its own internal EV charging network.

City staff continue to review and support education and awareness opportunities brought to our attention from EV vendors, associations and community groups. Also, the Corporation continues to work with London Hydro in identifying new programs to encourage and support the use of electric vehicles.

8 Energy Procurement

As mentioned in 2013-2015 Corporate Energy Management and Activities report, the Corporation continues to work with Wattsworth Analysis Inc. as its procurement advisor. The Corporation uses energy procurement strategies in an effort to mitigate the cost of energy. Since 2005, summaries of our accounts



indicate that our electrical procurement strategy has helped to avoid over \$6.5 million in accumulated electricity costs versus the use of the Provincial Government’s Regulated Price Plan (RPP).

Applying the most economical rate class allowable to the Corporation’s varied electrical accounts is one of the near term strategies on increasing and maintaining cost efficiencies in electricity procurement and will be a focus of upcoming discussions and market assessments. Near the latter part of 2016, many mid-size accounts that had previously benefitted from a spot market billing structure were shifted over to RPP plans as the price difference lowered. RPP accounts have Global Adjustment costs incorporated.

In addition to procurement strategies, Wattsworth provides projections in commodity price forecasts for electricity and natural gas. This assists the Corporation to project long term budgetary considerations in preparation for budget projections. Currently, projections indicate rate change increases for the next four years for electricity and natural gas contracts. There is expected to be some short term relief on electricity costs from Global Adjustment cost escalation as the Province refinances the portion of the cost associated with the 20 year generation contracts that it signed and extends them to 30 years. It is not clear yet that this relief will apply to only residential units or will include small City buildings as well, hence not included in the current electricity projections. These projections in market forecasts give the Corporation the opportunity to prepare for increased operating costs and to develop additional measures to mitigate some of these financial impacts.

Market influences including the technology advancements have seen natural gas projected price increases mitigated. Natural gas prices are more volatile than electricity prices and hedging strategies have continued to be employed to reduce potential cost exposure. The overall percentage is decreasing over time as one hedge expires at the end of October in 2017.

Annual Commodity Price Adjustments			
Year	Electricity % Change	Natural Gas % Change	% Fixed Price (Hedged) (based on consistent quantity of 387GJ's/day)
2017	4.3%	5.6%	73.2%
2018	4.4%	6.2%	54.3%
2019	4.8%	7.3%	45.2%
2020	5.1%	7.8%	0.0%

9 Culture of Conservation

Engaging City staff and stakeholders in energy conservation initiatives is a challenging, rewarding and proven method of achieving conservation targets. With energy costs on the rise, Londoners expect their government to lead the way.

The City has a corporate energy program to embrace a culture of conservation called **energyMatters, people. thinking. green.** This program was launched in 2013 at various City facilities including office spaces, operation centres and WWTP’s between 2013 and 2015. This program scope extended corporate wide in 2016 and some of the simple and

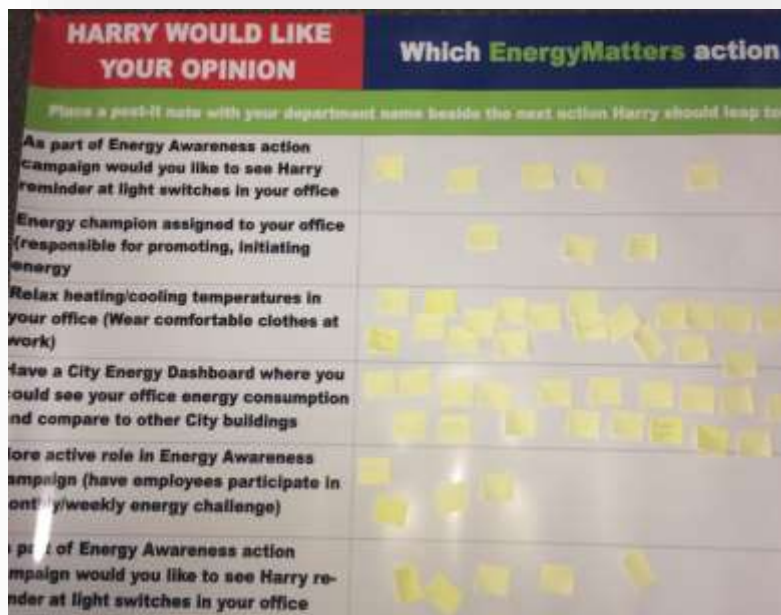


“quick win” deliverable actions that employees have taken part to provide assistance in a broader education and awareness approach to conservation in 2016 included:

Employee Engagement Event – 2016 employee event presented an excellent occasion meet staff in person and answer questions on corporate energy consumption. Since there was a gap in *energyMatters* program in 2015, this event presented an opportunity to solicit input from employees to assist in the re-development of the program. Feedback received from this event helped the Energy Management team to list series of employee engagement activities that the City can undertake for the coming years.

Temperature and Space Heater Policy -

It has been identified that use of unauthorised space heaters, fans which combined with manual adjustments to thermostat settings at various employee locations can create hot and cold spots within the working area. This can cause the centralised heating/cooling system within City buildings to operate inefficiently. From the employee event in Fall 2016 it was noted that City employees are aware of this issue and have shown interest to participate in initiatives that makes the work space more comfortable. Using of space heaters incorrectly can also present a fire safety hazard.



In an effort to address the items noted above while providing clear criteria for the addressing thermal comfort concerns, the Corporation is contemplating the implementation of a policy or practice relating to this subject. The main purpose of such a policy or practice would be to:

- Provide a formalized standard on indoor temperature ranges to be expected by building occupants based on industry standards.
- Provide staff a documented policy of accepted standards to and process with which to address indoor thermal comfort concerns.
- Prevent inefficient and wasteful operation of centralized heating and cooling equipment.
- Reduce utility costs associated with electricity or with natural gas. Appropriate and efficient use of these resources contributes to the corporate goal of reducing greenhouse gas (GHG) emissions.
- Adhere to the safety aspect of using a Space Heater within City offices.
- Contribute towards the City of London’s Strategic Plan of Building a Sustainable City.
- Assist in achieving Corporate Energy Conservation and Demand Management Plan (CDM) targets by providing appropriate space temperatures as efficiently as is possible.



Re-launching the Energy Mascot and Extended Holiday Energy Message – resurrecting City’s energy mascot was crucial to re-launching *energyMatters* program. Harry – the leopard frog, native to the Thames River has been energy mascot for the City since 2013. In 2016, with the help of City’s communications division, Harry’s image has been designed to suit various energy messages for employees.

One of the best practices, which have been followed by many private and government organizations as employment awareness activity, has been to send out energy shutdown reminders before any long weekend or extended shutdown periods. The Corporation has implemented this reminder message starting holiday shutdown in December 2016. City staff tracked energy reduction for each long weekend and compares it to the same weekend for previous year and identifies buildings with best energy reduction numbers. This year over year information

is also shared with employees in energy messages, which encourages employees to shut down further for the next long weekend.

Building Operator Certification – in Fall 2016, the Corporation had six facility staff members complete the “Building Operator Certification” course for which the City will recover its costs through IESO, Union Gas and London Hydro.

Appendix A

2016 and ongoing Energy Conservation Projects

Facility Name	Project Name	Estimated/Actual Electricity Savings (MWh)	Estimated Completion Date (DD-MM-YY)	Actual Completion Date (DD-MM-YY)
Elgin Middlesex Pump Station (EMPS)	EMPS Pumps	850 MWh	31-12-17	
City Hall	Phase 1 of the LED Streetlight Upgrade Program	4,958 MWh	10-08-15	05-07-16
AJT Operations Centre	Exterior Lighting Upgrades	49 MWh	31-03-17	25-11-2016
Kiwanis Senior's Community Centre	General Lighting Upgrades	9 MWh	15-01-16	22-01-16
Carling Heights	General Lighting Upgrades	2 MWh	03-03-17	25-11-2016
Canada Games Aquatic Centre (CGAC)	CGAC Cogeneration project	465 MWh	31-03-17	06-06-17
Centennial Hall	Centennial Hall Building Automation	25 MWh	31-12-17	
Allen.J.Tyler (AJT) Operations Centre	AJT Lighting	47 MWh	30-06-17	Scheduled for installation to start in July 2017
South London Community Pool	South London Community Centre (CC) Pool Lights	21 MWh	31-12-17	
Carling Heights	Carling Heights CC Pool Lights	20 MWh	30-06-17	Pending
AJT Operations Centre	AJT 2nd Floor Office Lighting	13 MWh	31-03-17	25-08-2016
Arva Pumping Station	Arva Pumping Station Pumps	1,125 MWh	31-12-17	
Earl Nicols Recreation Centre	Arena Desiccant Dehumidification	86 MWh	30-06-17	16-09-2016
AJT Operations Centre	Garage - high bay lighting	32 MWh	30-06-17	Pending
AJT Operations Centre	Heating ventilation and Air Conditioning (HVAC) upgrades	4 MWh	30-06-17	
Oakridge Arena	Arena Desiccant Dehumidification	17 MWh	30-06-17	27-01-2016

Lambeth Community Centre	Interior Lighting Upgrades	6 MWh	30-06-17	25-11-2016
North London Optimist CC	Replace 4 pad mounted HVAC units	4 MWh	31-03-17	27-11-2015
Greenway Wastewater Treatment Plant	Greenway Aeration Blowers-Section 1-3	4,500 MWh	17-02-17	15-06-17
Earl Nicols Recreation Centre	Nichols Arena - Lighting Upgrades	3 MWh	31-03-17	25-11-2016
City Hall	City Hall Executive Parking Garage Lighting Upgrade	29 MWh	22-09-15	22-09-16
Adelaide Operations Centre	Parking Lot Light Replacement	1 MWh	31-12-17	
City Hall	Arena Programming Consolidation	116 MWh	31-12-16	09-01-16
Argyle Arena	Argyle Arena - Equipment Summer Schedule	25 MWh	06-01-16	06-06-16

Appendix B

Incentive Funding Chart

Organization	Program	Year	Funding Amount	Comments	Status
London Hydro	Process and Systems Upgrade Incentive (PSUI) Program	2016	\$27,756	EEM Program – FTE Burden Recovery Y4/Q1	Received
London Hydro	Retrofit Program	2016	\$11,119	Dearness Home Energy Audit	Received
London Hydro	Retrofit Program	2016	\$4,045	Carling Arena Energy Audit	Received
London Hydro	Retrofit Program	2016	\$4,814	NLOCC Energy Audit	Received
London Hydro	Retrofit Program	2016	\$2,205	Kiwanis Senior centre Lighting	Received
<i>ENERNOC</i>	Demand Response	2016	\$2,204	Earls Nichols Arena Jan/Feb/March 2016	Received
<i>ENERNOC</i>	Demand Response	2016	\$2,204	Earls Nichols Arena April/May/June 2016	Received
<i>ENERNOC</i>	Demand Response	2016	\$2,204	Earls Nichols Arena July/Aug/Sep 2016	Received
London Hydro	Retrofit Program	2016	\$60,455	Oxford Blower Upgrade	Received
London Hydro	PSUI Program	2016	\$22,600	EEM Program – CFF Y1 Invi1	Received
London Hydro	PSUI Program	2016	\$24,781	EEM Program – FTE Burden Recovery Y4/Q2	Received
Union Gas	Enersmart - Prescriptive	2017	\$4,000	AJT Boiler Upgrade Project	Received
<i>ENERNOC</i>	Demand Response	2017	\$2,204	Earls Nichols Arena Oct/Nov/Dec 2016	Received
Union Gas	EnerSmart-prescriptive	2017	\$18,000	Normal School boilers and ERV	Received
<i>ENERNOC</i>	Demand Response	2017	\$2,006	Earls Nichols Arena Jan/Feb/March 2017	Received
Union Gas	EnerSmart-Custom	2017	\$7,485	CIET Building Operator Certification	Received
London Hydro	PSUI Program	2017	\$146,900	EEM Program – FTE Burden Recovery Y4/Year-end	Received
London Hydro	PSUI Program	2015	\$93,000	CGAC – CHP	In Process
Hydro One	Retrofit Program	2014	\$369,000	EMPS Pump Replacement	Pre-Approval
			\$164,387	Total for 2016	
			\$344,979	Total Received (2016,2017)	
			\$462,000	Total in Process since 2014	

**ENERNOC* – a company that specializes in utility analysis by using their Energy Intelligent Software (EIS). They work with various businesses and organizations on Facility Analysis Optimization, Demand Response, Demand Management etc., to improve operational performance.