THE CITY OF WINDSOR
ONTARIO, CANADA

Corporate Energy Management Plan

2019-2023

City of Windsor

Corporate Energy Management Plan 2019 - 2023

Prepared for the City of Windsor - June 2019

Prepared by:

City of Windsor
Energy Initiatives Unit
Asset Planning Division
Finance Department

Acknowledgements

The Energy Initiatives Unit / Asset Planning Division of the Finance Department of the City of Windsor prepared The Corporate Energy Management Plan in compliance with Ontario Regulation 507/18 of the Electricity Act 1998.

The document has been developed in co-operation with and participation of City of Windsor Employees as identified below:

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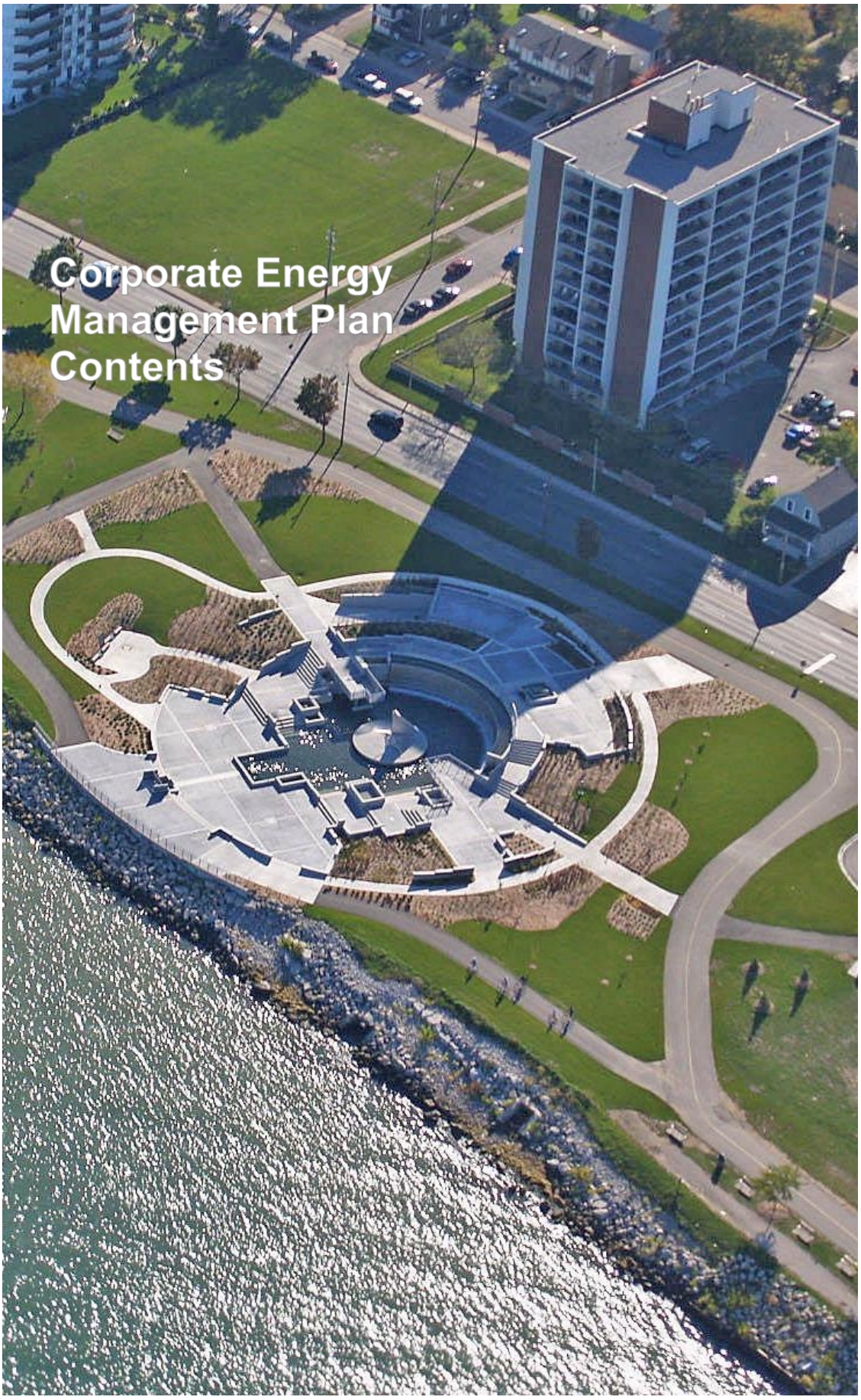

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Section 0
Acronyms, Abbreviations & Definitions

Acronyms and Abbreviations:

BAS – Building Automation System
BEPI – Building Energy Performance Index
CHP – Combined Heat and Power
CSA – Canadian Standards Association
eCO_2 – Carbon Dioxide Equivalent
ekWh – Equivalent kilowatt-hour
EMIS – Energy Management Information System
EMP – Energy Management Plan
FIT – Feed-In-Tariff
GA – Global Adjustment
GHG – Greenhouse Gas
HOEP – Hourly Ontario Electricity Price
HPS – High Pressure Sodium
HVAC – Heating, Ventilation and Air Conditioning
IESO – Independent Electricity System Operator
kWh – Kilowatt-hour
LDC – Local Distribution Company
LED – Light-Emitting Diode
LRPCP – Little River Pollution Control Plant
LRWRP – Lou Romano Water Reclamation Plant
m^3 – Cubic meters
ML – Million liters
MWH – Megawatt-hour
NHL – National Hockey League
OHL – Ontario Hockey League
OPA – Ontario Power Authority
PSUI – Process and Systems Upgrade Initiative
PV – Photovoltaic
RFQ – Request for Quotes
TSSA – Technical Standards and Safety Authority
VFD – Variable Frequency Drive
WFCU – Windsor Family Credit Union Centre
WIATC – Windsor International Aquatic and Training Centre

Section 1
Executive Summary

1.0 Executive Summary

1.1 Introduction

This Energy Management Plan (EMP) is prepared in compliance with Ontario Regulation 507/18 of the Electricity Act 1998.

Energy conservation and the strategic management of energy usage are critical steps in contributing to reducing the effects of greenhouse gas emissions on the environment, ensuring a reliable energy supply, and securing a sustainable community.

Energy Initiatives is a division of Asset Planning under the organizational governance of the Finance Department of the City of Windsor. Energy initiatives is committed to working with internal municipal stakeholders to monitor energy use and identify opportunities to improve energy efficiency and environmental performance.

The Corporate Energy Management Plan (EMP) contained herein aligns with and supports the Municipal Environmental Master Plan, Windsor's Community Energy Management Plan and Corporate Climate Action Plan 2017. Further to this, the Plan is supported by Senior Administration and approved by Windsor City Council on June 17, 2019 as follows:

City Council
Decision
Monday, June 17, 2019

Moved by: Councillor Morrison
Seconded by: Councillor Sleiman

Decision Number: CR301/2019
That Council **APPROVE** the City of Windsor's Corporate Energy Management Plan (EMP) 2019-2023 in compliance with Ontario Regulation 507/18; and,

That Council **SUPPORT** the continuing development, implementation, and monitoring of the EMP to reduce the Corporation's energy consumption and related environmental impact; and further,

That Council **CONFIRM** the following as the Corporate Vision Statement as described in the EMP:

The City of Windsor will continue to reduce energy consumption and mitigate costs through the wise use of energy and by demonstrating environmental sensitivity. This will involve a collaborative effort to increase conservation awareness and a better understanding of energy management within the Corporation.
Carried.

Report Number: C 95/2019
Clerk's File: EI2019 8.4

Steve Vlachodimos
Deputy City Clerk/Senior Manager of Council Services
June 19, 2019

The purpose of the EMP is to create a flexible living document that sets goals, strategies, and initiatives to reduce the Corporation's energy consumption and greenhouse gas emissions.

Ontario Regulation 507/18 requires the EMP be updated at the end of the five-year period (2014 – 2018). Administration provided City Council with an updated EMP 2019 – 2023 on June 17, 2019.

1.2 Key Energy Successes 2014 - 2018

The implementation of recommendations resulting from initiating energy audits and related studies have generated the following savings, reductions, or revenues for the period 2014 – 2018:

- Total electricity savings – 17.7 million kWh or 19.8% reduction compared to 2014 consumption
- Total electricity cost savings – $2.94 million or 23.2% compared to 2014 costs
- Total natural gas reduction (2014-2017) – 680,000 cubic meters natural gas
- Annual electricity production PV Systems - 2 million kWh
- Annual corporate revenues PV Systems - $750,000
- Annual combined-heat-and-power (CHP) electricity displacement – 3.2 million kWh (2018 production)
- Annual combined-heat-and-power (CHP) thermal displacement – 475,000 cubic meters natural gas
- Annual GHG emissions reduction – 1631 tonnes

It is worth noting that the initial EMP 2014-2018 set an electricity reduction target of 10%. As identified above consumption decreased by 19.8%.

For a complete list of projects implemented in the period 2014-2018, refer to Section 4.2. Below is a brief abstract of some of the major completed projects.

1) Combined Heat and Power (CHP)

In 2017/2018, the City installed two combined heat and power systems. The CHP units are located at the Huron Lodge Long Term Care Facility and the WFCU Centre sports complex and have an installed capacity of 400 and 800 kW respectively. When fully operational they will displace over 6.7 million kWh from the provincial grid and provide 65% of the heating load of the two sites. The anticipated combined operational savings are estimated to be $631,000 annually.

2) Streetlights Conversion to LED

In 2016, the City converted over 23,500 streetlights from HPS (high-pressure sodium) to LED fixtures reducing electricity consumption by over 10.7 million kWh or 11.8% of the corporation's annual 2015 electricity usage while saving approximately $1.2 million in utility costs. In addition annual streetlight maintenance costs will be reduced by over $900,000 as the lamp recycling program will increase from once every five years to once in fifteen years. The streetlight project was completed in January of 2017.

3) Renewable Energy / Photovoltaic Rooftop Systems

The City has installed three (3) photovoltaic rooftop systems with a combined capacity of 1.35 MW. These PV projects have an annual electricity output of approximately 2.0 million kWh and generate income of $750,000.

4) Building Optimization Pilot Project (BOP)

In 2016, the City of Windsor was asked to participate in a pilot project with the Independent Electricity System Operator (IESO) and CLEAResult Engineering Consulting to perform 30 building optimization studies of the City's

highest electricity users. Buildings with over 125,000 kWh of annual consumption were identified and evaluated for low-cost and no-cost electricity conservation opportunities. An assessment of potential capital-cost upgrades was also performed for each of the 30 sites.

5) WFCU Center Upgrades

The WFCU Center implemented a number of significant upgrades between 2015 - 2018 including automated ice plant controls, LED lighting conversion in the main spectator bowl and community arenas, a dehumidification system, and the installation of combined heat and power system (CHP). These projects reduced electricity consumption by approximately 1.3 million kWh at a net capital cost of $822,000 resulting in operational saving of over $200,000.

6) The Industrial Conservation Initiative (ICI)

This is an electricity cost reduction program administered by the Province of Ontario's IESO.

One of the initiatives within the ICI program allows large electricity customers with average monthly electricity peak demand greater than one (1) MW to reduce their costs by reclassifying from Class B to Class A accounts. Class A accounts enjoy the benefit of lower Global Adjustment costs. The City reclassified the Lou Romano Water Reclamation Plant, Little River Pollution Control Plant, and the Windsor International Aquatic and Training Center. This has resulted in electricity cost savings in excess of $1.2 million for the period July 2017 to June 2018.

7) Energy Management Software

In April 2016, the City implemented EnergyCAP, an energy management software solution to assist with data monitoring and verification of the City's 600 utility accounts. The automated system eliminated various manual efforts rendering more efficient staff time dedicated to other projects. Among the many benefits, EnergyCAP dramatically improved the budget process, the ability to analyze energy information and run reports in a timely manner.

In addition to saving valuable staff time, it is estimated implementing the software will generate energy related savings/cost avoidance ranging between $50,000 and $100,000 annually.

8) Greenhouse Gas Emission Reduction

The City's efforts to achieve both energy and cost savings also result in another equally important outcome – reducing the City's carbon footprint by reducing GHG emissions. Identifying reductions in carbon dioxide (CO_2) emissions by translating abstract measurements into everyday terms can be a helpful reference. Implementing the various measures contained herein, GHG emissions during the period 2014 - 2018 were reduced by approximately 1631 metric tons and are equivalent to the following:

- Taking 499 vehicles off the road, or
- Electricity annual usage of 382 homes, or
- Carbon sequestered effect of 1918 acres of forests.

The graph below Figure 1.1 identifies the amount of GHGs emitted from the City's building and facilities. The reduction in carbon dioxide (CO_2) emissions for the period 2014 – 2017 is reflective of the various energy efficiency measures that were implemented. The increase in 2018 is in part the result of commissioning two CHP systems.

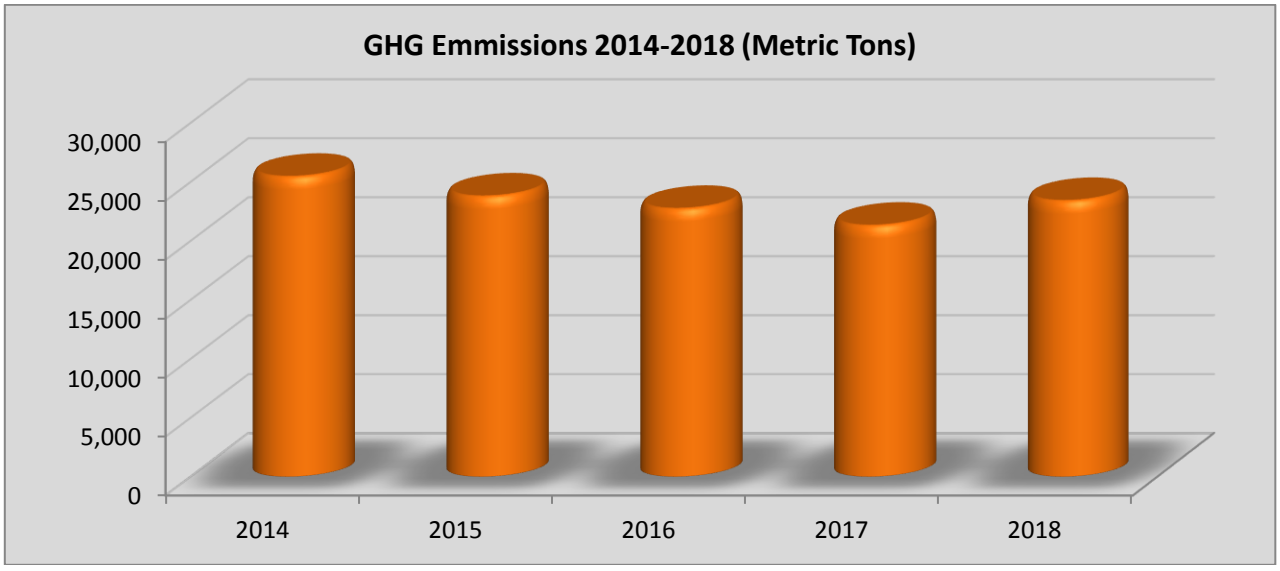


Figure 1.1 – GHG Emissions 2014 – 2018

1.2.1 Consumption Reduction and Price Volatility

The ongoing evolution of the Energy Management Plan demonstrates the City has and will continue to employ strategies that will both reduce consumption and operational costs as well as generate revenues. However, there is a caveat to be recognized, which is, the risk of volatile energy prices, specifically related to natural gas and electricity. This risk is unpredictable and can negate all or part of the financial benefit resulting from energy consumption reductions. In other words, while the City is experiencing a decrease in consumption, a corresponding decrease in costs is not a certainty and will ultimately be a function of price volatility. It is important to underscore that without the implementation of the energy reduction and efficiency measures the energy cost to the City would be significantly higher.

This cautionary note is substantiated by the electricity consumption reduction of 17.7 million kWh experienced during the period 2014 to 2018, while at the same time corporate electricity cost decreased marginally by approximately $132,000. In addition, during this period the City's cost per kWh actually increased by 23.4%. However, without the electricity consumption reduction of 17.7 million kWh, the City would have incurred an additional cumulative cost increase of approximately $2.94 million.

Section 2
Corporate Energy Management Plan

2.0 Corporate Energy Management Plan 2019-2023

2.1 Introduction

The Ontario Provincial Government has committed to assist the broader public sector to better understand and manage their energy consumption. As part of this commitment, Ontario Regulation 507/18 requires public agencies, municipalities, municipal service boards, school boards, universities, colleges, and hospitals to:

a) Continue reporting on energy consumption and greenhouse gas annually
b) Update existing Energy Management Plans every five years

Ontario Regulation 507/18 continues the focus of the need to understand how and when buildings and facilities use energy. By adopting this regulation City Administration will be better able to discover opportunities for improving efficiency, decrease consumption and ultimately generate cost savings / cost avoidance opportunities. Managing the corporation's $18 million annual utility budget (2019) requires clear strategies for our technical systems, operational staff, and occupants. Having an Energy Management Plan helps to identify goals and supports City Administration in systematically working to achieve those goals.

The initial Energy Management Plan (EMP) was developed for the five-year period 2014-2018. Contained herein is an updated framework for the EMP that will enable administration to better understand our current energy use, and what influences consumption as well as opportunities available to reduce that use. The EMP is a road map for the period 2019 – 2023, whereby energy management best practices are incorporated to deliver energy savings in an effective and flexible manner.

The Energy Management Plan is a living document that will continue to evolve throughout and beyond the 2019 – 2023 period. Surveys indicate most Ontarians have concerns about the cost of energy whether its personal home or business use. The City has an opportunity to lead by example to conserve and use energy wisely through the implementation of new technologies in concert with educational efforts to create an overall culture of energy conservation, both at home and in the workplace.

Administration will continue to report to City Council all projects being considered for implementation. Council will be provided with a detailed business case to include; capital costs, annual operating expense, return on investment; whole lifecycle cost analysis.

2.2 Corporate Vision

The City of Windsor will continue to reduce energy consumption and mitigate costs through the wise use of energy as well as demonstrating environmental sensitivity. This will involve a collaborative effort to increase conservation awareness and a better understanding of energy management within the Corporation.

2.3 Goals and Objectives

To safeguard the success and strategic direction of the Energy Management Plan, a number of goals and objectives must be aligned with its development and implementation. The goals and objectives identified below will act as a guide and provide a common focus and direction for the Plan:

- Achieve a 10% reduction in overall energy consumption over the five-year 2019 – 2023 timeframe of the EMP.
- Improve financial accountability achieved through savings and cost avoidance that will lead to both direct and indirect annual corporate savings.
- Develop a broad-based corporate awareness and commitment.
- Become a leader in energy conservation and demand management among municipalities in Ontario.
- Integrate information systems and coordinate corporate programs to support energy related actions.
- Improve energy efficiency and environmental performance.
- Introduce new technologies where prudent.

2.4 Energy Management Plan Methodology

The City of Windsor spent approximately $17.3 million in utility costs (electricity, natural gas, district heating and cooling, and water) in 2018, and operates over 230 buildings encompassing approximately 3 million square feet of space. With an ongoing commitment of time and dedicated resources for the implementation of the outlined management plan, administration believes that a significant amount of energy savings can be realized immediately, throughout, and beyond the 5-year (2019 – 2023) Plan.

The development of Energy Management Plans can have a variety of different methodological approaches; for example:

a) Building-by-Building Assessment – Identifies saving opportunities in all buildings by utilizing a prioritized scheme from the most to the least in consumption and cost reduction.
b) Payback Period – An optimized payback approach identifies each energy measures within a building and the associated estimated payback period. These measures are prioritized from the most favourable in payback years to the least.
c) Goal Specific – Establish improvement targets as a percentage of the energy usage or a percentage reduction of average enterprise wide energy intensity.

The Energy Management Plan contained herein is a hybrid of the three methods identified above, with a specific focus on the payback period and available funding as a means of prioritizing the measures considered for implementation.

2.5 Energy Management Plan Components

The Energy Management Plan outlined in this report consists of the following components:

Historical Energy Consumption and Cost
- Establishes the historical 2014 – 2018 energy use for electricity, natural gas, district energy and water. This data is the benchmark to evaluate future actions, monitor results and set future targets.

Energy Saving Measures
- Identifies energy reduction opportunities through a wide variety of technical, behavioral, and organizational measures implemented throughout the timeframe of the 2019 – 2023 5-year plan.

Renewable Energy
- Outlines renewable energy opportunities, such as roof and ground mounted photovoltaic systems, anaerobic digestion, and energy recovery.

Energy Management Plan Implementation
- Summarizes the prioritization of the various energy efficiency measures considered for implementation.

Monitoring and Evaluation
- Recommends metering systems and energy management software that provides analytical data that assists with decision-making, identifying anomalies, optimizing daily operations, and evaluating achievements related to energy reduction targets.

Section 3
Energy Consumption and Cost

3.0 Energy Consumption and Cost

3.1 Historical Consumption and Cost Data 2014 – 2018

Energy management starts with understanding how and when energy is used. The scope of this Plan is limited to energy use of electricity, natural gas, water, and district heating and cooling within the City's building portfolio including streetlights.

Table 1 below identifies the annual corporate consumption and corresponding costs for the period 2014 – 2018. The following sub-sections describe the energy and water consumption over this 5-year period.

Table 1 – Annual Energy Consumption & Cost 2014 – 2018

Utility	2014		2015		2016		2017		2018	
	Usage	Costs	Usage	Costs	Usage	Costs	Usage	Costs	Usage	Costs
Electricity [kWh]	89,498,095	$12,680,475	86,600,493	$13,384,800	82,399,462	14,501,638*	74,097,489	13,416,844*	71,606,331	12,548,341*
Natural Gas [m^3]	4,777,140	$1,447,930	4,223,073	$962,631	4,074,418	$770,524	4,101,023	$1,031,395	5,378,450	$1,102,011
Water [m^3]	505,014	$1,430,276	490,413	$1,335,606	551,739	$1,383,416	602,407	$1,479,961	619,227	$1,613,970
District Energy [MWh]	22,096	$1,987,941	24,077	$2,089,691	25,652	$1,853,468	26,051	$2,253,554	28,001	$1,998,484
Total Annual Costs	$17,546,622		$17,772,728		$18,509,046		$18,181,754		$17,262,817	

* Energy Initiatives funds a number of energy efficiency projects by allocating the anticipated annual operational savings against the capital cost of the project until the capital cost is fully recovered. Allocations/transfer have occurred as follows: 2016, $152,751; 2017, $1,320,394; 2018, $1,701,727. The electricity costs in Table 1 include those annual transfers as stated, meaning that the true cost of electricity in those years would be less by those transfer values.

3.2 Average Annual Cost 2014 – 2018 by Utility Type

Having a historical perspective of energy usage provides for a better understanding of challenges and opportunities and assists with developing strategic actions towards a sustainable net zero energy future. Below is an analysis of the City's average consumption and cost experience over the period 2014 – 2018.

Figure 3.1 demonstrates the average annual cost by utility type over a five-year period. Electricity is by far the largest cost driver and represents 75% of the City's average annual energy expenditure. Average utility cost over the 5-year period is $17.8 million.

While the Corporation continues to make significant enterprise wide improvements in terms of energy reduction, price volatility represents a budget risk that is both unpredictable and uncontrollable.

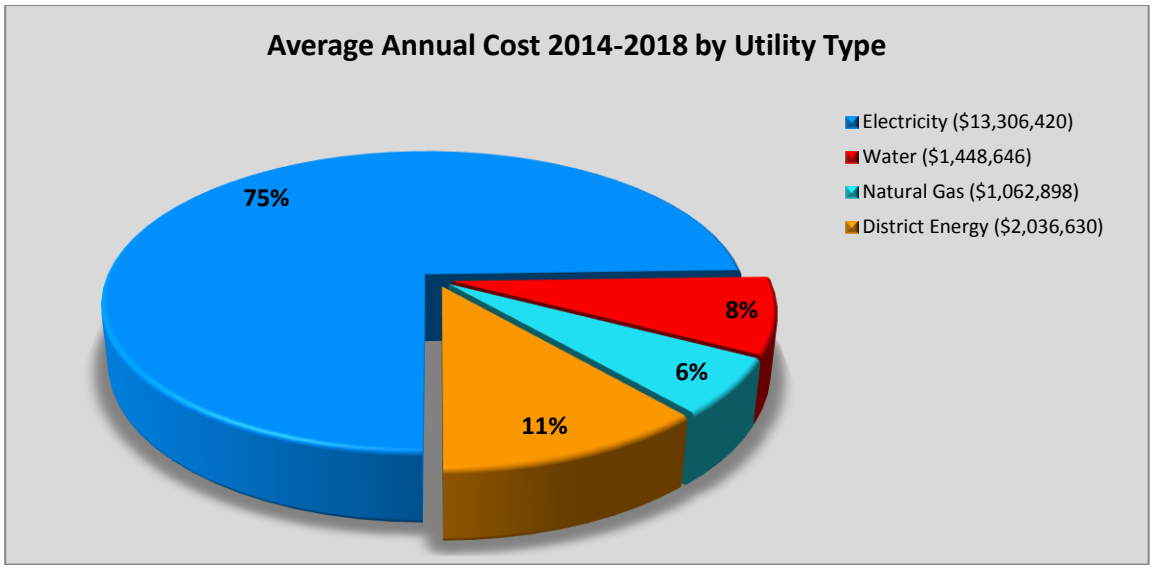


Figure 3.1 – Average Annual Cost Breakdown by Utility Type 2014 – 2018

3.3 Consumption 2014 – 2018 by Utility Type

The graphs below depict consumption by utility type for the period 2014 – 2018. During this period, the City has added the following facilities that have increased the energy and water consumption:

- January 2014 – full opening of the Windsor International Aquatic and Training Centre
- January 2016 – addition of the Windsor Public Library
- June 2016 – addition of a 25-meter indoor pool at WFCU Centre
- August 2016 – addition of a 12,000 sq. ft. Community Center at the Capri Pizzeria Recreation Complex
- 2016/2017 – replaced three Fire Halls

Electricity

As depicted in Figure 3.2, electricity consumption decreased by 19.8% between 2014 - 2018 or 17.7 million kWh and has reduced GHG emissions by 357 metric tons. This reduction is due to the energy efficiency programs implemented during the 5-year period. Overall costs have decreased by approximately 1% compared to 2014.

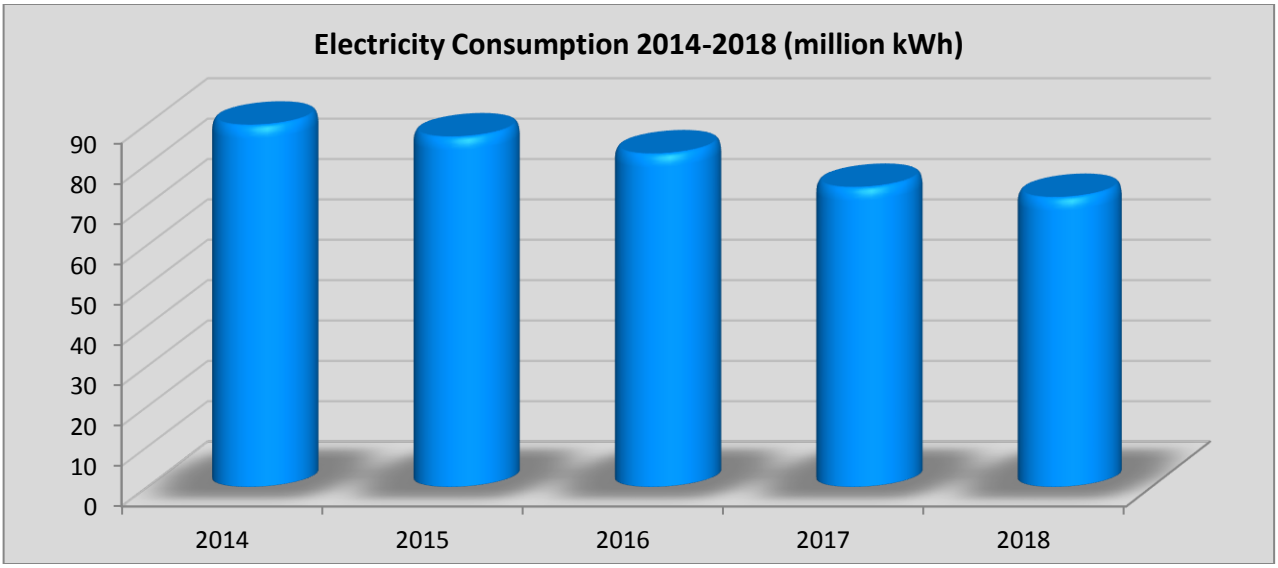


Figure 3.2 – City of Windsor Electricity Usage

Natural Gas

As depicted in Figure 3.3 below, natural gas consumption decreased by approximately 680,000 cubic meters between 2014 and 2017 as the result of numerous efficiency measures. This decrease has reduced GHG emissions by 1277 metric tons. The increase of approximately 800,000 cubic meters in 2018 is primarily the result of two CHP systems becoming operational. Commodity prices have been trending lower mainly due to significant shale gas well-drilling creating record high storage capacity. Total costs have decrease by 23.9% and cost per cubic meter also declined by 32.4% since 2014.

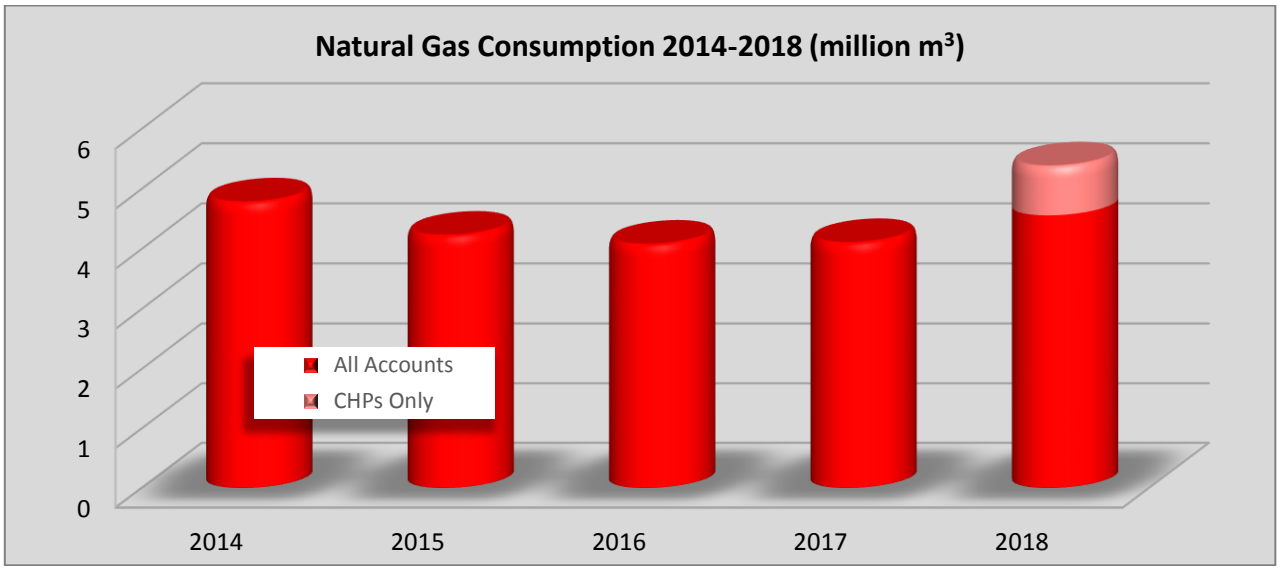


Figure 3.3 – City of Windsor Natural Gas Usage

Water

Water consumption has remained relatively stable during the period 2014-2018. As indicated in Figure 3.4, a consumption increase occurred in 2016 due to the addition of Windsor Public Libraries to the corporate

portfolio, as well as the installation of a 25-meter pool at the WFCU Center. In 2018 several site-related operational anomalies also caused consumption and cost to increase which have since been corrected.

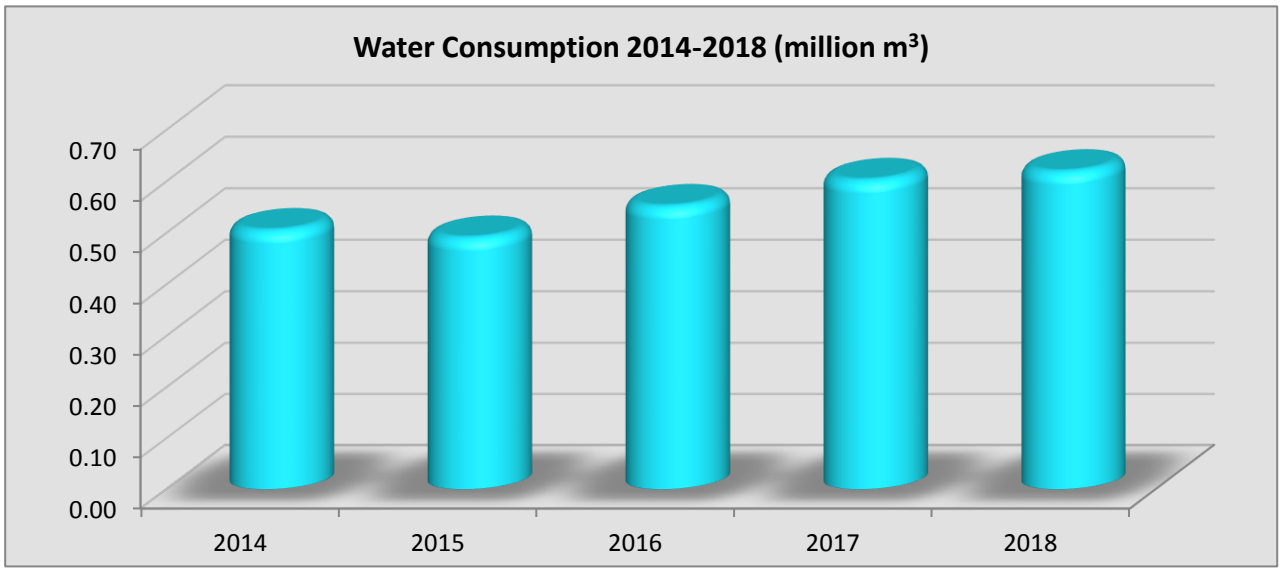


Figure 3.4 – City of Windsor Water Usage

District Energy Windsor

District Energy is the utilization from a central source that provides chilled water for cooling and hot water for heating to buildings in the district energy loop. The central source in Windsor is located at Caesars Windsor Hotel & Casino. As depicted by the graph below, consumption presented a marginal increase. The City currently has six facilities located in the downtown area that are serviced by District Energy Windsor including the new 350 City Hall completed in May of 2018. Figure 3.5 below combines the consumption of both chilled and hot water usage.

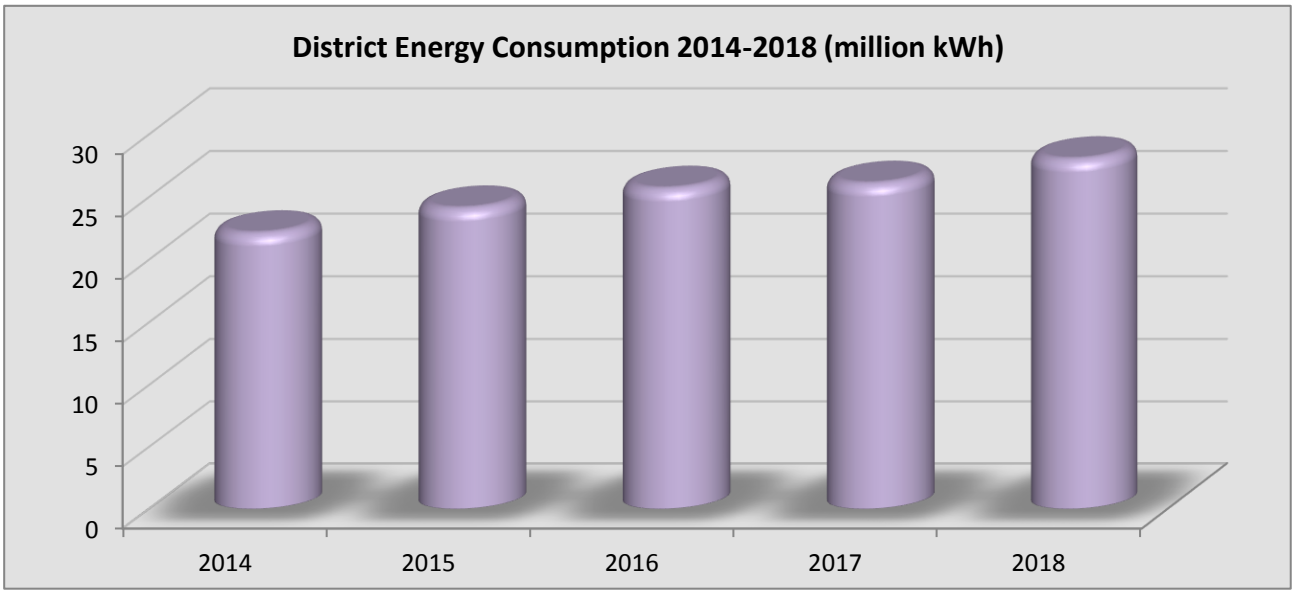


Figure 3.5 – City of Windsor District Energy Usage

In addition to the data provided in Section 3.3 above, Appendix A (to be added July 1, 2019) provides consumption data for the City's buildings as prescribed by Ontario Regulation 507/18 for the year 2017.

3.4 Electricity Consumption by Municipal Sector

Electricity is by far the corporation's largest cost driver representing 73% (2018) of the total annual utility expenditures. The following chart displays the 2018 electricity usage by the various municipal service sectors.

As depicted in figure 3.6 below, the two water treatment plants and pumping stations together with parks & recreation facilities account for 68.8% of the annual electricity consumed. Accordingly, a significant number of energy initiatives will continue to be planned and implemented for these larger users.

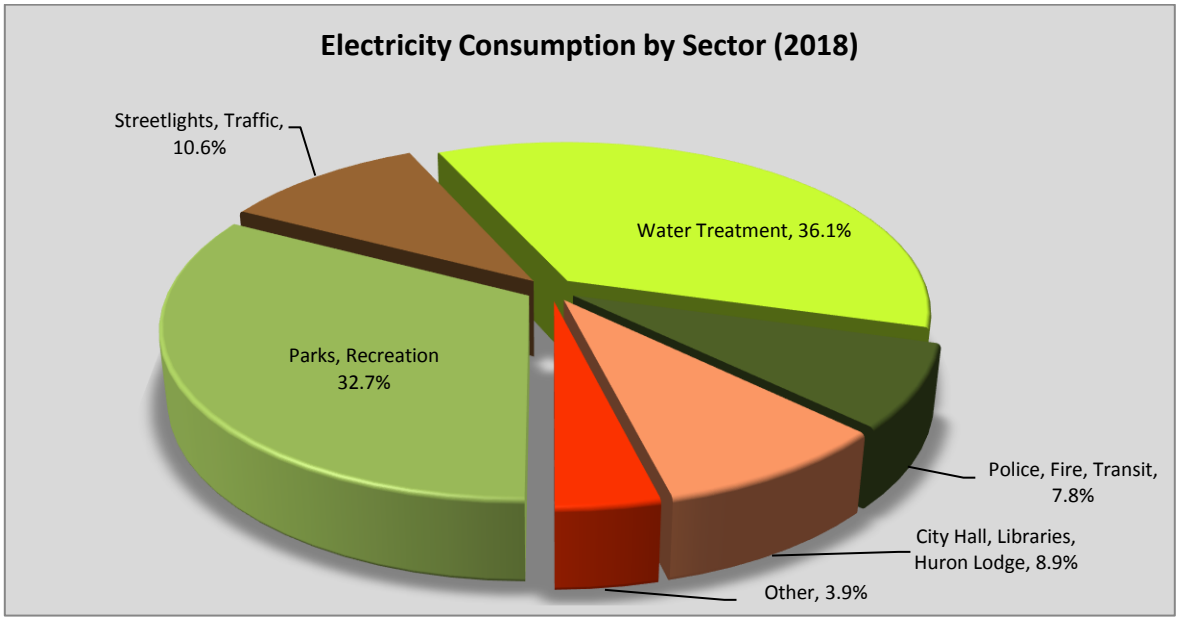


Figure 3.6 – Electricity Consumption by Sector 2018

Figure 3.7 identifies annual costs by utility type, with electricity being the more significant cost driver.

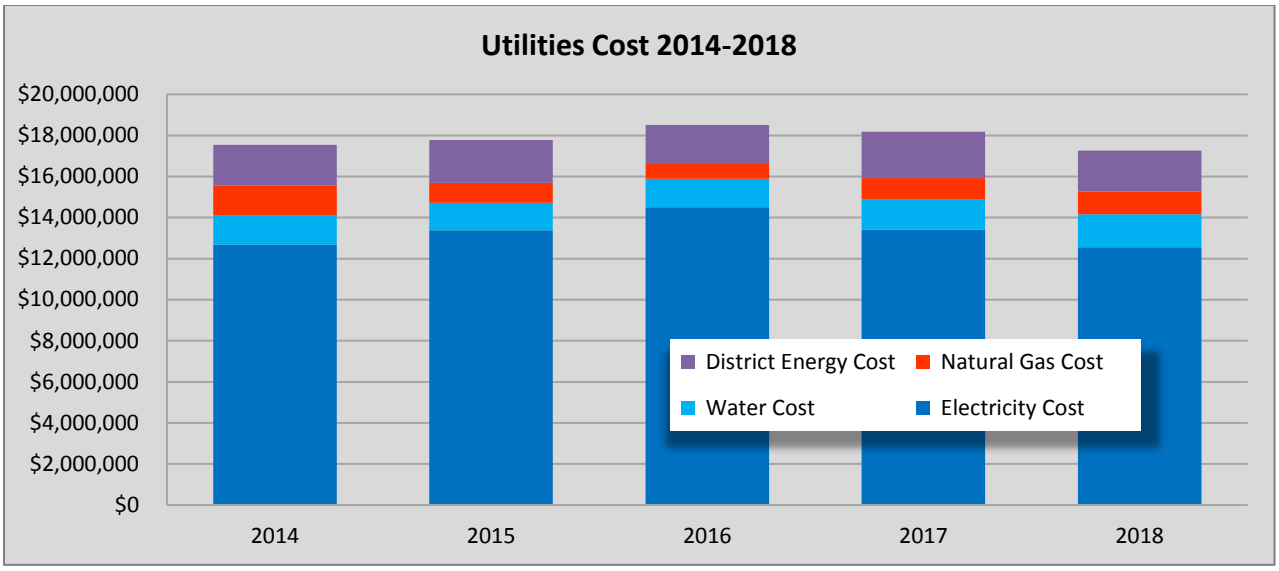


Figure 3.7 – Annual Cost by Utility Type

3.5 Cost Effects of Electricity Price Volatility

The effective commodity price of electricity per kilowatt-hour (kWh) is comprised of two parts, the wholesale price or the Hourly Ontario Energy Price (HOEP) and the Global Adjustment (GA). These two combined rates are the primary cost drivers of monthly electricity invoices.

The Hourly Ontario Energy Price is the hourly price charged to local distribution companies (LDCs). HOEP becomes the basis of the commodity charges in the retail electricity market if customers receive their electricity from their LDC. The HOEP rate continues to experience significant volatility.

The GA represents a "true-up" of the province wide electricity cost and accounts for the difference between the market price (HOEP) and the rates paid to regulated and contracted generators as well as for the cost of green energy and conservation & demand management programs. The Independent Electricity System Operator (IESO) sets the monthly GA, which also demonstrates significant price volatility similar to the HOEP. For example, the City's average annual cost per kWh increased 27.8% from 2014 to 2017 and has since stabilized due to the Provincial energy related initiatives implemented in 2017/2018. These unpredictable price swings have an impact on municipal energy budgets, which are often set 4-5 months in advance of any given year.

Figure 3.8 below demonstrates that while annual costs are lower by approximately 1% in 2018 compared to 2014, the "unit cost" or cost per kWh is actually higher by 23.4% during the same period. Again, the impact of market fluctuations and electricity cost price volatility cannot be overstated.

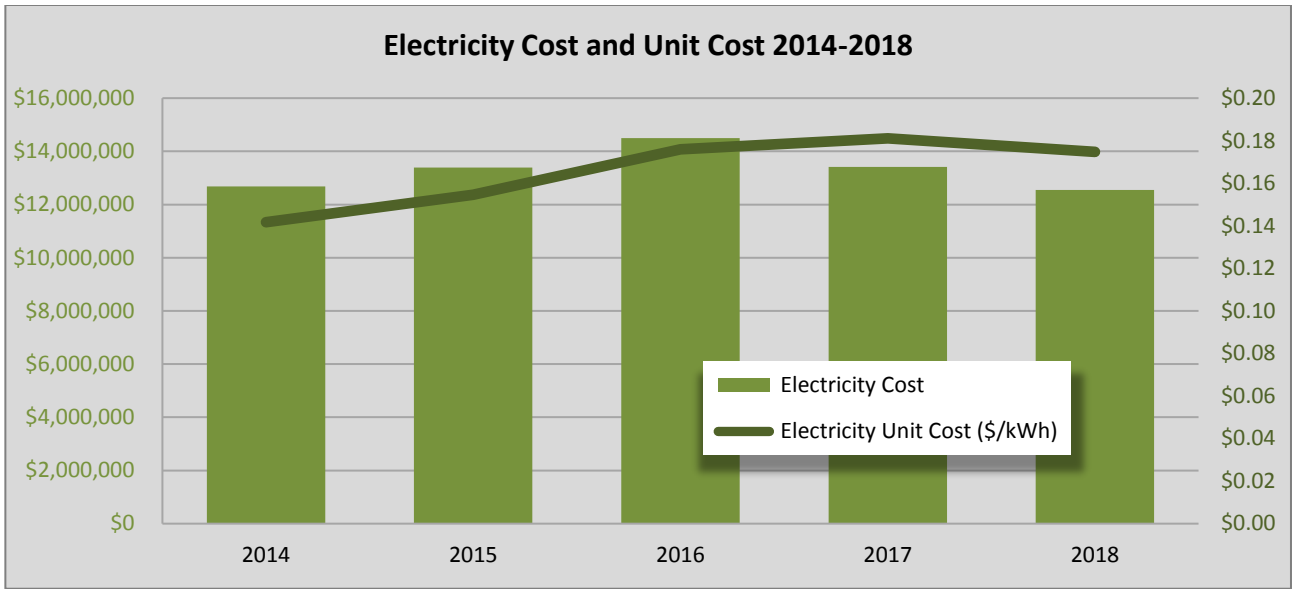


Figure 3.8 – Annual Electricity Cost and Unit Cost 2014-2018

Figure 3.9 below identifies the average monthly electricity price (HOEP plus GA) from January 2014 to December 2018. The trend line demonstrates a price increase of approximately 35% or an average of 7% annually.

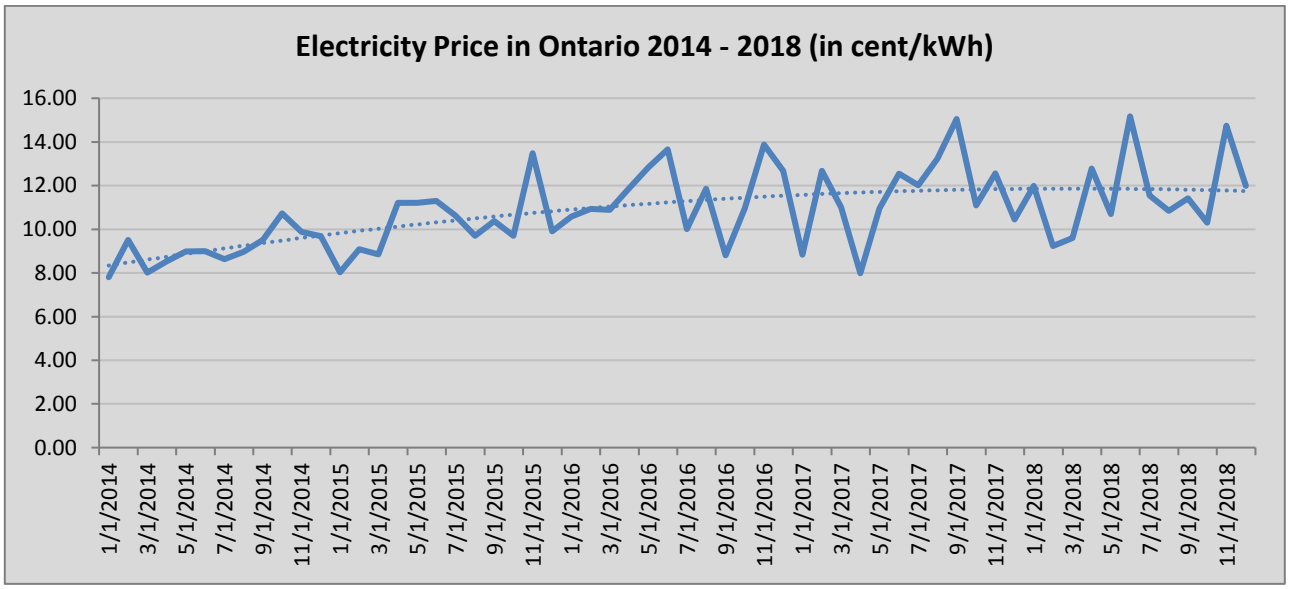


Figure 3.9 – Ontario Electricity Price January 2014 - December 2018

Figure 3.10 below identifies the annual electricity consumption for the years 2014 – 2018 against the City of Windsor's total annual electricity cost for the same period. While consumption decreased by 17.7 million kWh, corresponding costs have only marginally decreased by 1.04%. Similar to Figure 3.8 above costs also include annual capital project transfers for the years 2016-2018.

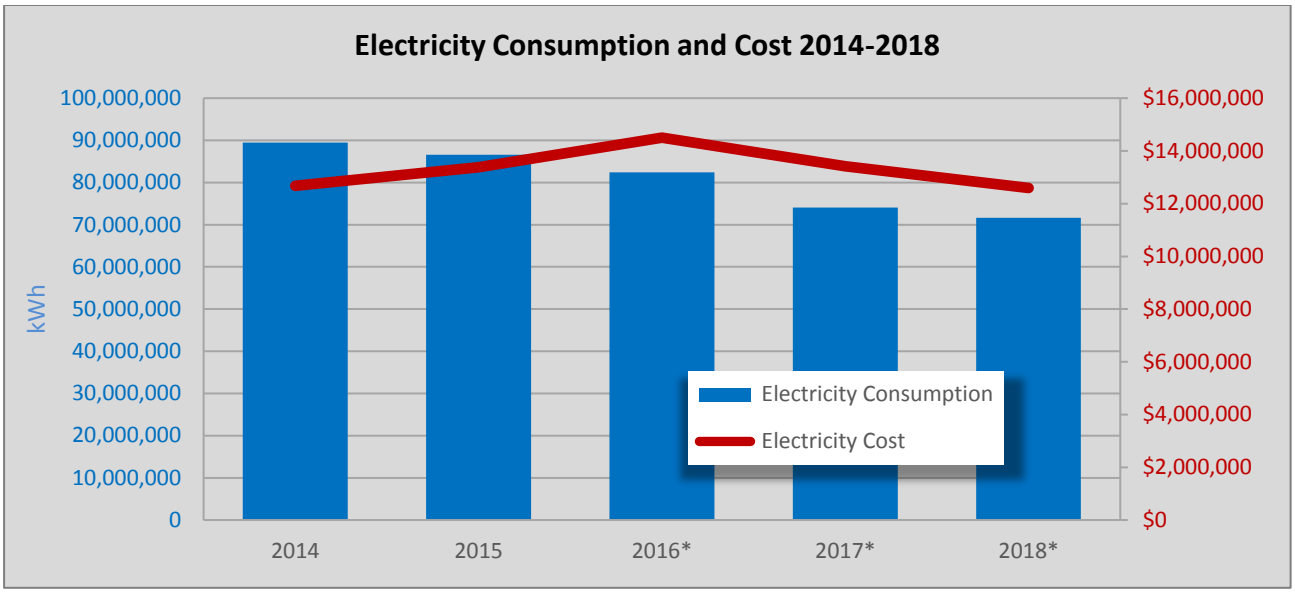


Figure 3.10 – Electricity Consumption and Cost 2014-2018

* It should be noted that Energy Initiatives funds a number of energy efficiency projects by allocating the anticipated annual operational savings against the capital cost of the project until the capital cost is fully recovered. Figure 3.10 includes annual capital project transfers of; $152,751 in 2016, $1,320,394 in 2017, and $1,701,727 in 2018. As many of the projects completed in 2014-2018 were self funded, actual electricity costs are lower by the value of the capital project transfers in the stated years.

Section 4
Energy Savings Measures

4.0 Energy Reduction Measures

4.1 Introduction

Energy Reduction Measures are actions taken to save energy and to help achieve the goals and objectives of the City. They constitute the bulk of the Energy Management Plan (EMP) implementation strategy.

There are three basic types of energy saving measures:

a) Technical Measures: e.g. lighting retrofit and redesign, upgrades to HVAC/Refrigeration systems and controls, installation of occupancy sensors, variable frequency drives (VFD).
b) Behavioural Measures: e.g. develop and implement an employee awareness and education program.
c) Organizational Measures: e.g. develop a policy requiring that all new buildings be designed to LEED Gold standard, and new equipment purchases be Energy Star rated.

This Plan will identify:

- Previous measures
- Current measures
- Future / Proposed measures
- Energy and cost savings associated with each measure (cost savings identified in Section 4.2 below are based on utility rate for the year when the energy audit or study was completed)

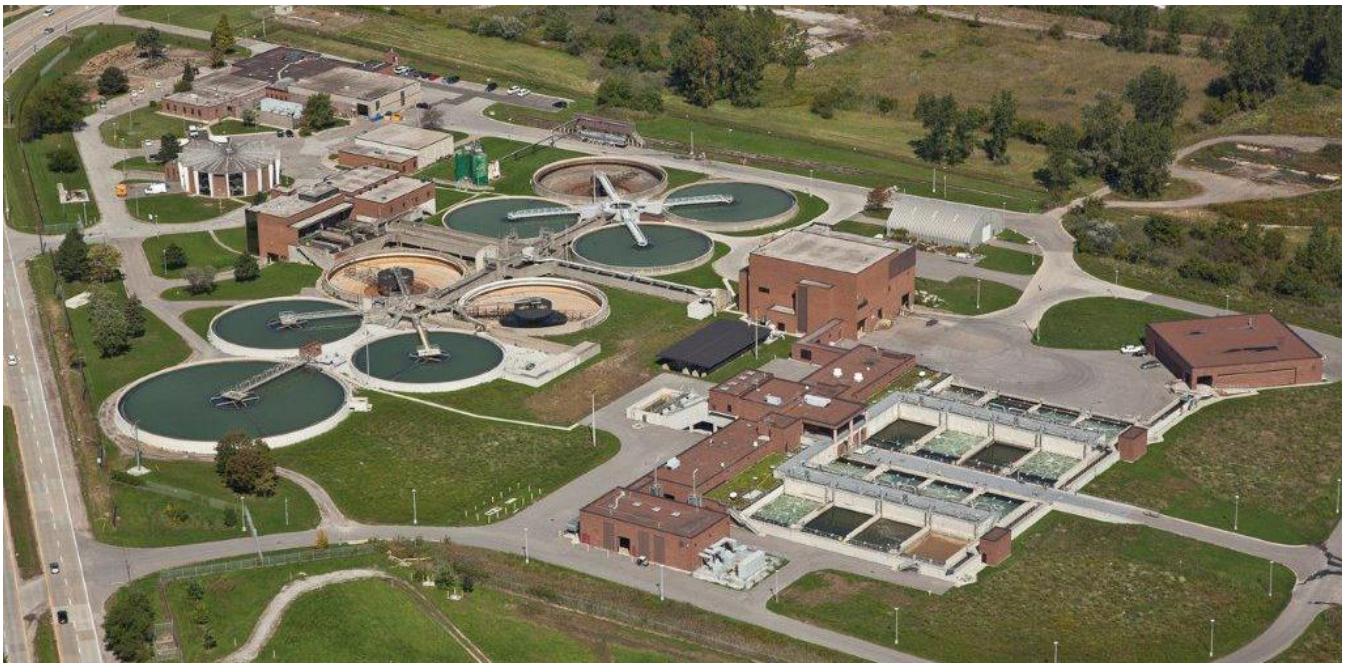
4.2 Previous Energy Reduction Measures 2014 - 2018

The City of Windsor owns and operates over 230 buildings and facilities. Throughout 2014 – 2018 a variety of energy reduction measures were implemented across a broad spectrum of building types and included the following improvements: Lighting retrofit and redesign, mechanical modifications, controls including building automation systems upgrades, new technology, electricity generation, and renewables.

Below is a description of the various projects that represent technical measures completed during this period.

4.2.1 Lou Romano Water Reclamation Plant Energy Efficiency Measures

Building Profile and Project Background



Address	4155 Ojibway Parkway
Total Floor Area (ft^2)	36,845
Storey Above Grade	1 - 2
Storey Below Grade	1 - 2
Year Opened	1969

The Lou Romano Water Reclamation Plant (LRWRP) is located on 46-acres in west Windsor and has a capacity of 273,000 m^3/day. The plant provides primary treatment (chemical) for up to 273 million liters and secondary treatment (biological) for up to 218 million liters followed by ultraviolet disinfection. The plant has undergone several upgrades and expansions, the most recent in 2008.

The LRWRP is the largest energy user within the City's portfolio of buildings. In 2015, the plant consumed 16,918,046 kWh of electricity, 264,584 cubic meters of natural gas, and 100,432 cubic meters of water for a combined annual expenditure of $2,522,647.

Variable Frequency Drives

In 2015, the installation of VFDs has reduced consumption by 24,000 kWh and annual savings of approximately $3,600.

Air Compressors

An energy audit for the Lou Romano Water Reclamation Plant compressor air system was completed in 2015. It showed that the existing 50 HP compressor was oversized. In 2017 a new 40 HP compressor, together with a storage tank and all the components was installed at the facility. The annual energy savings are estimated to be 53,800 kWh or $6,000 in annual cost savings.

Turbo Blower Detailed Engineering Study

The City undertook a Detailed Engineering Study to evaluate the economics of adding two high efficiency turbo blowers, which have demonstrated potential energy savings of approximately 30%. The previous blowers were purchased in 2005 and still had significant amount of remaining shelf life. Each of these blowers were equipped with 450 horsepower motors and in total consumed 4.5 million kWh or approximately 27.5% of the annual electricity used at the plant. One of the objectives for replacing the blowers was to reduce the requirement of operating two blowers during periods of average demand with only one turbo blower, which has a significantly higher capacity range.

The project was completed in November 2015.

Table 2 below outlines the reduction in electricity consumption and the corresponding cost savings:

Table 2 – LRWRP Turbo Blowers Replacement Program

Building Measure	Total Savings [$]	Electrical Savings [kWh]	Incentive	Total Measure Cost with Incentive	Simple Payback [Years]
Two Turbo Blowers / Annual Maintenance	$ 232,900 / $20,000	1,480,481	$248,000 (net of DES costs)	$820,500	3.2

Installation of the turbo blowers has resulted in the following savings and consumption reductions:

- Annual savings $232,900 (inclusive of $34,500 in electricity demand costs, based on 2016 electricity costs)
- Electricity savings – 1,480,481 kWh
- Annual maintenance savings $20,000
- Annual eCO_2 (GHG) emission reduction – 30 metric tons

The net municipal cost of this measure was $820,500 (including eligible incentives) with a simple payback of 3.2 years.

Figure 4.1 below identifies LRWRP electricity usage 2014 -2018 with a noticeable decrease in 2016 resulting from the installation of two turbo blowers. Consumption slightly increased in 2017 and 2018 due to significant wet weather patterns.

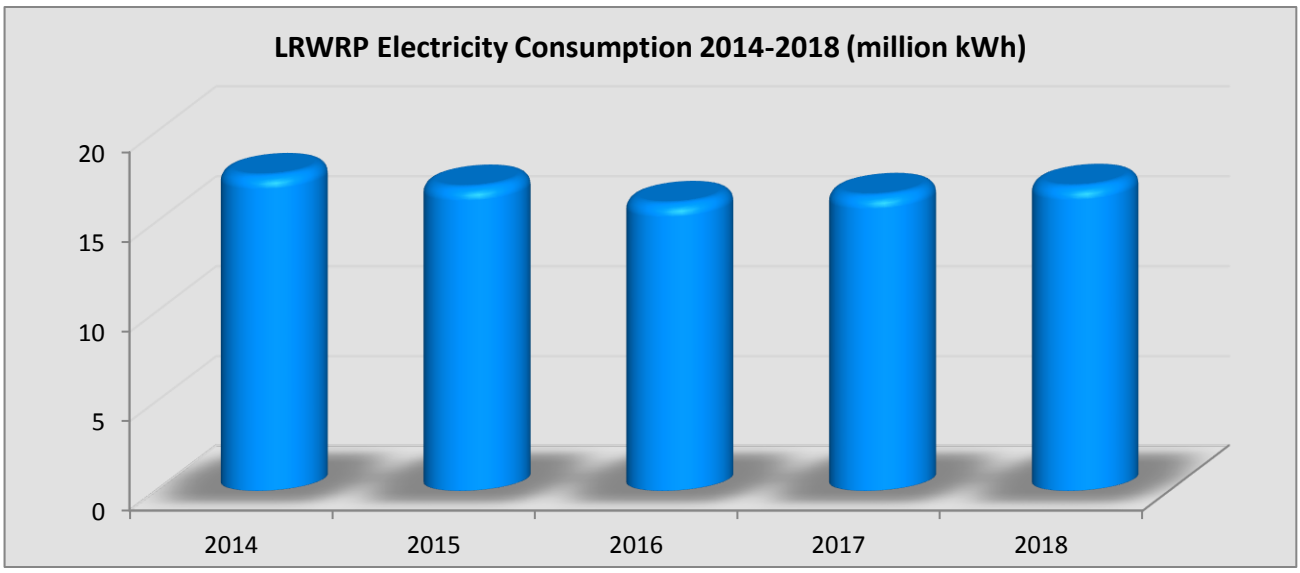


Figure 4.1 – LRWRP Electricity Consumption 2014-2018

4.2.2 WFCU Centre Lighting and Ice Plant Upgrade

Building Profile

Address	8787 McHugh Street
Total Floor Area (ft^2)	332,000
Storey Above Grade	3
Storey Below Grade	1
Year Opened	2008

The WFCU Centre is a multipurpose recreation and entertainment complex with a variety of uses. Opened in 2008, the main bowl houses a NHL size arena with approximately 6500 seats and 35 luxury suites, three community ice rinks and a 25-meter pool. In addition, there are two gymnasiums, banquet hall, meeting rooms, concession areas, dressing rooms, training facilities and retail shops. The pool was added in 2016 and a combined heat and power system (CHP) was installed in 2018.

The facility is the third highest energy user within the corporation's building portfolio consuming nearly 7.6 million kWh of electricity, 1 million cubic meters of natural gas and 26,000 cubic meters of water for a total cost in 2014 of $1,188,211.

Subsequent to an energy audit of the WFCU Centre undertaken by MCW Custom Energy Solutions Ltd in 2014, the efficiency measures reflected in Table 3 below were implemented during the years 2015-2016.

Table 3 – WFCU Centre Energy Efficiency Measures

Building Measure	Total Savings [$]	Electrical Savings [kWh]	Natural Gas Savings [m^3]	Total Measure Cost [$]	Simple Payback [years]
LED Lighting Retrofit & Re-design	$22,441	152,462		$250,747	11.2
Lighting Controls	$4,985	33,910		$5,014	1.0
Ice Plant Controls DDC	$73,500	500,000		$130,560	1.8
Building Controls Re-commissioning	$4,040	20,000	5,000	$8,220	2.0
LED Retrofit Main Bowl	$47,785	257,038		$369,616	7.7
TOTAL	**$152,751**	**963,410**	**5,000**	**$764,157**	**5.0**

- Annual cost savings $152,751 (based on 2016 electricity costs)
- Electricity savings – 963,410 kWh
- Natural Gas savings – 5,000 cubic meters
- Annual eCO_2 (GHG) emission reduction – 19.3 metric tons

The net municipal costs for this project totalled $764,157 (inclusive of eligible incentives) with a simple payback of 5 years.

In 2017, a recommission of the ice plant controls was undertaken resulting in further efficiency improvements and corresponding consumption decrease. The recommissioning included the following:

- Reducing air temperature in the rinks
- Optimizing ice temperature set points
- Calibrating the IRC Cameras
- Purging non-condensables
- Clean foot valve on condenser water supply
- Acid wash compressor heads and clean solenoids
- Water treatment to de-scale condenser coils
- Email alarm if system is turned into back up mode by operators

4.2.3 WFCU Centre Dehumidification Upgrades

In 2015/2016 WFCU Center upgraded the dehumidification units to a higher efficiency system.

- Annual savings $35,280 (based on 2016 electricity costs)
- Electricity savings – 240,000 kWh
- Simple payback 1.1 years
- Annual eCO_2 (GHG) emission reduction – 6 metric tons

The net municipal cost for this project including eligible incentives was $38,000.

4.2.4 WFCU Centre Heat Pumps

The WFCU Centre concourse is cooled and heated by two Variable Volume Air Handling units (RTU-3 and RTU-4). The units handle 18,500 and 19,970 CFM of air. They each have supply and return fans and compressors for cooling while heat is supplied by boilers.

The concourse is cooled and heated even when not occupied because there are two small occupied rooms in the area served by the HVAC system. Two heat pumps were installed in December 2017, one for each room, in order to shut down the RTUs when the concourse is unoccupied. The energy savings are calculated to be 100,000 kWh or $14,400 annually. The net project cost was $20,000 with a simple payback period of 1.4 years.

The graph in Figure 4.2 below demonstrates the impact of various energy efficiency measures undertaken during the period 2014 – 2017. Additionally, two major events occurred in 2016 and 2017, the FINA International Swimming Championships and the Memorial Cup, both of which contributed to higher electricity consumption. The commissioning of a CHP system in August 2018 saw an electricity consumption reduction of approximately 1.3 million kWh. When fully operational the CHP system will generate 4.5 million kWh of electricity annually.

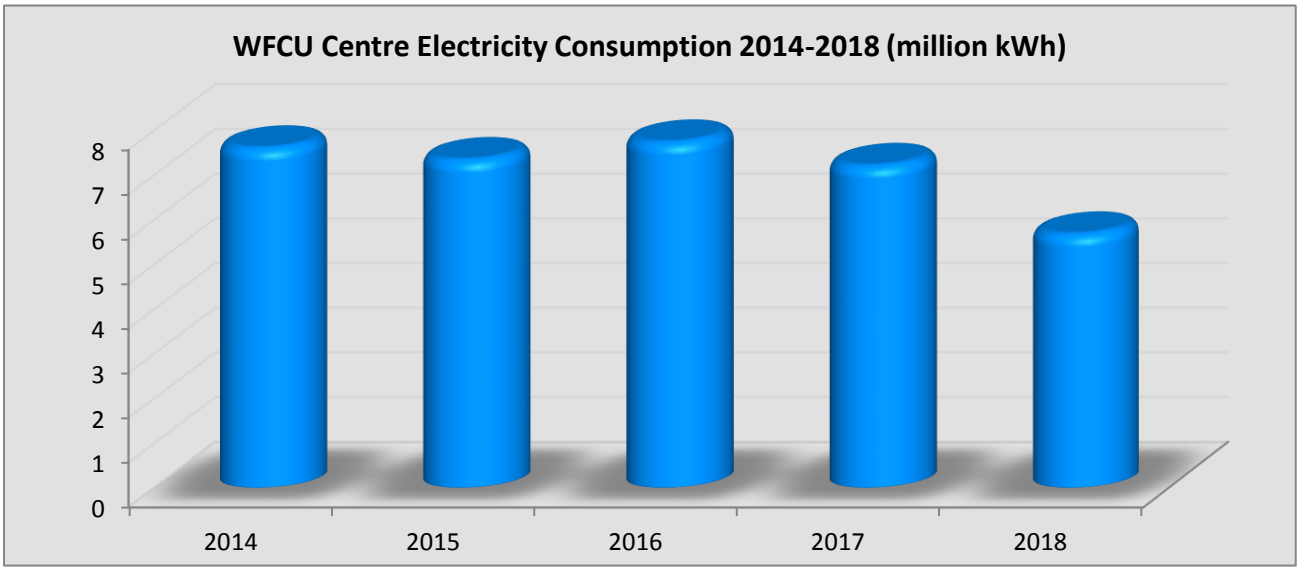


Figure 4.2 – WFCU Centre Electricity Consumption 2014-2018

* 25-meter pool was added in 2016
* CHP was added in August 2018, electricity production from the CHP represents 1,282,000 kWh.

The graph in figure 4.3 below shows the Cumulative Sum (CUSUM) of all the energy savings including the LED conversion, ice plant digital controls, installation of the CHP, refurbishment of dehumidification system, etc.

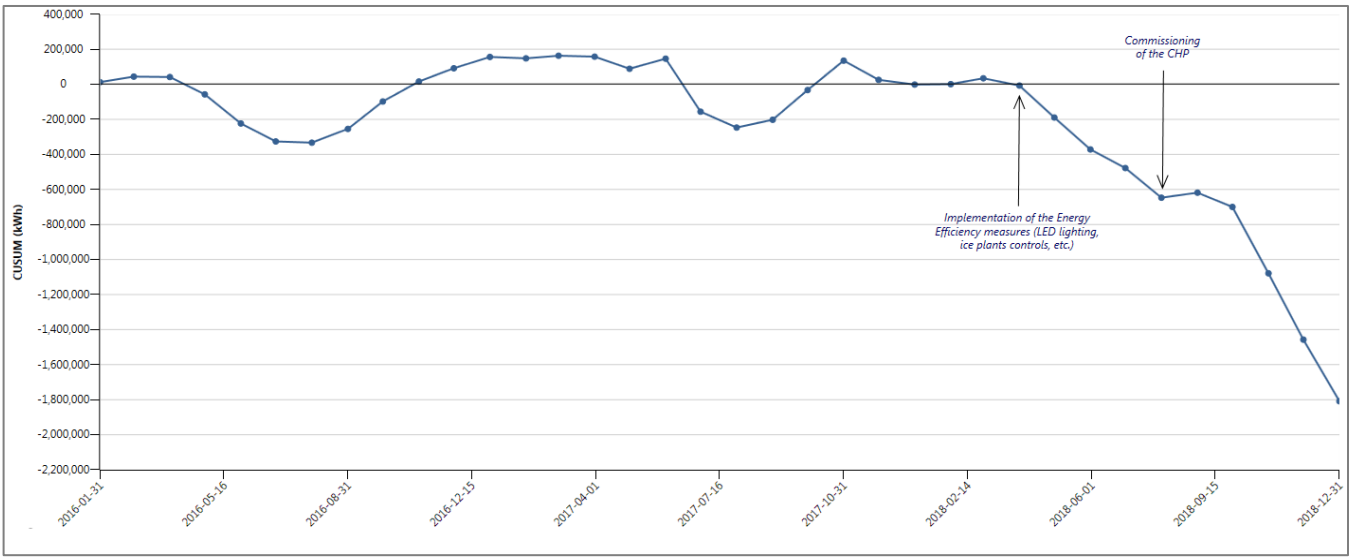


Figure 4.3 – WFCU Centre CUSUM Graph

4.2.5 Windsor Justice Facility (WJF) Humidification Upgrades

In 2015 WJF replaced the 18-year-old electric humidification system with high efficiency ultrasonic technology at a net municipal cost of $547,000. The old electric humidification setup could not meet the humidification requirements for the facility and was consuming huge amounts of electricity to supply the 1300 lbs/hr of steam required. The new system installed utilizes a low voltage / high frequency process to create a cool mist of water with no heat involved. The energy consumption of an ultrasonic humidification system is approximately 1/13 of a traditional system's consumption.

- Annual savings $103,000 (based on 2016 electricity costs)
- Electricity savings – 430,000 kWh
- Simple pay back - 5.3 years
- Annual eCO_2 (GHG) emission reduction – 9 metric tons

4.2.6 Intelligent Electronic Compressor Controller

Intelligent electronics compressor controllers were installed on approximately 60 air conditioning units at designated City buildings in the years 2015-2016. Air conditioning is one of the largest energy consumers in both the residential and industrial sectors. Many existing air conditioning units use old and inefficient technology. Installing electronic control units add state of the art intelligence to air conditioning systems and improve their energy efficiency.

An electric compressor controller is designed to detect thermodynamic saturation and to optimize the compressor accordingly. When over-capacity is detected the controller switches the compressor off and avoids inefficient over-cooling.

Table 4 below outlines the estimated reduction in electricity consumption and corresponding cost savings.

Table 4 – Intelligent Electronic Compressor Controller Project

Building Measure	Total Savings	Electrical Savings [kWh]	Total Measure Cost with Incentives	Simply Payback [years]
Electronic Compressor Controller – 60 units	$15,704	104,000	$20,000	1.2

Installation of the electronic control units was completed in May 2016 resulting in the following reduction in costs and consumption:

- Annual savings - $15,700 (based on 2016 electricity costs)
- Electricity savings - 104,000 kWh
- Annual eCO_2 (GHG) emissions reduction – 2 metric tons

The net municipal cost of this measure was $20,000 (including eligible incentives) with a simple payback period of 1.2 years.

4.2.7 City Streetlights LED Conversion

In 2016, in collaboration with Windsor's local distribution company, EnWin Utilities Ltd., the City began converting over 23,500 streetlights from high-pressure sodium to LED at a net cost of approximately $14 million. Consumption was reduced by approximately 10.7 million kWh or 60% compared to the previous year saving the City $1.2 million annually. In addition, annual streetlight maintenance costs were reduced by over $900,000 as the lamp recycling program requirements improved from once every five years to once every fifteen years. The streetlight project was completed in January of 2017.

- Annual savings - $1,167,000 (based on 2016 electricity costs)
- Electricity savings – 10.7 million kWh
- Annual maintenance savings $900,000
- annual eCO_2 (GHG) emissions reduction – 214 metric tons

4.2.8 Rooftop Photovoltaic (PV) Solar Systems

The picture below depicts the PV solar array of 1200 panels installed at the WIATC in downtown Windsor.

a) FIT 2.0

The installation of a 350 kW photovoltaic (PV) array on the roof of the Windsor International Aquatic and Training Center was completed in March 2015 under the provincial Independent Electricity System Operator (IESO) Feed-In-Tariff (FIT) 2.0 Program. The PV system generates 500,000 kWh of electricity, earning the City an income of approximately $260,000 annually.

b) FIT 3.0

The City installed two additional PV systems consisting of approximately 4,500 solar panels under IESO FIT 3.0 at the following locations:

- WFCU Center 500 kW system, commercial operation date August 2016
- Transit Windsor 500 kW system, commercial operation date January 2018

The three FIT 2.0 and 3.0 projects have a combined installed capacity of 1.35 MW with an annual electricity output of approximately 2.0 million kWh and income of $750,000. The systems were installed at a cost of $4.9 million and have a combined simple payback period of 6.5 years.

- Annual revenues (3 PV Systems) - $750,000
- Electricity production – 2.0 million kWh
- annual eCO_2 (GHG) emissions reduction to date – 40 metric tons

c) FIT 5.0

In 2017, the City received two contract approvals from the IESO under FIT 5.0 for the Little River Pollution Control Plant and the Parks and Recreation Maintenance building. The total installed capacity was 273 kW at a cost of $675,200. IESO informed the City in July 2018 that the two contracts were cancelled as directed by the Provincial government.

These two sites will be given priority in the City's future net-metering project.

Table 5 below identifies electrical production, cost of FIT projects, simple payback and contracted revenue per kWh.

Table 5 – Photovoltaic FIT Projects

Building Measure	Total Annual Revenues	Electrical Production [kWh]	Total Cost	Simply Payback [years]	IESO 20 Year Contract Value
Solar PV FIT 2	$260,000	501,000	$1.2 million	4.6	$0.539 / kWh
Solar PV FIT 3*	$490,000	1,500,000	$3.67 million	7.5	$0.329 / kWh

*The WFCU PV system under FIT 3.0 includes $720,000 to rehabilitate the roof structure and an additional $100,000 repair associated with the Transit Windsor site.

4.2.9 Combined Heat and Power Systems

Table 6 – Huron Lodge & WFCU Centre CHP Projects

Building Measure	Total Annual Operational Savings	Electrical Generation [kWh]	Total Measure Cost with Incentives	Simply Payback [years]	Incentives
Huron Lodge CHP	$203,000	2,200,000	$1,840,000	9.1	$505,200
WFCU Centre CHP	$428,000	4,500,000	$2,140,280	5	$988,800

Combined Heat and Power (CHP) or "cogeneration" systems are an efficient means of on-site self-generating electricity and thermal energy for a facility. The electricity produced partially displaces the electricity purchased from the local utility grid. The heat produced as a by-product of generating electricity is captured and utilized to offset the thermal load of the facility. These two combined processes result in overall utility costs reduction.

Table 6 above identifies the annual operational savings, system net costs, simple payback and provincial incentive values.

The installation of a 400 kW cogeneration plant at the Huron Lodge Long Term Care Facility is producing sufficient electricity to reduce the need for power from the provincial grid by approximately 2.3 million kWh annually representing 69% of the facility's 2017 consumption. In addition, the system generates the equivalent energy of 315,000 cubic meters of natural gas or 65% of the facility's current thermal needs. The plant was operational in late December 2017.

The installation of an 800 kW cogeneration plant at the WFCU Centre is producing sufficient electricity to reduce the need for power from the local utility grid by approximately 4.5 million kWh annually representing 63% of the

facility's 2017 consumption. In addition, the system generates the equivalent energy of 750,000 cubic meters of natural gas or 75% of the facility's current thermal needs. The plant was operational in August 2018.

The capital cost of the two units will be funded through annual operational savings expected to be a combined $631,000.

The picture below reflects the actual CHP unit located the Huron Lodge Long Term Care Facility.

In 2018 administration retained an engineering firm, to undertake three Detailed Engineering Studies (DES) to determine the suitability of installing combined heat and power systems at the following three locations; Capri Pizzeria Recreation Complex, Forest Glade Arena and Adie Knox Herman Recreation Complex.

The study examined three sizes of reciprocating engine CHP systems. An annual analysis of the three CHP systems was completed to compare the performance of each system both technically, as well as economically to determine the best option for the facility to implement.

Based on results of the DES', each facility presented limited financial potential for installation. These results were based primarily on minimal facility thermal demand during the year. Based on the financial evaluations, CHP implementation was not recommended at any facility.

4.2.10 Building Optimization Pilot (BOP) Project

Building Optimization provides a methodical approach to assess and correct existing building operations and procedures to improve the energy performance of a building or facility. Often during the life of a building, many changes are made including functional use, occupancy levels, layout, additions and expansions, new equipment, and upgrades. Similarly, facility management, the number of tenants and occupants change over time. Given these constant changes, operational issues such as occupant comfort, security, and facilities maintenance take priority over energy performance. Although still functioning, the building may not be balanced to ensure performance in an optimal energy efficient state.

In 2016, the City completed a pilot project with IESO and CLEAResult Engineering Consulting to perform 30 building optimization studies of the City's highest electricity users (over 125,000 kWh of annual consumption) to identify and evaluate low-cost and no-cost opportunities for electricity conservation. An assessment of potential capital-cost upgrades was also performed for each of the 30 sites.

The results from these individualized site reports will assist the City with future energy efficiency strategies. The BOP initiative resulted in the implementation of an LED lighting conversion project involving 32 of the Corporation's largest electricity users. This project began in 2018 with a detailed lighting audit and is further described under the Current and Future Energy Efficiency Measures, Section 4.3.

4.2.11 Industrial Conservation Initiative (ICI)

This is an electricity cost reduction as well as a peak shaving program administered by the Province of Ontario's IESO.

The ICI program allows large electricity customers with average monthly electricity peak demand greater than one (1) MW to reduce their costs by reclassifying from Class B to Class A accounts. Class A accounts enjoy the benefit of lower Global Adjustment (GA) costs. The City reclassified the Lou Romano Water Reclamation Plant (LRWRP), Little River Pollution Control Plant (LRPCP) and the Windsor International Aquatic and Training Center. This has resulted in electricity cost savings in excess of $1.2 million for the period July 2017 to June 2018.

In addition, the ICI provides an incentive for large electricity consumers (Class A) to reduce their electricity consumption (peak shaving) during peak electricity demand hours, thereby lowering costs by up to one-third. By reducing the province's electricity peak demand, the ICI reduces electricity system costs by deferring the need to build new generation in the province and helps reduce greenhouse gas emissions.

IESO retroactively determines the five days in which the provincial hourly peak demand was highest. The sum of those peaks during a 12-month base period (May 1 to April 30) is compared to Class A customers' contribution to the five hourly peaks. The ratio obtained is called the Peak Demand Factor and is used to calculate the GA rate for each Class A customer. At the end of the 12-month base period, the top five peak hours will be used to calculate GA allocation for the next 12-month billing period (July 1 to June 30).

Class A customers can reduce their GA costs based on their ability to anticipate the top five peak hours for the current base period and reduce their consumption accordingly. The more accurately that a Class A customer can predict the top five hours of peak demand and shift their demand, the more they will be able to take advantage of this initiative. The City plans to participate in the GA peak shaving program. A 1.6 MW emergency backup generator purchased in 2018 for the LRWRP will be retrofitted with a Selective Catalytic Reduction (SCR) system that meets the Ministry of the Environment, Conservation, and Parks' emission standards required for ICI participation. Operating the generator during periods of high provincial demand will reduce the City's consumption from the electricity grid, thereby proportional lowering the City's contribution to the provincial peak demand. The outcome is a reduced GA rate resulting in an anticipated annual savings of approximately $200,000. The City of Windsor has contracted with a third-party agency, Rodan Energy Solutions who performs electricity market analysis to assist with predicting the five provincial peaks.

The generator is scheduled for installation in late 2019.

The graph in Figure 4.4 below identifies the combined annual costs of the three facilities (LRWRP, LRPCP, and WIATC) that qualified as Class A customers. The years 2017 – 2018 demonstrate the annual cost avoidance of $1.74M since participating in the ICI program (from July 2017).

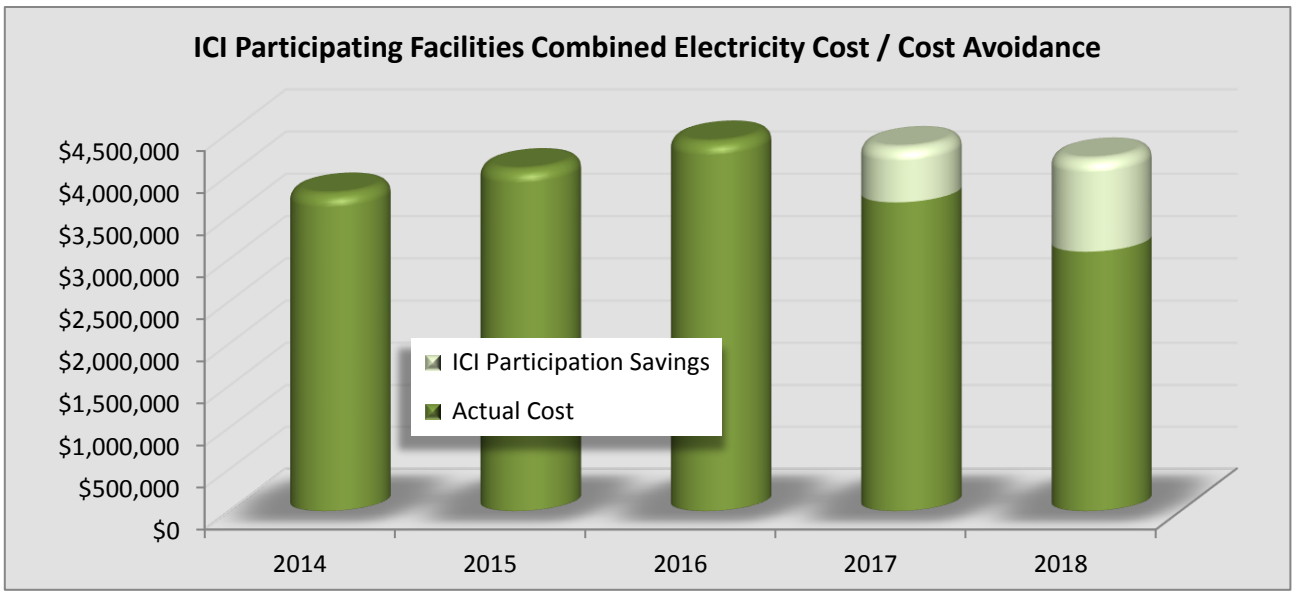


Figure 4.4 – ICI Participating Facilities Combined Electricity Cost / Cost Avoidance

4.2.12 Little River Pollution Control Plant Energy Efficiency Measures

Building Profile and Project Description

Address	9400 Little River Road
Total Floor Area (ft^2)	97,080
Storey Above Grade	1 - 2
Storey Below Grade	1 - 2
Year Opened	1965/1974/1992

The Little River Pollution Control Plant (LRPCP) is located in east Windsor and after multiple expansions has a capacity of 73,000 m^3/day. It is equipped to provide phosphorus removal as well as conventional secondary treatment (biological).

The LRPCP is the fourth largest energy user within the City building portfolio behind the Lou Romano Water Reclamation Plant, WIATC, and the WFCU Center. In 2018 the plant consumed 5.8 million kWh of electricity, 119,000 cubic meters of natural gas and 14,800 cubic meters of water for a combined annual expenditure of $656,515.

High Efficiency Motors

Installation of the two high efficiency 250 hp motors in 2014 represents the following savings and consumption reductions:

- Annual operational savings – $25,600 based on 2015 electricity costs.
- Electricity savings – 189,000 kWh or 3.2% reduction based on 2014 consumption.
- Annual eCO_2 (GHG) emission reduction – 3.8 metric tons

- Completed in 2014

OCWA Detailed Engineering Study & IESO Energy Hunt

In 2018, Ontario Clean Water Agency (OCWA) completed a Detailed Engineering Study (DES). The DES analyzed the performance of the LRPCP to understand the pattern of energy consumption related to the aeration and blower system. This was required to determine a base case energy usage of the system and proposed energy savings opportunities or measures. Additionally, the study identified any capital incentive project opportunities that might exist for the system and help support a capital investment business case for process efficiency improvements through the provincial saveONenergy program.

The two main recommendations include: a) the replacement of the existing centrifugal blower system with two (2) 150 horsepower turbo blowers; and b) the installation of an ammonia-based aeration control system. These upgrades would cost $742,000 and reduce energy consumption by 487,000 kWh annually.

An Integrated Site Energy Master Plan initiative currently underway (see Current Measures Section 4.3) involving the City's two water treatment plants, administration determined not to proceed with the DES recommendations but rather wait for the Master Plan findings expected in early 2020.

In June 2018, in association with EnWin Utilities Ltd., the IESO, and CLEAResult Consulting Inc., the City organized an on-site hunt for energy conservation opportunities with regional Energy Managers, which served to provide training and define potential projects at the LRPCP.

Table 7 identifies various energy efficiency measures resulting from the above-mentioned studies.

Table 7 – LRPCP Proposed Energy Efficiency Measures

LRPCP Building Measures	Annual Electricity Savings [kWh]	Potential Operational savings [$]
OCWA Aeration Detailed Engineering Study		
Replacement of Existing Centrifugal Blowers with Turbo Blowers	163,600	16,400
Advanced Aeration Control	323,500	32,400
IESO Energy Hunt		
Upgrade interior lighting (office spaces, operational spaces) to LED and complete installation and commissioning of occupancy sensors	80,200	8,100
Clean/ Replace Diffusers to reduce back-pressure to blowers	49,000	4,950
Upgrade UV lamp control method to make up BOD difference from primary/ secondary treatment	22,700	2,300
Replace existing exterior HVAC Units	5,700	580
Add anaerobic digester with biogas fed to CHP	1,662,000	167,862
Upgrade belt-driven ventilation fans with ECG fans	14,700	1,480

4.2.13 Energy Management Software

The efficient management of energy use requires effective monitoring systems that provide accurate real time data analysis. Energy monitoring and management information software integrated with various existing and future BAS and sub-metering systems will optimize the management of energy resources.

As the first step toward an enterprise-wide energy monitoring system, in April 2016, the City implemented EnergyCAP, an energy management software used for tracking, managing, processing, reporting, benchmarking, and analyzing utility bills as well as energy and sustainability information. Some of the benefits and features are outlined below:

- Automatic import of monthly electric, water, and gas bills into a secure system.
- Ability to analyze the utility data, spot billing errors, produce reports and budget forecasting.
- Ability to perform energy savings and cost avoidance analysis on the energy information.
- Ability to run reports on demand for analysis, billing, budget, cost avoidance, calendarized, and normalized data.
- Elimination of collection and filing of all utility paper billings.
- Validation of billing accuracy and completeness as well as consumption and cost variances above tolerances.
- Streamline the workflow process from manually bill data entry to auditing and bill verification, detailed analysis, budgeting and forecasting, energy project identification and assessment, and day-to-day reporting.
- Managing all of the data in a consolidated system.
- Ability to quickly respond to energy consumption and cost questions.

Based on internal analysis potential annual savings range between $50,000 - $100,000 resulting from the implementation and use of the EnergyCAP software.

4.2.14 Corporate Energy Champions

The Energy Initiatives unit established a team of corporate operational stakeholders having direct responsibility in the consumption of energy within their respective jurisdictions/workplaces. The team “Corporate Energy Champions” mandate is to ensure the efficient use of energy is a priority within their respective operation and throughout the municipal workplace.

The Corporate Energy Champions meets quarterly with the following objectives:

- Promote, support and assist with the implementation of a broad range of energy consumption reduction measures as identified in the Energy Management Plan.
- Integrate best practices into daily operations where applicable
- Provide a forum for ideas and energy management strategies that benefit the Corporation
- Assist with the execution of the corporation’s energy education and awareness campaign.

4.2.15 Embedded Energy Manager, saveONenergy Process and Systems Initiative

The Energy Initiatives division hired two full time personnel (bringing the staff compliment to three) to assist with the multitude of energy related projects that are being developed and implemented across the City's building portfolio.

These positions initially hired through the IESO's saveONenergy Process and Systems Initiative in May 2013 and August 2016 respectively, hold the title of Supervisor, Energy Contracts. The positions were also supported with provincially funded professional development opportunities such as Certified Energy Manager and Certified Energy Auditor training.

EnWin Utilities Ltd. as IESO's program delivery agent, assisted with the salaries of these positions via a performance-based funding model. EnWin had reimbursed the City of Windsor up to a maximum of $150,000 annually per position based on verification of 3,750 Megawatt-hours (MWh) of electricity consumption savings.

To date the City has received approximately $600,000 in salary reimbursement payments. The positions are now part of the corporate staff establishment.

Many of the completed projects described in this plan would not have been initiated without the addition of the two Embedded Energy Managers/Supervisors of Energy Contracts positions.

4.2.16 Transit Windsor Bus Garage / Administrative Offices

A preliminary engineering study undertaken by MCW Energy Solutions in 2014, examined the building's existing ventilation system in order to identify opportunities for energy savings as well as to evaluate the ventilation load and compare it to current standards.

A redesign of the aging mechanical system was recommended. The new design included modifying the existing mechanical equipment and control sequences and replacing aging mechanical infrastructure.
In 2017 with $750,000 funding from the Federal Gas Tax the ventilation system was upgraded, and a new NOx/CO system installed. This resulted in annual electrical savings of 126,000 kWh and associated cost savings of $19,000.

The installation of a kiosk to accommodate dispatch attendant(s) has allowed the garage area temperature to be set at 13° C, compared to the previous setting of 22° C. This has resulted in a reduction of 50,000 cubic meters in natural gas consumption generating annual savings of approximately $15,000.

4.2.17 Capri Pizzeria Recreation Complex Ice Plant Upgrade

Building Profile

Address	2555 Pulford Street
Total Floor Area (ft^2)	93,600
Storey Above Grade	1
Year Opened	1968 / 1995 / 2016

The Capri Pizzeria Recreation Complex is a multi-use facility constructed in 1968 with the second ice surface and auditorium added in 1995. A further addition in 2016 included a 12,000 sq. ft. community center.

In 2016, the facility consumed 1,396,134 kWh of electricity and 156,009 cubic meters of natural gas for an annual cost of $239,900.

In tandem with the addition of a new community centre in 2016, a number of energy measures were undertaken. These upgrades were implemented based on a 2013 audit, which included floating head pressure control with new condenser and ice plant controls. Similar to the WFCU Center, an infrared direct digital control (DDC) system was installed to better manage the twin ice pad facility. Total cost of measures was $181,000 and represents the following savings and consumption reductions:

- Annual operational savings $30,100
- Electricity savings – 199,200 kWh or 14.3% reduction based on 2016 consumption.
- Annual eCO_2 (GHG) emission reduction – 4 metric tons

4.2.18 Voltage Harmonization Pilot Project

Electrical distribution systems in Canada are designed around a common set of voltage standards to ensure the reliable operation of electrical equipment within buildings. Since electrical substations often supply a large number of diverse facilities, a heightened voltage level that balances the needs of multiple buildings is typically deployed. As a result, facilities can experience fluctuating voltage levels in excess of what they require.

A "Voltage Harmonizer" monitors and controls electricity entering a facility and lowers its voltage to the minimum required level for reduced electricity costs. The benefits of Voltage Harmonizers were investigated at the Art Gallery of Windsor, 400 City Hall Square East, the Forest Glade Arena, and the Capri Pizza Recreation Complex. Of the buildings analysed, 400 City Hall Square East presented the most viable business case with a projected annual savings of $12,000 and payback period of approximately 6 years. This project will be given future consideration.

4.2.19 Miscellaneous Improvements / Upgrades

a. Conversion to LED Lighting

A number of small LED conversions were undertaken at various sites with the following savings and consumption reductions:

Table 8 – Various LED Conversion Projects

Lighting Project	Consumption Reduction	GHG Emissions Reduction	Annual Cost Reduction
Parking Garage 2 - Street Level	28,560 kWh	0.57 metric ton eCO_2	$3,998
Optimist Library Expansion	32,934 kWh	0.66 metric ton eCO_2	$4,610
New Fire Hall & Emergency Operations Centre	42,485 kWh	0.85 metric ton eCO_2	$5,948
Total	**103,994 kWh**	**2.1 metric ton eCO_2**	**$14,556**

- Annual savings – $14,556 based on 2016 electricity costs.
- Electricity savings – 103,994 kWh
- Annual eCO_2 (GHG)emission reduction – 2.1 metric tons

b. Heritage Property Improvements

Various improvements were undertaken at a number of heritage properties throughout Windsor:

- Mackenzie Hall Cultural Centre: Two boilers were replaced with higher efficiency units, as were four fan-coil units and compressors which serve the facility's second floor.
- Willistead Manor Events Centre: In 2018 the 100-year-old facility underwent a $1.95M heritage restoration, which included masonry, stucco, woodwork repairs, drainage improvements and window restoration for improvements in thermal performance of the building envelope.
- Capitol Theatre: In 2016, the theatre's HVAC system was modified to create zones using automated volume control dampers and thermostats in each tenant space on the second floor. In 2018, the Capitol

Theatre's main auditorium was re-roofed and its ceiling's thermal properties increased using rigid insulation.

4.3 Current and Future Energy Efficiency Measures

4.3.1 WIATC Combined Heat and Power

Building Description

The Windsor International Aquatic and Training Centre (WIATC) is the City of Windsor's competitive pool and indoor water park facility. The natatorium is comprised of a 71 meter x 25 meter 10 lane pool featuring two moveable bulkheads that allow multiple configurations to fit the ideal length for any swim competition or community use. The pool varies from 2 m to 5.2 m in depth and features a moveable floor for shallower depths and greater accommodation for community programming. The diving well is comprised of a dive tower with five platforms ranging in height from 1 m to 10 m and two springboard platforms.

Adventure Bay is a family oriented water theme park and features multiple slides, wave pool, lazy river, water play zone, and other water amusement related amenities.

The WIATC's building footprint is approximately 116,000 square feet. The mezzanine area occupying administrative offices and public viewing space is 30,000 square feet with the basement encompassing 31,000 square feet. The facility is one of six municipal buildings heated and cooled by district energy.

The facility opened in January 2014.

Address	401 Pitt Street West
Total Floor Area (ft^2)	176,280
Storey Above Grade	1 (plus mezzanine) 45 ft. ceiling height
Storey Below Grade	1
Year Opened	2014

Utility Overview

WIATC is the second highest energy user within the City's building portfolio. The facility consumed 7,404,515 kWh of electricity, 16,534 MWh of district energy (chilled and hot water), and 48,591 cubic meters of water for a total energy cost of $1,674,869 in 2018.

In 2015/2016 a number of operational changes were implemented including staff training in energy savings techniques, reduced hours of operation, changing lighting schedule, equipment shut-off, etc. These changes resulted in electricity savings of approximately 600,000 kWh or $89,000 based on 2016 costs. The graph in Figure 4.5 below shows the Cumulative Sum (CUSUM) of the savings since the changes were implemented.

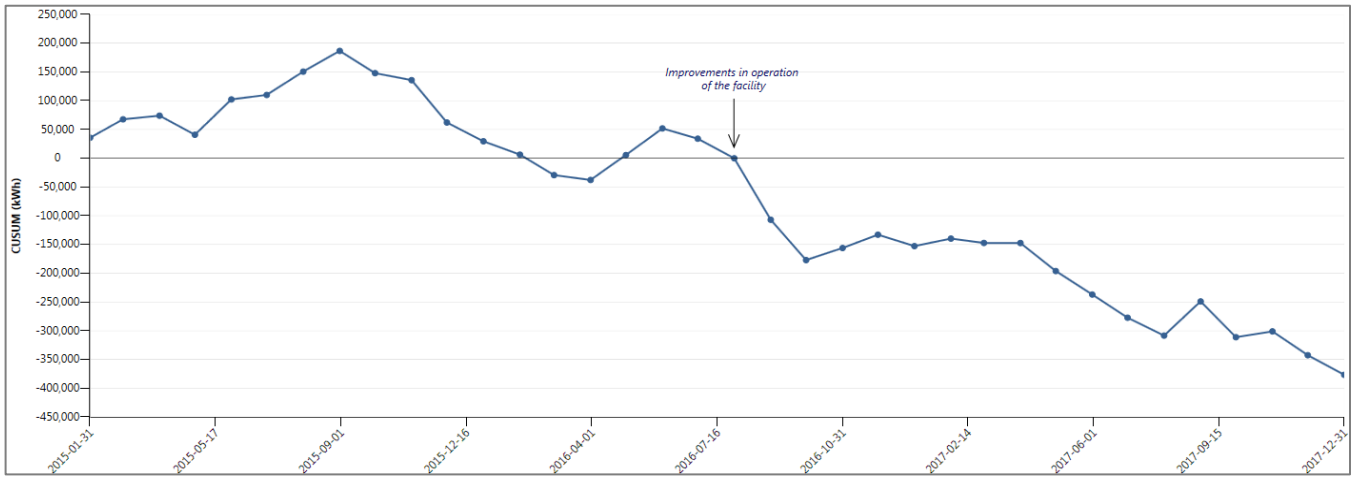


Figure 4.5 – WIATC CUSUM Graph

Figure 4.6 below depicts WIATC electricity consumption, showing decreases in 2015 and 2017 based on operational improvements.

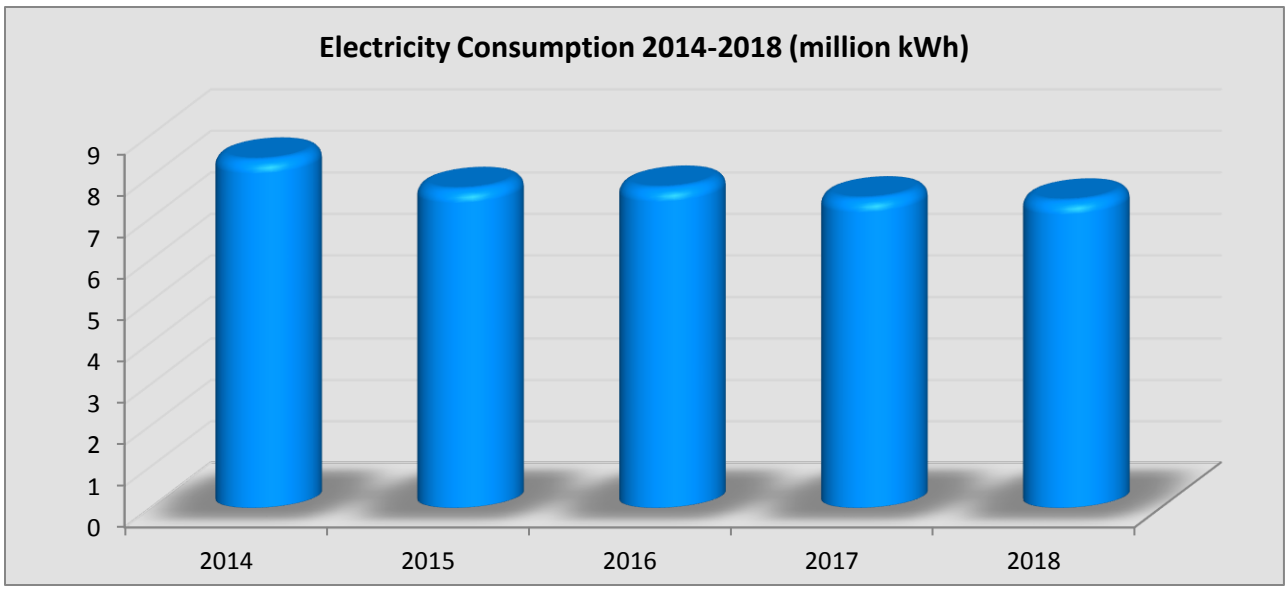


Figure 4.6 – WIATC Electricity Consumption 2014 – 2018

The City's third cogeneration (CHP) plant located at the Windsor International Aquatic Training Center will be completed by summer 2019. A Detailed Engineering Study recommended an 800 kW plant, which would produce approximately 5.8 million kWh of electricity representing 78% of the facility's 2018 consumption. The system will also displace approximately 70% of the thermal load currently provided by District Energy Windsor and generate operational savings of $370,000 annually.

4.3.2 Corporate LED Conversion 32 Buildings, Phases 1, 2, & 3

The BOP initiative resulted in the implementation of an LED lighting conversion project involving 32 of the Corporation's largest electricity users. Preliminary estimates indicate the project will reduce consumption by 3.8 million kWh and generate operational savings of $551,000 annually, resulting in a simple payback period of 6.5 years. The anticipated consumption reduction of 3.8 million kWh represents 5% of the City's 2018 electricity usage, while operational savings of approximately $551,000 represents 4.2% of electricity costs in 2018.

This $3.6 million project commenced in 2018 with a completion date of fall 2020 and involves the re-lamping of over 10,000 fixtures.

Upon project completion, a portion of the annual savings will be allocated to the Sewer Surcharge Reserve and Off-street Parking Reserve in the amounts of $80,548 and $51,896 respectively. As part of the project, City Council approved the establishment of a Corporate Facilities Maintenance Reserve Fund dedicated to asset renewal funded by an annual transfer from operational savings of $313,820, once the original capital project is paid off. In addition, an annual transfer of $104,607 will be made to the Energy Reserve Fund. This reserve was set up in 2009 to assist with funding energy related initiatives.

Table 9 below identifies project costs and associated savings.

Table 9 – Corporate LED Conversion Project

	Number of Buildings	Total Cost [$]	Annual Savings [kWh]	Annual Savings [$]	Incentive Value [$]	GHG Reduction [metric tons eCO_2]
Phase 1	8	$1,496,809	1,330,000	$191,460	$66,479	26.6
Phase 2	12	$1,216,209	1,531,000	$231,465	$76,928	30.6
Phase 3	12	$1,103,251	819,000	$127,882	$44,976	16.4
Total	**32**	**$3,816,269**	**3,680,000**	**$550,807**	**$188,383**	**73.6**

4.3.3 Forest Glade Arena Ice Plant Upgrade

Address	3205 Forest Glade Drive
Total Floor Area (ft^2)	62,000
Storey Above Grade	1
Year Opened	1975 / 1990

The Forest Glade Arena is a multi-use facility with two ice surfaces, kitchen facilities and auditorium. The complex was constructed in 1975 with the second ice surface and auditorium added in 1990.

A programmable direct digital control system (DDC) is scheduled for installation in 2019 at the twin pad facility. The DDC system will not only cycle the compressors and brine pumps to maintain ice temperature set points, but also allow for sophisticated control strategies such as unoccupied ice temperature setback, compressor optimization, and floating head pressure controls. This system has been successfully installed at the WFCU Center (2015) and the Capri Pizzeria Sports Complex (2016).

Table 10 – Forest Glade Arena Ice Plant Upgrade Project

Building Measure	Total Annual Savings [$]	Annual Electrical Savings [kWh]	Total Measure Cost with Incentives	Simply Payback [years]	Incentives [$]
ICE Plant Digital Control System	$13,000	91,161	$64,000	4.9	$9,116

4.3.4 Integrated Site Energy Master Plan / Lou Romano Water Reclamation Plant & Little River Pollution Control Plant

The City is undertaking an Integrated Site Energy Master Plan for two wastewater treatment plants: Lou Romano Water Reclamation Plant and Little River Pollution Control Plant. The plan will not only look at the individual equipment but would also review treatment plant processes to identify complimentary gains. The plan will provide a list of actions that will move the plants towards a net zero energy future and drastically reduce GHG emissions.

The development of the Integrated Site Energy Master Plan will look at various best management strategies including those that are technological and operational in nature. The plan will identify strategies for energy conservation, improved energy efficiency, on-site renewable energy generation, all with the goal of achieving "net-zero" energy and significantly reduced GHG emissions associated with both plants.

The study will look at operational needs, capital costs, potential for GHG emissions reductions, energy savings, capacity, public/private partnerships, and shared opportunities. Triple bottom line and life cycling costs will be considered during the development of the proposed strategies. The benefits to the corporation will include a long- term sustainable strategy for wastewater treatment and energy use. Additionally, this will assist in reducing the overall operational costs thereby controlling costs for rate-payers.

As part of the investigation into on-site renewable energy generation, the plan will evaluate the potential for Anaerobic Digestion and Renewable Natural Gas generation. It will also review the recommendations of the Little River Pollution Control Plant Detailed Engineering Aeration Study.

The Master Plan is expected to be completed by early 2020.

4.3.5 Energy / Battery Storage Feasibility Study

For years, battery storage was considered elusive, hindered by high upfront costs and technical setbacks. But over the past decade, battery storage has taken great leaps toward mainstream use, expanding exponentially alongside renewable technologies. Advances in technology and materials have greatly increased the reliability and output of modern battery systems, and economies of scale have dramatically reduced the associated costs.

Large-scale battery storage is an emerging technology and presents an opportunity to reduce expenses associated with peak-demand electricity use. By charging battery banks "off-peak" and utilizing this stored electricity when costs are increased by time-of-use billing, grid electricity demand can be trimmed when costs are highest.

The City has undertaken a Battery Storage Feasibility Study to evaluate the potential for electricity bill savings and enhanced reliability that could be achieved with a battery storage system at the Lou Romano Water Reclamation Plant and Little River Pollution Control Plant.

The savings and reliability to be investigated is whether adding battery storage systems to the two facilities would produce a net benefit in the following categories:

- Reduction in Global Adjustment rates due to lowering of peak demand
- Reduction in electricity commodity charges due to shifting of energy consumption to nonpeak periods
- Ability to participate in Demand Response
- Impact on facility operations due to power loss
- Identify operating costs
- Analysis of lease versus ownership

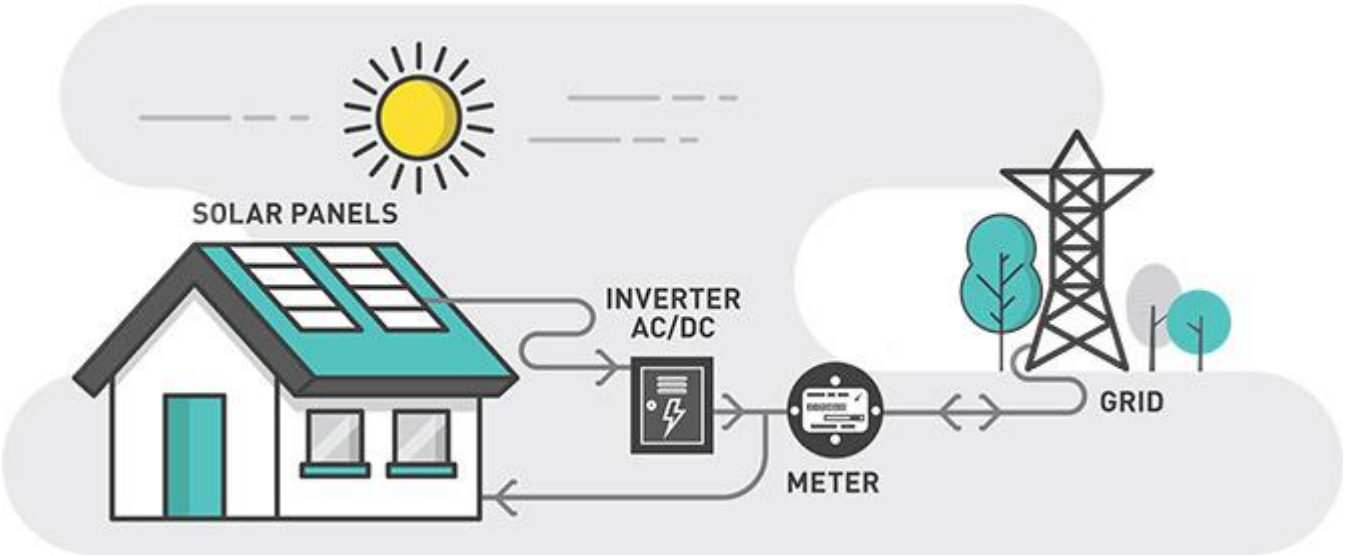
The Study is expected to be completed in June 2019.

4.3.6 Net Metering

"Net metering" is an agreement with the local distribution company (EnWin Utilities Ltd.) and Ontario's Independent Electricity System Operator (IESO) to utilize on-site the renewable power generated at a facility. Electricity production in excess of that utilized by the building is delivered to the local utility grid and credited to the customer to offset future electricity costs.

Customers are still responsible for charges not calculated based on the customer's consumption (i.e. monthly fixed charges or peak demand-based charges). Excess monthly renewable generation greater than monthly consumption creates a credit for the customer that can be carried forward for up to a rolling 12-month period. After a positive credit balance has been carried for that period, any excess generation credit is reduced to zero and lost by the customer.

The illustration below depicts a simple schematic of how net – metering works.



Under Ontario's net metering program, customers can generate renewable energy onsite for their own use, and receive bill credits for any surplus electricity sent to the grid. The customer draws from the grid when their onsite needs are not met by the renewable energy source.

Administration will be seeking City Council approval to install 2.5 MW of capacity over the next five (5) years at an approximate cost of $4 million. Inclusive of the existing installed capacity of 1.35 MW, the City will be able to generate 5.7 million kWh of electricity annually, representing approximately 8% of the City's current electricity needs or the equivalent of powering 475 homes.

The selected sites below encompass 1.5 MW of installed capacity and represent 60% of the net metering initiative:

- Parks and Recreation Administration .....160 kW
- Fontainebleau Library .....66 kW
- 400 City Hall.....175 kW
- Fire Hall #1.....50 kW
- Huron Lodge Long Term Care Facility.....90 kW
- Forest Glade Arena.....65 kW
- Lou Romano Water Treatment Plant .....165 kW
- Little River Pollution Control Plan.....115 kW
- Roseland Golf and Curling Club .....200 kW
- Gino A Marcus Complex.....200 kW
- Adie Knox Arena.....208 kW

Project implementation is expected to commence in fall of 2020.

4.3.7 Hybrid Photovoltaic-Thermal Solar Collectors

Solar-thermal collectors can be combined with photovoltaic (PV) modules to produce hybrid PV-thermal (PV-T) collectors. These can deliver both heat and electricity simultaneously from the same installed area and at a higher overall efficiency compared to individual solar-thermal and PV panels installed separately. Hybrid PV-T technology provides a particularly promising solution when roof space is limited or when heat and electricity are required at the same time.

In tandem with the net metering project, opportunities to install hybrid PV-thermal collectors will be analyzed on an individual basis in order to leverage solar technology.

Picture below depicts the installation of a hybrid PV-thermal solar collector system.

4.3.8 Sub-Metering

Sub-meters are metering devices that monitor electricity, gas, water, steam, and other utilities. Electrical sub-meters are installed to monitor systems/equipment, i.e. pumps, motors, compressors, lighting, etc. that consume significant amounts of energy. The electricity usage data is typically transmitted every 15 minutes to an energy management software for analysis with the intent of identifying savings opportunities.

Sub-metering can be used to measure the energy consumption of HVAC, lighting, refrigeration, compressors, pumps, and more. In addition to the main meter used by utilities to determine overall building or facility consumption, sub-metering utilizes individual meters that allow building and facility managers to have real-time visibility into the energy use and performance of their equipment, creating opportunities for energy and capital expenditure savings.

Traditional utility bill analysis uses information that is simply outdated (up to 60 days after usage) and is too aggregated, (bill represents a 28-35 day period, not 15 minute intervals). Sub-metering addresses this information gap, providing real-time granular visibility of energy consumption. This information can be utilized to optimize the facility's operations.

Benefits include:

- Identification of unnecessary equipment running at night, off shift, or during weekends.
- Ability to transmit information back to operators and facility managers on the same day.
- Comparison and benchmarking of usage across similar facilities over time.
- Detection of utility bill errors by comparing sub-meter usage with actual utility bill.
- Better management of electricity usage when facility faces demand limits or peak usage pricing from the utility.

Administration is currently reviewing various metering technologies with the intent of introducing sub-metering to ten (10) of the City's largest energy consumers in 2019/2020.

4.3.9 Enterprise Wide Energy Management System Software

Centralized and common support for the development and installation of an energy management system throughout the City of Windsor's many properties and buildings brings an enhanced means of addressing shared issues. This includes joining and leveraging similar projects for overall capital cost savings, and bettering communication and transparency concerning energy asset management throughout the Corporation.

Because energy data is currently received at regular billing intervals, abnormal changes in consumption are ordinarily observed between forty-five and sixty days following an event. Daily monitoring enabled by an integrated monitoring system can prevent the persistence of increased consumption and cost by alerting the Energy Initiatives Unit. By responding to anomalies in individual equipment use, staff can prolong the life of motors, pumps, compressors, and other systems throughout the Corporation.

The development of an integrated energy management system requires liaison between the City of Windsor's Asset Planning, Facilities, and Information Technology (I.T.) departments, and local utilities to work toward establishing fundamental elements of hardware, software, and infrastructure including distributed sub-metering and building automation systems. The anticipated completion date is 2023.

4.3.10 Pelican Wireless Thermostat Pilot Project

Energy Initiatives is current investigating Pelican Wireless Systems. This wireless building automation system offers solutions designed specifically for commercial buildings and claims to reduce energy costs by as much as 30%. Pelican offers powerful hardware, innovative wireless mesh network and web-based management tools. The system provides for easy thermostat adjustments, manages temperature in building spaces, reduces inefficiencies and eliminates occupant complaints.

The proposed candidate site to test this technology is the Gino A Marcus Community Complex which contains a pool, gymnasium, banquet hall, and meeting rooms.

In 2018, the facility consumed 606,432 kWh of electricity, 92,578 cubic meters of natural gas and 6,000 cubic meters of water for an annual utilities' cost of $128,343.

The project cost is $49,072 with anticipated annual savings of $17,802 representing 16% of the total electricity and natural gas costs for 2018. The project has a simple payback period of two (2) years.

The Pelican Wireless system is projected to be installed October 2019.

Table 11 – Pelican Wireless Thermostat Pilot Project

Building Measure	Total Savings [$]	Electrical Savings [kWh]	Natural Gas Savings [m^3]	Total Cost with Incentives	Simply Payback [years]	Incentives [$]
Gino A Marcus Pelican System	$17,802	48,500	10,300	$49,072	2	$13,343

4.3.11 Voltage Harmonization Pilot Project

Electrical distribution systems in Canada are designed around a common set of voltage standards to ensure the reliable operation of electrical equipment within buildings. Since electrical substations often supply a large number of diverse facilities, a compromised voltage level that balances the needs of multiple buildings is typically deployed. As a result, facilities can experience fluctuating voltage levels in excess of what is required.

A "Voltage Harmonizer" monitors and controls electricity entering a facility and lowers its voltage to the minimum required level for reduced electricity costs. The benefits of Voltage Harmonizers were investigated at the Art Gallery of Windsor, 400 City Hall Square East, the Forest Glade Arena, and the Capri Pizza Recreation Complex. Among the five buildings, the 400 City Hall Square East facility presented the greatest overall annual savings of approximately $12,000 per year. A pilot project based on the analysis is being considered in 2021.

4.3.12 Municipal Storm and Sanitary Pumping Stations

As part of the City's Asset Management Program a site condition assessment of 45 sanitary and storm pumping stations is being undertaken in 2019. The pump stations consume approximately 3.2 million kWh of electricity at an annual cost of $533,000 in 2018. In addition to the energy consumption a preliminary review has noted some stations are experiencing a high inductive load. This means the power factor, which ideally should register between 1.0 and 0.9, is too low. If the power factor is below 0.9, the City is paying a premium for the kilowatt (kW) component of the monthly electricity bill. Installation of capacitors and / or installing variable frequency drives (VFD's) will increase the power factor and reduce costs. Dillon Consulting was engaged to provide a scope of work and associated costs with undertaking this project.

Upon completion of the site condition assessments, administration will review the optimum solutions to insure the pump stations operate at maximum efficiency.

Table 12 below outlines a preliminary estimation of electricity consumption and corresponding cost savings.

Table 12 – Pumping Stations Energy Efficiency Measures Program Summary

Building Measure	Total Savings	Electrical Savings [kWh]	Total Measure Cost with Incentives	Simply Payback [years]
Power Factor correction / VFD's	$27,600	184,000	TBA	TBA

Depicted below is one of the City's 45 pump stations.

4.3.13 Caron Pump Station / WIATC Wastewater Energy Transfer Pilot Project

Administration is analyzing the design of a Wastewater Energy Transfer (WET) system, proposed by Noventa Energy Partners, to supply environmentally friendly energy to Windsor's District Energy System (DEW) and Windsor International Aquatic and Training Center (WIATC).

Wastewater is an abundant and underutilized source of thermal energy in North America. Sewers experience predictable flow profiles and consistent temperatures ranging between 18°C and 25°C year-round. The high density and specific heat capacity of wastewater, coupled with its constant availability, makes it an excellent source of thermal energy or a heat sink for heat pump-based HVAC systems.

Noventa's patented Huber ThermWin® WET system is capable of rejecting and extracting thermal energy to/from wastewater and repurposing it to supply heating and cooling to DEW system and WIATC respectively. The WET system will be able to supply the DE System with chilled water while simultaneously supplying low-grade hot water to the WIATC.

This initiative is projected to generate operational savings of $172,000 and reduce GHG emissions by 715 tonnes annually.

4.3.14 Electric Vehicles and Charging Stations

Each the City's Corporate Climate Action Plan and Community Energy Plan identify opportunities for vehicle electrification throughout Windsor.

The transition of corporate fleet vehicles to electric vehicles

A comprehensive audit of the City of Windsor's corporate fleet revealed that a minimum of 30 light duty gas vehicles are suitable for replacement with electric vehicles by the year 2020. The primary barrier to this ambition is the considerable capital cost increase of transitioning to electric vehicles. The City of Windsor's 2017 Corporate Climate Action Plan has targeted fleet replacement in the short-term, though it is also realized that this will require a grant of matching funds to achieve. The City of Windsor is actively pursuing funding opportunities toward this goal.

City-wide availability of public electric vehicle charging stations

The City of Windsor's 2017 Community Energy Plan pursues the widespread availability of electric vehicle charging stations at the numerous sites of interest in addition to curb-side locations. Recent communication with manufacturers, suppliers, and network providers has provided estimates of capital and lifecycle costs, business models, and operational requirements for the provision of public charging. Approximately 50 dual-port units are geographically and strategically dispersed throughout Windsor in the preliminary plan, with additional stations to be added as needs are presented.

4.4 Behavioural Measures

4.4.1 Energy Awareness and Education Campaign

Introduction

In 2018, the City spent $17.3 million on energy and water consumption. Stressing the importance of staff participation in energy related efficiency measures, whether it's the installation of a new technology or simply turning off office lights and computers, cannot be overstated. Studies have shown that engaging staff working within a facility (as occupant or operational staff) where an education awareness campaign was implemented, coupled with the implementation of energy efficient technologies, resulted in energy savings as high as 15%.

Benefits of efficient energy management at municipal facilities include:

- Saves taxpayers money
- Reduces greenhouse gas emissions
- Protects the environment and natural resources; and
- Contributes to the preservation of energy security at national level

To become truly energy-efficient, the City must make basic changes in the way the employees behave, in the technologies adopted, and in the internal policies and procedures. No single change can deliver maximum savings. Benefits are maximized when a combination of behavioural, technological, and organizational changes are implemented simultaneously with support from senior management.

While efforts to adopt energy-efficient equipment, maintenance and operational practices can be challenging, it is a much more difficult challenge to establish energy efficiency as a fundamental value. People tend to take energy for granted, and many are unaware of the opportunities they have to reduce energy use. Some may claim to support energy efficiency, but do not commit themselves in changing their behaviour. Increasing people's awareness toward energy use is therefore important to ensure the success of energy efficiency initiatives and should be part of the energy management plan.

Energy Awareness Campaign Objectives

A well-designed Awareness Campaign would support and strengthen the energy conservation objectives of the City. The Awareness Campaign will incorporate the following objectives:

- Increase the employees' understanding of energy efficiency and explain the City's objectives toward energy savings
- Create the link between the individual actions and behaviour of employees and potential energy use and savings
- Motivate the employees to modify their behaviour towards energy consumption
- Improve City's operations and increase employees productivity and morale
- Reduce energy consumption and save money
- Increase City's reputation and serve as a positive model
- Transfer the behaviours learned in the workplace to the home and community

Coupled with an effective energy management plan, an awareness campaign is a non-expensive and relatively easy to implement opportunity for the City to lower consumption and energy costs. Conscientious use of energy would potentially bring significant energy savings in the range of 5-10%. A 5% reduction in energy consumption would equate to approximately 3.5 million kWh of electricity, 270,000 cubic meters of natural gas, 1,441 MWh district heating and cooling and 31,000 cubic meters of potable water, resulting in potential annual savings of $725,000.

Design and Implementation

The awareness campaign will be implemented as follows:

- Assembling the Players
  - Obtaining Senior Management commitment
  - Assembling a working “Energy Champions” team
- Establishing Baselines
  - Establishing a baseline of energy consumption
  - Establishing a baseline of energy efficiency awareness (survey/questionnaire)
- Formulating Objectives
  - Supporting the energy saving objectives
  - Establishing awareness and communication objectives
- Developing a Communications Plan
  - Identifying communication tools (dashboard, emails, posters, social media)
  - Confirming target audiences
  - Anticipating challenges
  - Developing messages (“Kill-A-Watt”, “Watt’s the problem? Turn it off!”, “It makes cents to turn it off”, “You’ve got the power to save energy!”)
- Implementing the Awareness Campaign
  - No / low cost actions (dashboard messages, emails, City Circuit newsletter, social media, stickers)
  - Meetings, lunch-and-learns, and seminars
  - Actions requiring some budget (posters, video-messages, calendars and other promotion materials)
- Program Evaluation
- Monitoring and Reporting
- Following Through
  - Reinforcing the message
  - Adapting the approach
  - Sharing success

Energy Initiatives will be rolling out a phased approach to an energy awareness and education campaign beginning in the Spring of 2020. Once implemented Administration is anticipating a 1.5% decrease (1.3 million kWh) of overall energy consumption with expectations to expand the programs as deemed appropriate.

4.4.2 Corporate Energy Champions

The Energy Initiatives unit established a team of corporate operational stakeholders having direct responsibility in the consumption of energy within their respective jurisdictions/workplaces. The team “Corporate Energy Champions” mandate is to ensure the efficient use of energy is a priority within their respective operation and throughout the municipal workplace.

The Corporate Energy Champions will continue to meet quarterly with the following objectives:

- Promote, support and assist with the implementation of a broad range of energy consumption reduction measures as identified in the Energy Management Plan.
- Integrate best practices into daily operations where applicable
- Provide a forum for cross pollination of ideas and energy management strategies that benefit the Corporation
- Assist with the execution of the corporation’s energy education and awareness campaign.

4.5 Organizational Measures

4.5.1 City Council and Administrative Support

At the organizational level commitment from Council and senior administration will demonstrate leadership and commitment required to ensure the realization of the Energy Management Plan by all of the corporation's energy consumers. City employees play a key role in the efficient use of energy which cannot be overstated, and which further underscores the proposition that harnessing administrative and political support will greatly assist in developing a corporate culture of energy conservation.

The Corporation's Energy Initiative unit was approved by Council in 2010 and forms part of the Asset Planning Division. It is comprised of:

- Manager of Energy Initiatives
- Two Supervisors of Energy Contracts (Permanent, full-time)

The mandate of Corporate Energy Initiatives is as follows:

"To promote and implement cost effective energy efficient products, services and programs that reduce corporate consumption of electricity, natural gas, and water".

City Council has also been supportive by the following actions:

a) Environmental Master Plan

The Environmental Master Plan was updated in 2017 in accordance with the goals and objectives established in the Official Plan and the Corporation's Community Strategic Plan. One of the key objectives of the Environmental Master Plan identifies the need for development and implementation of a corporate energy management plan.

Decrease Corporate Energy Consumption and Greenhouse Gas Emissions

The following actions are needed to complete this objective:

- *Implement and update the Corporate Energy Management Plan and the Corporate Climate Action Plan.*
- *Implement retrofits and energy saving mechanisms with a payback time and greenhouse gas reductions.*
- *Consider energy consumption, lifecycle costing and greenhouse gas emissions when planning capital projects.*
- *Develop an energy awareness campaign for municipal employees.*
- *Assess current water usage across all municipal buildings.*

b) Corporate Climate Action Plan

The City's Corporate Climate Change Action Plan will guide the City towards reducing GHG emissions and energy use and help the City prepare for legislative changes and carbon pricing initiatives by senior levels of government. In addition, the Plan will demonstrate the City of Windsor's commitment to being an environmentally progressive community in the province of Ontario.

The Corporate Energy Plan is aligned with the Corporate Climate Action Plan under the following Categories and action items:

Organizational and Institutional Policy Change

- P1: Create an Internal 'Energy First' Ethic
- P3: Increase Staff Training, Education and Awareness
- P4: Continue to Pursue Funding and Incentive Opportunities

Buildings

- B1: Continue Existing Building Retrofits
- B2: Increase Efficiency through New Building Design and Building Replacement
- B3: Continue to Improve Operations, Maintenance, and Monitoring

Renewable Energy Generation

- R1: Explore Net Metering
- R2: Continue to Invest in Rooftop Solar Photovoltaic (PV)

4.5.2 Embedded Energy Manager – IESO saveONenergy Process and Systems Initiative

The City of Windsor in cooperation with EnWin Utilities Ltd. hired two (2) Embedded Energy Manager (EEM) in May 2013 and August 2016 respectively through the Independent Electricity System Operator (IESO) saveONenergy Process and Systems Initiative. These positions are now part of the City's staff establishment as regular full-time employees and hold the title of Supervisor of Energy Contracts.

The IESO's assists with the salaries of these positions via a performance-based funding model. The City of Windsor is reimbursed up to a maximum of $150,000 annually per position based on verification of 3,750 Megawatt-hours (MWh) of electricity consumption savings.
The core function of the Supervisor of Energy Contracts is to identify, assess, report and implement energy savings opportunities within the corporation's building/facility portfolio and other related assets.

Duties and responsibilities include the following:

- Report to the Manager of Energy Initiatives or designate
- Review existing reports/data and undertake a primary assessment of City sites with a focus on major energy users to identify savings opportunities and identify operations/systems that will require more detailed analysis
- Provide a database and an energy tracking and monitoring system for each facility/process that captures monthly consumption and electrical load inventory of major equipment
- Develop and deliver training to City staff on the energy tracking and monitoring system
- Review control systems, operating schedules and maintenance practices at each facility to identify operational savings
- Develop maintenance practices and programs to enhance energy efficiency
- Develop and recommend an energy saving opportunities action plan that includes capital improvement projects as well as operational and maintenance changes
- Co-ordinate the implementation of energy saving projects including planning, and budgeting with service providers
- Assist with development of a corporate wide measurement and verification system
- Implement a employee training and awareness program that promotes energy efficiency initiatives undertaken
- Assist with fostering a sustainable energy management culture within the corporation

- Co-ordinate and assist with site inspections by utilities and the IESO to review projects and related information
- Prepare quarterly reports

The program requires quarterly status reports as to the activity levels and savings opportunities resulting from the EEM initiative.

This program has been a huge success and to date the City has received approximately $600,000 in salary reimbursement payments. The positions are now part of the corporate staff establishment.

Section 5
Renewable Energy

5.0 Renewable Energy

5.1 Solar PV (Photovoltaic)

5.1.1 Solar Thermal Pool Water Heating Systems

The City began its renewable solar program in 2010 with the installation of three (3) solar pool water-heating systems. These systems pump pool water directly through unglazed solar collectors mounted on the roof when solar heat is available. They are much simpler than solar domestic water heating systems since they do not involve potable water and only need to achieve temperatures of around 28°C. Although a domestic water style heating system can be used to heat pool water, there are significant cost saving realized by using less expensive unglazed collectors and avoiding the cost of a heat exchangers. The trade-off is the systems cannot provide heat at night since they do not have storage and only operate in the summer months of July and August.

Solar pool water heating systems were installed at the following facilities:

- Lanspeary Park has an ideal south facing roof and sufficient space to accommodate an 81-panel system making it the largest outdoor solar pool watering, heating installation in Canada at the time of installation.
- Remington Park 15 panels
- Mic Mac Park 16 panels.

On average, the systems reduce gas consumption by approximately 35%.

5.1.2 Solar PV Arrays

In March 2015 the first PV system was commissioned at the WIATC. The project comprised of 1200 panels has an installed capacity of 350 kW generating 500,000 kWh and annual revenues of $260,000.

Two 500 kW systems were installed in August of 2016 generating a combined 1.5 million kWh and annual revenues of approximately $500,000.

5.1.3 Net Metering

Electricity consumers in Ontario who produce some of their own power from a renewable resource may take advantage of the “net metering” initiative. Net metering allows generating consumers to send excess electricity to the distribution system for a credit toward their energy costs. In essence, it is a “trade” of electricity supplied against electricity consumed.

Once the renewable source is connected to the provincial electricity grid, your local distribution company will continue to read your meter just as they do now, and then at the end of billing cycle subtract the value of electricity supplied to the grid from the value of what the consumer has taken from the grid. The bill will identify the “net” difference between these two amounts. If more power is supplied than what was taken from the grid a credit toward future energy bills will be issued. This credit can be carried forward for up to 12 months.

Eligibility criteria include, but are not limited to:

- Consumer must generate electricity primarily for own use; and
- The electricity must be generated solely from a renewable resource (wind, water, solar energy or biomass).

Administration will be seeking approval from City Council for $4 million for a net metering initiative to be phased in over five years. The project will involve 2.5 MW of additional installed capacity bringing the City's total capacity to approximately four (4) MW and the capability of generating 5.7 million kWh of electricity annually. This represents approximately 8% of the City's current electricity needs.

Phase one, valued at approximately $800,000 is anticipated to begin in fall of 2020 with 500 kW of installed capacity spread over multiple buildings and will serve as a template for future phases. This project will also review the opportunity for ground mounted solar installations where appropriate and practical.

5.1.4 Hybrid Photovoltaic-Thermal Solar Collectors

Administration is investigating combining Solar-thermal collectors with photovoltaic (PV) modules to produce hybrid PV-thermal (PV-T) collectors. This integration of these systems can deliver both heat and electricity simultaneously from the same installed area and at a higher overall efficiency compared to individual solar-thermal and PV panels installed separately.

5.1.5 Anaerobic Digestion

Anaerobic digestion is a collection of processes by which microorganisms break down biodegradable material in the absence of oxygen. The process is used for industrial or domestic purposes to manage waste or to produce fuels.

The Integrated Site Energy Master Plan for the two-wastewater treatment plants will investigate on-site renewable energy generation and evaluate the potential for anaerobic digestion and renewable natural gas production.

Section 6
Energy Management Plan Implementation

6.0 Energy Management Plan Implementation

6.1 Objective

The Energy Management Plan identifies a roadmap that provides direction to support the City of Windsor towards achieving its vision, goals and objectives over the life of the five-year plan 2019 – 2023. The Plan is intended to be a living document that is flexible, creative yet simple to execute and serves as the fundamental cornerstone for the City's successful energy management. Outcomes will include the development of new policies, procedures, processes and acquiring broader energy management knowledge corporately.

The intent of the EMP is to prepare a document that is going to be used by our municipality to better manage energy use, to reduce energy consumption and to demonstrate leadership in our community.

6.2 Prioritization of Energy Measures

The measurers being developed will not be of equal importance or immediately implemented. It will be necessary to prioritize the measures in order to make an informed decision as to which ones to implement first.

Measures with clearly define costs and savings will be prioritized according to their simple payback period. Other measures that do not have clearly defined costs and savings will be prioritized based on considerations such as importance, ease of implementation, and availability of lead department.

Table 13 below identifies the various energy improvements, programs, and initiatives that will be implemented during the period 2019 – 2023. A schedule for completing the prioritized measures will be established with an assignment of the year the measure is anticipated to be operational.

Table 13 – Summary of Prioritized Energy Efficiency Measures 2019 – 2023

Facility / Location	Energy Initiative Description	Projected Completion Date	Net Cost	Annual Savings		GHG Reduction	Simple Payback
				Electricity [kWh]	**Natural Gas** [m^3]	[metric ton]	[year]
WIATC	800 kW Combined Heat and Power System	September 2019	$2.3 million	5.9 million	N/A	118	6.3
Corporate Wide Lighting Project	32 Buildings Conversion to LED Lighting	November 2020	$3.6 million	3.8 million	N/A	76	6.8
Forest Glade	Ice Plant Control Upgrade to DDC system	November 2019	$75,000	91,161	N/A	1.8	1.9
LRWRP and LRPCP	Integrate Site Energy Master Plan	February 2020	$149,400	TBD	TBD	TBD	N/A
LRWRP and LRPCP	Battery Storage Feasibility Study	June 2019	$40,000	TBD	N/A	TBD	N/A
Multiple Facilities	Net Metering Initiative Phases 1-5	June 2023	$4 million	3.7 million	N/A	74	7.7
Multiple Facilities	Solar Thermal Collectors	June 2023	TBD	TBD	TBD	TBD	TBD
Multiple Facilities	Sub-Metering	2021	$60,000	TBD	TBD	TBD	TBD
Corporate Wide	Enterprise Wide Energy Management System Software	2023	$300,000	TBD	TBD	TBD	TBD
Gino A Marcus	Pelican Wireless Thermostat Pilot Project	November 2019	$35,700	48,500	10,300	20	2.1
400 City Hall Square E.	Voltage Harmonization Pilot Project	2021	$80,000	85,000	N/A	TBA	6.7
Pumping Stations	Efficiency Improvement, VFDs, Power Factor Correction	2021	$100,000	184,000	N/A	3.7	TBA
Corporate Wide	Energy Awareness Campaign	2019-2023	TBA	1,300,000	74,000	165	N/A

Section 7
Monitoring and Evaluation

7.0 Monitoring and Evaluation

7.1 Plan Review, Monitoring, Verification and Reporting

Continuous monitoring, verification and reporting is an integral part of energy management and a necessary tool to track consumption, cost savings / cost avoidance resulting from project implementation. Incorporating a monitoring/evaluation process will provide gateways to help better understand energy conservation and associated best practices.

While Ontario regulation 507/18 requires that municipalities report on the results of their respective plan at the end of the 5-year planning period, Asset Planning/Energy Initiatives division will be providing City Council periodic updates.

As the various, projects / measures become operational they will be regularly monitored and reviewed quarterly to document energy consumption, GHG emissions reduction and cost savings. The monitoring process will include updates to the departments affected by the implementation of their projects/measures. By regularly reporting consumption, cost savings and / or avoidance to the affected department, staff will become aware of outcomes of their energy management initiatives, resulting in constructive feedback and additional energy saving ideas and opportunities.

The annual report will provide the following information:

- Annual energy consumption with historical comparisons.
- An updated description of current and proposed measures toward conservation, energy reduction, and managing demand for energy.
- A revised forecast of expected results of current and proposed measures.
- An update of actual results achieved to-date.
- A description of any proposed changes to be made to assist the City in achieving established targets and forecasts.

7.2 Energy Data Management

To efficiently manage energy use requires effective monitoring systems that provide accurate feedback, ideally in real time. The ability to analyze useful data will serve to reinforce the concept that energy while a constant is a variable cost. Making individuals accountable and empowering them with the tools to better control energy use is fundamental and stresses the importance of engaging people in the development and execution of an energy management plan.

As previously stated it is important to develop a corporate wide understanding of energy consumption and costs. An essential set of tools to achieve this would involve a comprehensive metering and sub-metering program and an energy management information system.

The ability to analyze in real time requires collection of real time consumption data by an energy management information system (EMIS). This allows facility staff and energy administrators to react and respond to

operational abnormalities, market conditions in terms of peak pricing and other “troubleshooting” matters that often arise within a corporation that has multiple sites and large energy users.

Real time data analysis provides several benefits that include:

- Quick response time to poor operational performance
- Better understanding of larger facilities, i.e. the two water treatment plants, WFCU Center, WIATC
- Ability to better identify conservation opportunities
- Better monitoring and setting of consumption reduction targets
- Assist with budget preparation

The key objective of energy data management is to identify energy efficiency opportunities, reduce consumption, better manage costs, reduce our municipal carbon footprint and ultimately support a culture of energy conservation. The addition of an EMIS will dramatically improve both analytical capabilities and the ability to identify energy efficiency opportunities.

Section 8
Appendices

8.0 Appendices

Appendix A

City of Windsor 2017 Consumption Data as per Ontario Regulation 507/18

Energy Consumption and Greenhouse Gas Emissions Reporting - for 2017	
mth-yr)	Jan/2017 - Dec/2017
Sector	Municipality
Agency Sub-sector	Municipal
Organization Name	City of Windsor

Operation Name	Operation Type	Address	City	Postal Code	Total Floor Area	Unit	Avg hrs/wk	Annual Flow (ML)	Electricity Quantity	Electricity Unit	Natural Gas Quantity	Natural Gas Unit	District Heating Quantity	District Heating Unit	Renewable?	If Yes, enter Emission Factor	District Cooling Quantity	District Cooling Unit	Renewable?	If Yes, enter Emission Factor	GHG Emissions (Kg)	Energy Intensity (ekWh/sqft)	Energy Intensity (ekWh/Mega Litre)
350 CITY HALL	Administrative offices and related facilities, including municipal council chambers	350 CITY HALL SQ	Windsor	N9A 6S1	6,159.00	Square meters	40		849,437.38869	kWh	94,301.05490	Cubic Meter					1,693.72800	Giga Joule	No	0.00000	195,447.85637	30.08099	0.00000
400 CITY HALL	Administrative offices and related facilities, including municipal council chambers	400 CITY HALL SQ	Windsor	N9A 7K6	14,307.00	Square meters	40		2,111,835.36636	kWh	8.83771	Cubic Meter	2,281.32000	Giga Joule	No	0.00000	4,370.76000	Giga Joule	No	0.00000	178,189.68085	20.21787	0.00000
ADIE KNOX ARENA	Community centres	1551 WYANDOTTE ST W	Windsor	N9B 1H6	4,357.00	Square meters	105		1,219,833.32606	kWh	161,457.70350	Cubic Meter									326,356.97047	62.59854	0.00000
ADIE KNOX EAST WING	Indoor recreational facilities	1495 WYANDOTTE ST W	Windsor	N9b 1H6	1,161.00	Square meters	84		3,599.99000	kWh	7,907.91608	Cubic Meter									15,013.19228	7.01322	0.00000
AMBASSADOR PUMP STATION	Facilities related to the pumping of water	1021 SPRUCEWOOD AVE	Windsor	N9A 7K6	41.00	Square meters	168	68.09000	31,348.33705	kWh											542.26353	71.03304	460.39561
ARCHIVES / FILE RETENTION	Administrative offices and related facilities, including municipal council chambers	930 MERCER ST	Windsor	N9A 1N6	771.00	Square meters	40		42,772.43982	kWh	16,525.83785	Cubic Meter									31,984.07290	26.31714	0.00000
ASPEN LAKE PUMP STATION	Facilities related to the pumping of water	1418 FLORENCE AVE	Windsor	N9A 7K6	41.00	Square meters	168	413.16000	17,141.41906	kWh											296.51227	38.84120	41.48857
BRIDGEVIEW WPL	Public libraries	1295 CAMPBELL AVE	Windsor	N9B 3M7	464.00	Square meters	48		81,860.14600	kWh	4,781.13275	Cubic Meter									10,455.35547	26.56404	0.00000
BRIGHTON BEACH PUMP STATION	Facilities related to the pumping of water	4718 SANDWICH ST	Windsor	N9A 7K6	28.00	Square meters	168	130.37000	52,068.91254	kWh											900.68805	172.76279	399.39336
BUS TERMINAL	Administrative offices and related facilities, including municipal council chambers	300 CHATHAM ST W	Windsor	N9A 0A8	910.00	Square meters	115		306,116.61057	kWh			468.36000	Giga Joule	No	0.00000	317.52000	Giga Joule	No	0.00000	33,530.47690	47.26250	0.00000
CAPITOL THEATRE	Auditoriums	121 UNIVERSITY AVE W	Windsor	N9A 5P4	2,407.00	Square meters	68		403,377.23496	kWh	65,914.52480	Cubic Meter									131,597.39969	42.60732	0.00000
CARON PUMP STATION	Facilities related to the pumping of water	620 RIVERSIDE DR W	Windsor	N9A 7K6	929.00	Square meters	168	34923.58000	1,142,226.18000	kWh											19,758.22846	114.22631	32.70645
CENTRAL AVENUE PUMP STATION	Facilities related to the pumping of water	3601 GRAND MARAIS RD E	Windsor	N9A 7K6	115.00	Square meters	168	257.80000	5,890.00714	kWh											101.88534	4.75826	22.84720
CLAIRVIEW PUMP STATION	Facilities related to the pumping of water	9349 RIVERSIDE DR E	Windsor	N8S 1J2	120.00	Square meters	168	1825.35000	191,952.82000	kWh											3,320.39988	148.60827	105.15946
COLLEGE COMMUNITY CENTRE	Community centres	3325 COLLEGE AVE	Windsor	N9C 4E6	1,226.00	Square meters	84		61,534.61323	kWh	12,088.36920	Cubic Meter									23,919.02294	14.39823	0.00000
CRAWFORD YARD	Administrative offices and related facilities, including municipal council chambers	1531 CRAWFORD AVE	Windsor	N8X 2A9	6,043.00	Square meters	136		559,428.99794	kWh	97,156.55604	Cubic Meter									193,363.81089	24.47466	0.00000
DEVONWOOD PUMP STATION	Facilities related to the pumping of water	3867 ACORN CRT	Windsor	N9A 7K6	46.00	Square meters	168	55.53000	1,979.16400	kWh											34.23558	3.99718	35.64135
DROUILLARD PUMP STATION	Facilities related to the pumping of water	290 DROUILLARD RD	Windsor	N9A 7K6	117.00	Square meters	168	15.03000	14,226.89153	kWh											246.09677	11.29676	946.56630
EAST BANWELL PUMP STATION	Facilities related to the pumping of water	11520 PALMETTO ST	Windsor	N9A 7K6	58.00	Square meters	168	37.53000	2,342.87400	kWh											40.52703	3.75276	62.42670
EAST MARSH PUMP STATION	Facilities related to the pumping of water	10864 RIVERSIDE DR E	Windsor	N8A 7K6	60.00	Square meters	168	1731.73000	32,574.83392	kWh											563.47948	50.43833	18.81057
ENVIRONMENTAL SERVICES ADMIN BLDG	Administrative offices and related facilities, including municipal council chambers	3450 EC ROW AVE E	Windsor	N9A 7K6	1,013.00	Square meters	168		195,835.08343	kWh	21,406.24276	Cubic Meter									43,858.77580	38.82445	0.00000
FACILITIES STORAGE	Storage facilities where equipment or vehicles are maintained, repaired or stored	1356 TECUMSEH RD W	Windsor	N9A 7K6	288.00	Square meters	40		15,650.78882	kWh											270.72735	5.04863	0.00000
FESTIVAL PLAZA	Auditoriums	300 RIVERSIDE DR E	Windsor	N9A 7K6	380.00	Square meters	84		182,636.18604	kWh											3,159.24075	44.65118	0.00000
FIELD ENGINEERING BUILDING OLD	Storage facilities where equipment or vehicles are maintained, repaired or stored	2545 PILLETTE RD	Windsor	N8T 1P9	891.00	Square meters	40		16,318.71133	kWh	110.13600	Cubic Meter									490.50716	1.82357	0.00000
FIELD HOUSE	Administrative offices and related facilities, including municipal council chambers	2365 MCDOUGALL ST	Windsor	N8X 3N6	446.00	Square meters	40		15,092.62886	kWh	6,095.52959	Cubic Meter									11,785.44511	16.63809	0.00000
FIRE HALL 1	Fire stations and associated offices and facilities	815 GOYEAU ST	Windsor	N9A 1H7	2,388.00	Square meters	168		476,583.76491	kWh	55,362.85734	Cubic Meter									112,914.45894	41.43162	0.00000
FIRE HALL 2	Fire stations and associated offices and facilities	3121 MILLOY ST	Windsor	N8Y 1L6	744.00	Square meters	168		157,194.99000	kWh	22,178.80314	Cubic Meter									44,651.00299	49.08207	0.00000
FIRE HALL 3	Fire stations and associated offices and facilities	2750 OUELLETTE AVE	Windsor	N8Y 1L7	558.00	Square meters	168		99,802.70286	kWh	17,535.18655	Cubic Meter									34,878.88429	47.64405	0.00000
FIRE HALL 4	Fire stations and associated offices and facilities	2600 COLLEGE AVE	Windsor	N9B 3T1	772.00	Square meters	168		91,972.10888	kWh	15,493.08763	Cubic Meter									30,882.58332	30.88293	0.00000
FIRE HALL 5	Fire stations and associated offices and facilities	1905 CABANA RD W	Windsor	N9G 1C7	539.00	Square meters	168		61,956.33715	kWh	12,286.08690	Cubic Meter									24,300.12833	33.18484	0.00000
FIRE HALL 6 & EOC	Fire stations and associated offices and facilities	1587 PROVINCIAL RD	Windsor	N8W 5V7	1,270.00	Square meters	168		122,772.65947	kWh	5,165.01417	Cubic Meter									11,888.83670	12.99656	0.00000
FIRE HALL 7	Fire stations and associated offices and facilities	1380 MATTHEW BRADY BLVD	Windsor	N8S 4R6	942.00	Square meters	168		197,559.99068	kWh	27,492.49106	Cubic Meter									55,395.43862	48.30010	0.00000
FIRE PREVENTION	Fire stations and associated offices and facilities	65 ELLIOTT ST E	Windsor	N8A 3R5	622.00	Square meters	40		87,201.92300	kWh	7,160.37657	Cubic Meter									15,046.02013	24.39089	0.00000
FORD BUCKINGHAM PUMP STATION	Facilities related to the pumping of water	5270 RIVERSIDE DR E	Windsor	N8A 7K6	0.00	Square meters	168	1022.66000	20,421.37879	kWh											353.24901	0.00000	19.96888
FOREST GLADE ARENA	Indoor ice rinks	3205 FOREST GLADE DR	Windsor	N8R 1W7	5,760.00	Square meters	168		1,265,166.19445	kWh	73,605.88215	Cubic Meter									161,046.11298	33.02303	0.00000
FOREST GLADE COMMUNITY CENTRE	Community centres	3215 FOREST GLADE DR	Windsor	N8R 1W7	11,647.00	Square meters	84				25,448.34206	Cubic Meter									48,113.32261	2.15734	0.00000
FOUNTAINBLEU WPL	Public libraries	3030 RIVARD AVE	Windsor	N8W 1C2	761.00	Square meters	40		120,205.02138	kWh	11,785.15073	Cubic Meter									24,360.63062	29.96518	0.00000
FRANCOIS BABY HOUSE	Cultural facilities	254 PITT ST W	Windsor	N9A 5L5	222.00	Square meters	56		43,922.20165	kWh	5,064.87665	Cubic Meter									10,335.55880	40.90686	0.00000
GINO A MARCUS COMMUNITY CENTRE	Community centres	1168 DROUILLARD RD	Windsor	N9A 7K6	3,613.00	Square meters	168		535,312.80529	kWh	11,219.77853	Cubic Meter									30,472.25713	16.83090	0.00000
GNATCHIO PUMP STATION	Facilities related to the pumping of water	9855 WYANDOTTE ST E	Windsor	N8Y 2R1	46.00	Square meters	84	3.42000	1,085.53612	kWh											18.77760	2.19238	317.40822
GRAND MARAIS PUMP STATION	Facilities related to the pumping of water	3005 GRAND MARAIS RD E	Windsor	N9A 7K6	115.00	Square meters	168	353.21000	55,275.90352	kWh											956.16258	44.65476	156.49586
HURON ESTATES PUMP STATION	Facilities related to the pumping of water	2355 LAMBTON ST	Windsor	N9A 7K6	39.00	Square meters	168	38.35000	10,278.98200	kWh											177.80583	24.48585	268.03082
HURON LODGE LTC	Other	1881 CABANA RD W	Windsor	N9G 1C7	16,400.00	Square meters	168		3,326,157.34909	kWh	510,312.28306	Cubic Meter									1,022,346.05061	49.56512	0.00000
JAEROME STORAGE BUILDING	Storage facilities where equipment or vehicles are maintained, repaired or stored	9420 LITTLE RIVER RD	Windsor	N8S 4L7	80.00	Square meters	40		10,037.28094	kWh											173.62489	11.65617	0.00000
JANETTE CHARL PUMP STATION	Facilities related to the pumping of water	2331 CHARL AVE	Windsor	N9A 7K6	85.00	Square meters	168	97.07000	14,378.33198	kWh											248.71639	15.71518	148.12333
JEFFERSON PUMP STATION	Facilities related to the pumping of water	6340 TECUMSEH RD E	Windsor	N9A 7K6	96.00	Square meters	168	66.32000	31,370.44242	kWh											542.64591	30.35942	473.01632
JOHN ATKINSON COMMUNITY CENTRE	Community centres	4270 ALICE ST	Windsor	N8Y 2B8	1,328.00	Square meters	84		215,549.95202	kWh	41,504.79272	Cubic Meter									82,198.66481	45.93757	0.00000
LAKEVIEW MARINA	Administrative offices and related facilities, including municipal council chambers	9200 RIVERSIDE DR E	Windsor	N8S 1H1	371.00	Square meters	56		188,927.02135	kWh	2,517.46460	Cubic Meter									8,027.64616	54.00947	0.00000
LAKEVIEW PUMP STATION	Facilities related to the pumping of water	11999 RIVERSIDE DR E	Windsor	N9A 7K6	40.00	Square meters	168	1353.32000	48,125.94614	kWh											832.48262	111.77612	35.56139
LANSDOWNE GREENHOUSE	Other	1149 GILES BLVD E	Windsor	N8X 4L6	2,267.00	Square meters	168		63,767.82590	kWh	82,879.34737	Cubic Meter									157,796.98773	38.70990	0.00000
LITTLE RIVER PCP	Facilities related to the treatment of water	9400 LITTLE RIVER RD	Windsor	N8S 4L7	0.00	Square meters	168	15840.00000	5,784,386.91000	kWh	82,687.32316	Cubic Meter									256,389.21048	0.00000	420.65463
LOU ROMANO WRP	Facilities related to the treatment of water	4155 OJIBWAY PKY	Windsor	N9C 4A5	0.00	Square meters	168	52914.00000	16,458,436.90000	kWh	255,682.70920	Cubic Meter									768,098.67493	0.00000	362.39513
MACKENZIE HALL	Cultural facilities	3277 SANDWICH ST	Windsor	N9C 1A9	743.00	Square meters	72		177,439.50940	kWh	10,320.59997	Cubic Meter									22,581.75359	35.90139	0.00000
MALDEN PARK COMMUNITY CENTRE	Community centres	4200 MALDEN RD	Windsor	N8X 3N6	130.00	Square meters	84		80,706.78897	kWh	26,116.76969	Cubic Meter									50,773.13596	256.03352	0.00000
MALDEN PARK	Storage facilities where equipment or vehicles are maintained, repaired or stored	4200 MALDEN RD	Windsor	N8X 3N6	519.00	Square meters	40		70,520.07985	kWh	3,225.23620	Cubic Meter									7,317.57498	18.75910	0.00000
MIC MAC PARK AND SPORT FIELDS	Community centres	1035 PRINCE RD	Windsor	N9A 7K6	566.00	Square meters	84		349,770.63631	kWh	3,186.62557	Cubic Meter									12,061.53606	62.80943	0.00000
OAKWOOD COMMUNITY CENTRE	Community centres	2520 CABANA RD W	Windsor	N9G 1E5	1,068.00	Square meters	84		99,636.98099	kWh	15,932.58867	Cubic Meter									31,846.10281	23.39668	0.00000
OJIBWAY NATURE CENTRE	Community centres	5200 MATCHETTE RD	windsor	N9C 4E8	362.00	Square meters	84		88,652.48919	kWh	12,095.65875	Cubic Meter									24,401.88977	55.74243	0.00000
OPTIMIST COMMUNITY CENTRE	Community centres	1075 YPRES AVE	Windsor	N8W 4W4	975.00	Square meters	84		154,012.41727	kWh	18,659.42653	Cubic Meter									37,942.12240	33.57092	0.00000
PARKING GARAGE 1	Parking garages	62 CHATHAM ST E	Windsor	N9A 7K6	15,859.00	Square meters	168		330,864.17057	kWh	16,643.95717	Cubic Meter									37,190.80323	2.97445	0.00000
PARKING GARAGE 2	Parking garages	426 PELISSIER ST	Windsor	N9A 4K9	12,783.00	Square meters	168		286,073.32321	kWh											4,948.49634	2.07909	0.00000
PILLETTE PUMP STATION	Facilities related to the pumping of water	3499 PILLETTE RD	Windsor	N9A 7K6	40.00	Square meters	168	339.07000	9,135.32764	kWh											158.02290	21.21748	26.94231
POLICE 2	Police stations and associated offices and facilities	2696 JEFFERSON BLVD	Windsor	N8T 3C7	1,124.00	Square meters	56		140,099.45429	kWh	11,249.19787	Cubic Meter									23,691.47758	21.46137	0.00000
POLICE TRAINING AND DND	Police stations and associated offices and facilities	4007 SANDWICH ST	Windsor	N9C 1C3	8,175.00	Square meters	168		983,129.91000	kWh	96,684.13267	Cubic Meter									199,799.81289	22.84979	0.00000
PONTIAC PUMP STATION	Facilities related to the pumping of water	9410 LITTLE RIVER RD	Windsor	N9A 7K6	44.00	Square meters	168	1257.24000	147,184.61959	kWh											2,545.99955	310.77029	117.06963
PR ADMIN BUILDING	Administrative offices and related facilities, including municipal council chambers	2450 MCDOUGALL ST	Windsor	N8X 3N6	1,495.00	Square meters	40		135,812.41500	kWh	15,381.32479	Cubic Meter									31,429.63110	18.59811	0.00000
PR MAINTENANCE YARD	Storage facilities where equipment or vehicles are maintained, repaired or stored	2461 MCDOUGALL ST	Windsor	N8x 3N5	3,132.00	Square meters	40		174,583.03500	kWh	44,781.56924	Cubic Meter									87,685.18125	19.29581	0.00000
PRIMORD PUMP STATION	Facilities related to the pumping of water	9381 LITTLE RIVER RD	Windsor	N9A 7K6	44.00	Square meters	168	583.89000	89,723.78000	kWh											1,552.04195	189.44564	153.66555
PROVINCIAL SQUARE PUMP STATION	Facilities related to the pumping of water	1848 PROVINCIAL RD	Windsor	N9A 7K6	0.00		168	201.09000	6,956.06714	kWh											120.32605	0.00000	34.59181
PUBLIC WORKS ADMIN BUILDING	Administrative offices and related facilities, including municipal council chambers	1266 MCDOUGALL ST	Windsor	N8X 3M7	1,467.00	Square meters	40		160,011.19000	kWh	18,068.13944	Cubic Meter									36,927.98583	22.29389	0.00000
REMINGTON POOL	Community centres	2720 LILLIAN AVE	Windsor	N8V 7K6	278.00	Square meters	84		71,105.83279	kWh	19,110.36636	Cubic Meter									37,360.56331	91.63529	0.00000
REMINGTON WPL	Public libraries	2710 LILLIAN AVE	Windsor	N8X 4B5	185.00	Square meters	24		11,943.96314	kWh	2,421.34597	Cubic Meter									4,784.46874	18.92082	0.00000
RIVERDALE PUMP STATION	Facilities related to the pumping of water	594 RIVERDALE AVE	Windsor	N9A 7K6	41.00	Square meters	168	149.22000	28,525.89112	kWh											493.44086	64.63758	191.16667
RIVERSIDE WPL	Public libraries	6305 WYANDOTTE ST E	Windsor	N8S 4S5	1,315.00	Square meters	64		200,188.42247	kWh	20,100.82564	Cubic Meter									41,466.02301	29.23552	0.00000
ROSELAND GOLF COURSE	Indoor ice rinks	455 KENNEDY DR W	Windsor	N9G 1S8	4,143.00	Square meters	92		803,566.83781	kWh	75,747.54464	Cubic Meter									157,110.45224	36.07127	0.00000
SCIENCE CENTRE	Cultural facilities	930 MARION AVE	Windsor	N8A 2J2	4,255.00	Square meters	56		29,082.88408	kWh	874.42777	Cubic Meter									2,156.29249	0.83790	0.00000
SEMINOLE WPL	Public libraries	4285 SEMINOLE ST	Windsor	N8Y 1Z5	380.00	Square meters	40		52,018.79978	kWh	11,767.72807	Cubic Meter									23,148.20561	43.29368	0.00000
SIXTH CONCESSION PUMP STATION	Facilities related to the pumping of water	4177 DUCHARME ST	Windsor	N9A 7K6	42.00	Square meters	168	178.64000	20,903.65830	kWh											361.59148	46.23839	117.01555
SOUTH CAMERON PUMP STATION	Facilities related to the pumping of water	2255 ALEXANDRA AVE	Windsor	N9A 7K6	30.00	Square meters	168	100.17000	3,579.67857	kWh											61.92128	11.08543	35.73603
SOUTH WINDSOR ARENA	Indoor ice rinks	2555 PULFORD ST	Windsor	N8A 7K6	7,580.00	Square meters	168		1,657,890.66000	kWh	172,373.98389	Cubic Meter									354,573.10067	42.77268	0.00000
SOUTH WINDSOR WPL	Public libraries	1310 GRAND MARAIS RD W	Windsor	N9E 1E4	871.00	Square meters	93		77,827.51172	kWh	6,606.07294	Cubic Meter									13,835.88016	15.78982	0.00000
SOUTHWOOD LAKES PUMP STATION	Facilities related to the pumping of water	4502 HOWARD AVE	Windsor	N9A 7K6	37.00	Square meters	168	625.90000	16,568.65097	kWh											286.60452	41.60209	26.47172
ST PAUL PUMP STATION	Facilities related to the pumping of water	7730 RIVERSIDE DR E	Windsor	N8A 7K6	59.00	Square meters	168	2090.32000	284,359.33030	kWh											4,918.84770	447.75991	136.03627
TRAFFIC ADMIN AND SIGN SHOP	Storage facilities where equipment or vehicles are maintained, repaired or stored	1269 MERCER ST	Windsor	N8X 3P4	1,458.00	Square meters	75		199,411.59500	kWh	11,517.89012	Cubic Meter									25,225.45581	20.50628	0.00000
TRAFFIC PAINT SHOP	Storage facilities where equipment or vehicles are maintained, repaired or stored	1231 MERCER ST	Windsor	N9A 7K6	739.00	Square meters	168		41,770.29343	kWh	29,946.56007	Cubic Meter									57,340.31755	45.26169	0.00000
TRANSIT WINDSOR	Storage facilities where equipment or vehicles are maintained, repaired or stored	3700 NORTH SERVICE RD E	Windsor	N8W 5X2	12,235.00	Square meters	168		1,304,139.21448	kWh	335,170.92588	Cubic Meter									656,242.20222	36.95057	0.00000
WALKER FARMS PUMP STATION	Facilities related to the pumping of water	3400 RHODES DR	Windsor	N9A 7K6	46.00	Square meters	168	629.29000	17,927.36372	kWh											310.10754	36.20665	28.48824
WALKER HOMESITE PARK	Storage facilities where equipment or vehicles are maintained, repaired or stored	1900 SYDNEY AVE	Windsor	N9A 7K6	213.00	Square meters	105		43,760.21694	kWh											756.96423	19.08665	0.00000
WALKER UNDERPASS PUMP STATION	Facilities related to the pumping of water	2691 WALKER RD	Windsor	N9A 7K6	35.00	Square meters	168	36.44000	25,218.51557	kWh											436.22988	66.93931	692.05586
WELLINGTON UNDERPASS PUMP STATION	Facilities related to the pumping of water	1385 WELLINGTON AVE	Windsor	N9A 7K6	26.00	Square meters	168	8.25000	20,309.49235	kWh											351.31360	72.56972	2,461.75665
WFCU CENTRE	Indoor ice rinks	8787 MCHUGH ST	Windsor	N8S 0A1	29,740.00	Square meters	168		7,196,643.06000	kWh	981,979.13867	Cubic Meter									1,981,043.80465	55.08235	0.00000
WIATC	Indoor swimming pools	401 PITT ST W	Windsor	N9A 0B2	16,377.00	Square meters	96		7,457,411.36000	kWh	4,155.82645	Cubic Meter	39,282.98400	Giga Joule	No	0.00000	17,776.29600	Giga Joule	No	0.00000	2,492,152.26536	112.94399	0.00000
WILLISTEAD COACH HOUSE	Cultural facilities	950 CHILVER RD	Windsor	N8Y 2K7	929.00	Square meters	84		31,385.52822	kWh	18,295.88192	Cubic Meter									35,133.59521	22.58374	0.00000
WILLISTEAD MANOR	Cultural facilities	1899 NIAGARA ST	Windsor	N8Y 1K3	929.00	Square meters	84		118,215.82406	kWh	38,794.12161	Cubic Meter									75,390.11108	53.05282	0.00000
WILSON PARK CLUBHOUSE	Storage facilities where equipment or vehicles are maintained, repaired or stored	1499 WYANDOTTE ST W	Windsor	N9A 7K6	92.00	Square meters	16		2,242.16677	kWh											38.78500	2.26417	0.00000
WINDSOR JUSTICE FACILITY	Police stations and associated offices and facilities	200 CHATHAM ST E	Windsor	N9A 2W3	30,144.00	Square meters	168		3,984,328.60000	kWh			8,108.64000	Giga Joule	No	0.00000	9,506.52000	Giga Joule	No	0.00000	563,591.40121	21.68766	0.00000
WINDSOR PUBLIC LIBRARY MAIN	Public libraries	850 OUELLETTE AVE	Windsor	N9A 4M9	9,426.00	Square meters	66		987,903.42000	kWh	75,773.43680	Cubic Meter									160,348.05886	17.67391	0.00000
WINDSOR WATERWORLD	Indoor swimming pools	400 WYANDOTTE ST E	Windsor	N9A 3H6	1,207.00	Square meters	99		179,529.73986	kWh	24,052.77563	Cubic Meter									48,580.33247	33.49413	0.00000
YPRES PUMP STATION	Facilities related to the pumping of water	2170 YPRES BLVD	Windsor	N9A 7K6	38.00	Square meters	168	548.01000	55,243.66118	kWh											955.60485	135.06058	100.80776