St. Catharines

Energy Conservation and Demand Management Plan

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INTRODUCTION

Background

The St. Catharines Corporate Energy Conservation and Demand Management Plan (CDMP) has been designed to meet the requirements of Ontario Regulation 507/18 under the Electricity Act (1998). This regulation requires public agencies develop a five-year CDMP and update it every five years. The City's current Energy Management Plan was produced in 2014 to satisfy its obligations under a previous regulation (O. Reg. 397/11), and as such, this plan has been developed to help continue to move the City forward towards its energy conservation goals.

This CDMP details the City's progress towards meeting those goals, and its plans to reduce energy and Greenhouse Gas (GHG) emissions across corporate operations, including:

- Facilities and buildings owned and operated by the City of St. Catharines;
- Water distribution, wastewater collection, storage facilities and operations;
- Street lighting;
- Fleet vehicles; and
- Equipment.

The CDMP will form the foundation and guide the City towards conducting business more sustainably with energy conservation, energy efficiency and renewable resources top of mind. The CDMP will be a "living document", and is expected to grow, change and be updated over time. The City is committed to improving its environmental and economic performance while maintaining and improving service delivery.

Goals and Objectives

Investing in energy management and implementing the actions identified in this CDMP will provide valuable opportunities for the City including reduced energy costs and GHG emissions. In order to achieve this, the City needs to instill a deeper culture of energy conservation into the decision making process at the City, to engage and empower staff, lower energy cost risk exposure, and demonstrate leadership by the City.

The objective of the City's CDMP are to achieve the following:

- Assess the progress the City has made to date with respect to energy management;
- Benchmark how the City is performing compared to other similarly sized municipalities;
- Establish quantitative targets to guide the City's efforts on energy management from 2020 – 2025;
- Identify a suite of measures and a work plan over the next five years to help achieve those targets; and
- Reaffirm the City's long-term energy goals and targets.

ENERGY ANALYSIS

Historic Trends, Current Energy Use, Costs, and Greenhouse Gas Emissions

The City of St. Catharines is responsible for operating 46 major facilities, which cover a total area of over 1.35 million square feet (125,000 square metres). The City is also responsible for traffic and streetlights, water and wastewater systems, and a fleet of vehicles and equipment to provide public services. These service areas make up the City's corporate energy consumption and contributes to serving residents, businesses, and visitors. Table 1 below summarizes the 2018 energy consumption, costs, and greenhouse gas (GHG) emissions across the City's service areas.

Table 1: City of St. Catharines 2018 Energy Consumption, Costs and GHG Emissions

Service Area	Energy Consumption		Costs		GHG Emissions	
	ekWh[1]	%	$	%	tCO2e[2]	%
Buildings	37,544,258	74%	$2,968,092	58%	4,736	70%
Transport Fuels	7,360,094	15%	$747,897	15%	1,848	27%
Streetlights	4,798,717	9%	$1,165,318	23%	192	3%
Other Lighting	382,396	1%	$102,381	2%	15	0%
Water/Wastewater	123,388	0%	$26,101	1%	5	0%
Miscellaneous	383,438	1%	$127,438	2%	15	0%
TOTAL	50,592,291		$5,137,227		6,812	

[1] ekWh - equivalent kilowatt hour
[2] tCO_2e - tonnes of carbon dioxide equivalent

Energy Management

Since 2014, the City has actively explored and undertaken several initiatives to reduce corporate energy consumption. Various initiatives both large and small have been implemented. For instance, as part of a multi-phase and multi-year plan, the City is retrofitting streetlights and traffic signals to Light Emitting Diode (LED) equivalents. By the end of 2019, almost all the lights will have been retrofitted. A number of other additional equipment upgrades, or retrofits have been undertaken at a number of sites, which are detailed in a later section.

The base year of 2011 was used as a reference against which energy consumption and energy costs can be compared. This allows the City to assess whether energy management efforts have been successful. It is important to note that since 2011, the City has had a net increase of over 400,000 ft^2 in additional assets, which represents a 35% increase. The major additions and replacements include:

- 2012 – St. Catharines Kiwanis Aquatics Centre and Dr. Huq Family Library, 26,088 and 7,000 ft^2
- 2012 - Carlisle Street Parking Garage, 144,500 ft^2
- 2013 - Fire Hall #4, 16,800 ft^2
- 2014 - Meridian Centre, 160,651 ft^2
- 2015 - FirstOntario Performing Arts Centre, 95,000 ft^2

The St. Catharines Kiwanis Aquatics Centre

Combined with rising energy rates, this has meant that although energy management efforts have been undertaken that have substantially improved energy efficiency, overall energy consumption and energy costs have increased (Table 2). Energy consumption is 16% higher, and energy costs are 18% higher in 2018 compared to the 2011 baseline.

Table 2: City of St. Catharines Corporate Energy Consumption and Costs since 2011 Baseline

Service Area	Energy Consumption (ekWh)			Costs		
	2011	2018	% Δ	2011	2018	% Δ
Buildings	24,625,923	37,544,258	+52%	$2,469,953	$2,968,092	+20%
Streetlights	10,408,801	4,798,717	-54%	$915,376	$1,165,318	+27%
Other Lighting	445,203	382,396	-14%	$87,153	$102,381	+17%
Waste/Wastewater	89,773	123,388	+37%	$18,468	$26,101	+41%
Miscellaneous	991,022	383,438	-61%	$118,347	$127,438	+8%
Transport Fuels	7,213,814	7,360,094	+2%	$741,668	$747,897	+1%
TOTAL	43,774,536	50,592,291	+16%	$4,350,965	$5,137,227	+18%


Firehall #4

Building and facility related electricity consumption has been reduced by 14%, while natural gas consumption has increased by 82% compared to the 2011 baseline. In terms of the amount of transport fuels (diesel and gasoline) for fire trucks, service vehicles, and other equipment, consumption in 2018 was similar to 2011 baseline levels and was generally consistent year over year. Figure *1*, below summarizes the City's total annual corporate energy consumption and costs from 2011 to 2018.

Total Annual Electrity, Natural Gas, and Fuel Consumption and Costs 2011 - 2018

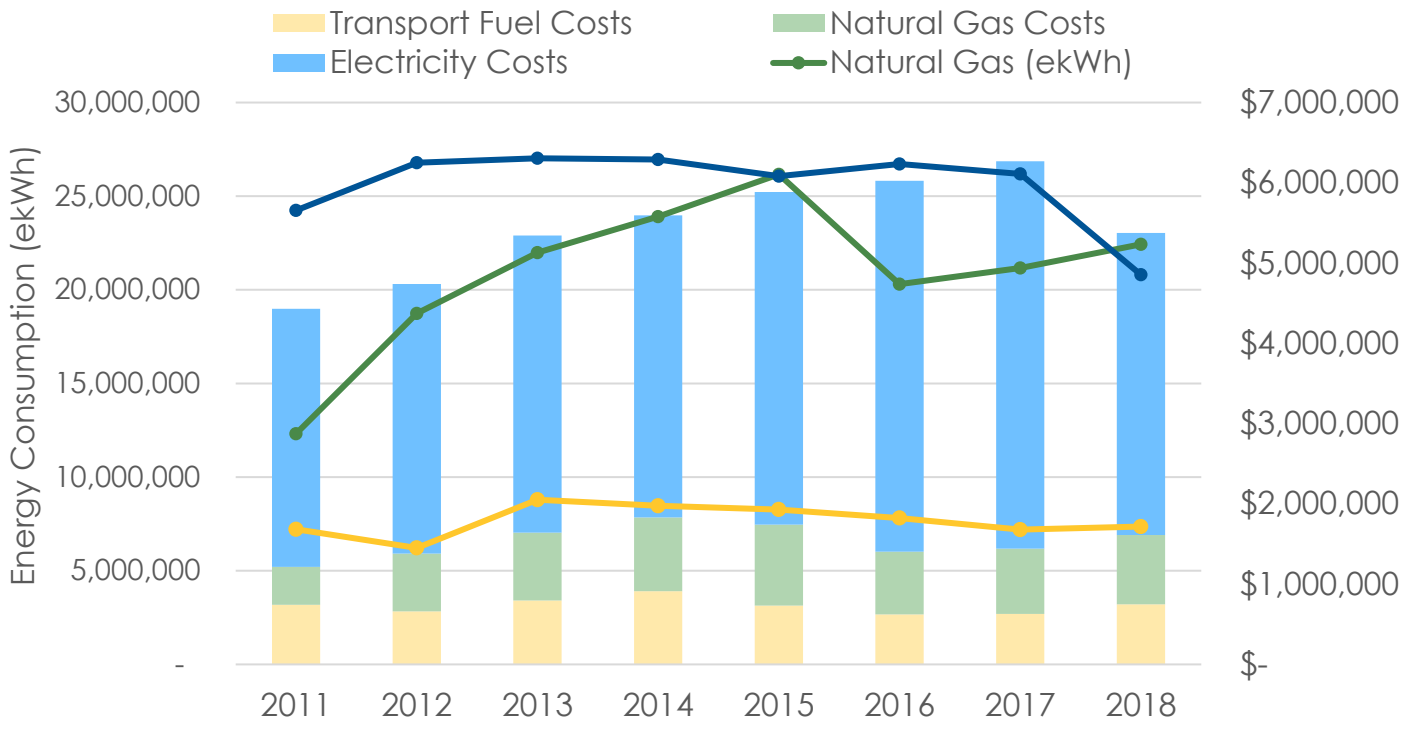

Figure 1: City of St. Catharines Corporate Energy Consumption and Costs 2011 - 2018

The increase in natural gas consumption from 2011 - 2015 can be partly attributed to the expanding building portfolio which increased by 35% in total square footage since the baseline year, and which included high natural gas consuming buildings, such as the St. Catharines Kiwanis Aquatic Centre, and the First Ontario Performing Arts Centre. In 2016, there was a decrease in natural gas, partly due to weather and partly due to an increase in the operational efficiency for a few of the recently constructed, larger buildings.

Building Energy Consumption

Figure 2 on the following page shows the energy consumption on a per building basis across the City's assets. Overall, the top 10 energy-consuming buildings represent just under 85% of the City's total building energy consumption.

Energy Consumption per Building (ekWh) - 2018

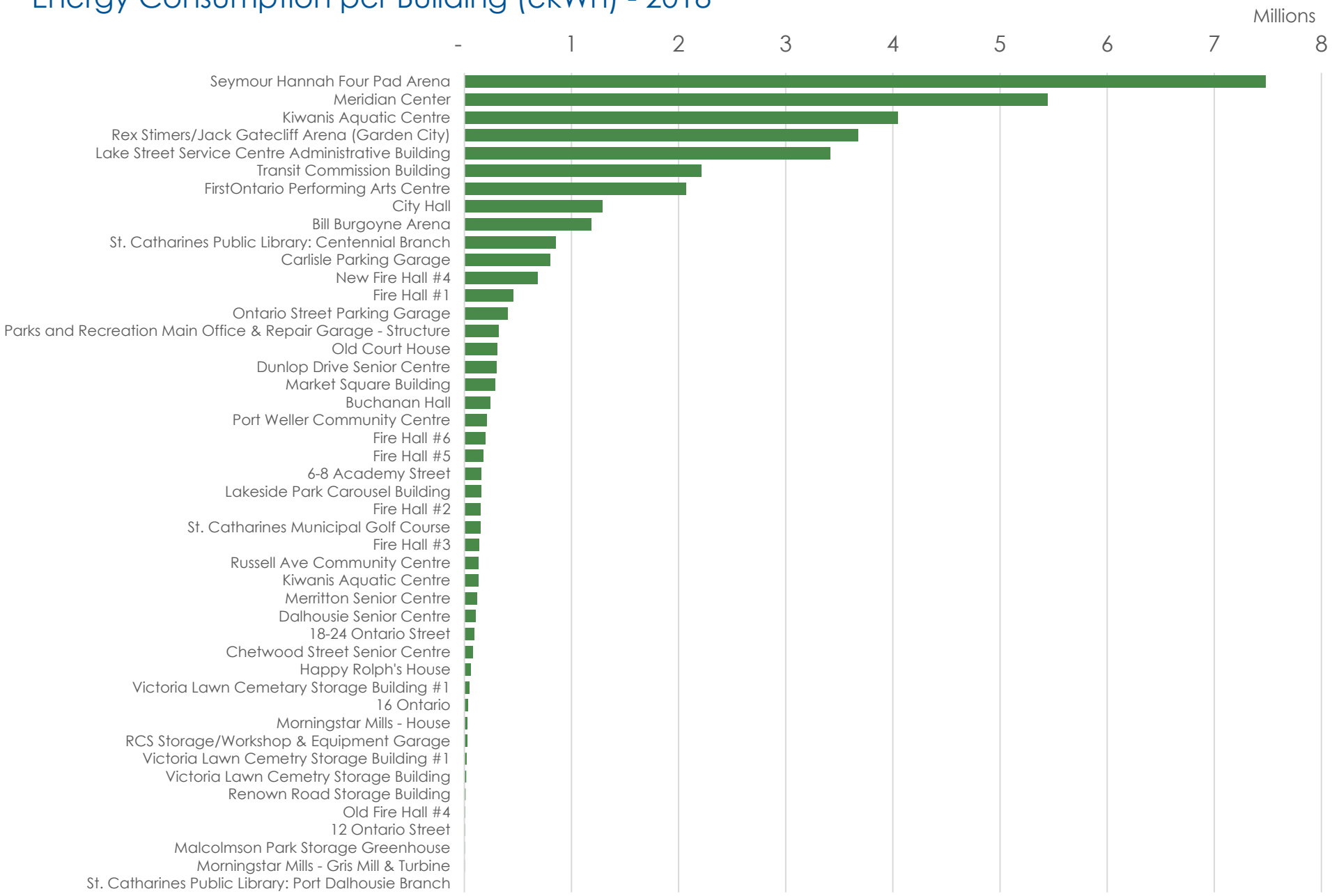

Figure 2: Energy consumption per building across the City of St. Catharine's assets - 2018

Greenhouse Gas Emissions

Although the City's overall energy consumption has increased almost 20% since 2011, the amount of GHG emissions have remained at a similar level[3]. The increase in natural gas consumption and the resulting increase in emissions has been offset by a reduction in electricity consumption, and a reduction in the emissions factor for electricity production in Ontario. The lower emissions factor is mainly the result of changes in the electricity sector, including the elimination of coal-fired electricity generation. Figure 3, below shows the City's GHG emissions since the 2011 baseline year.

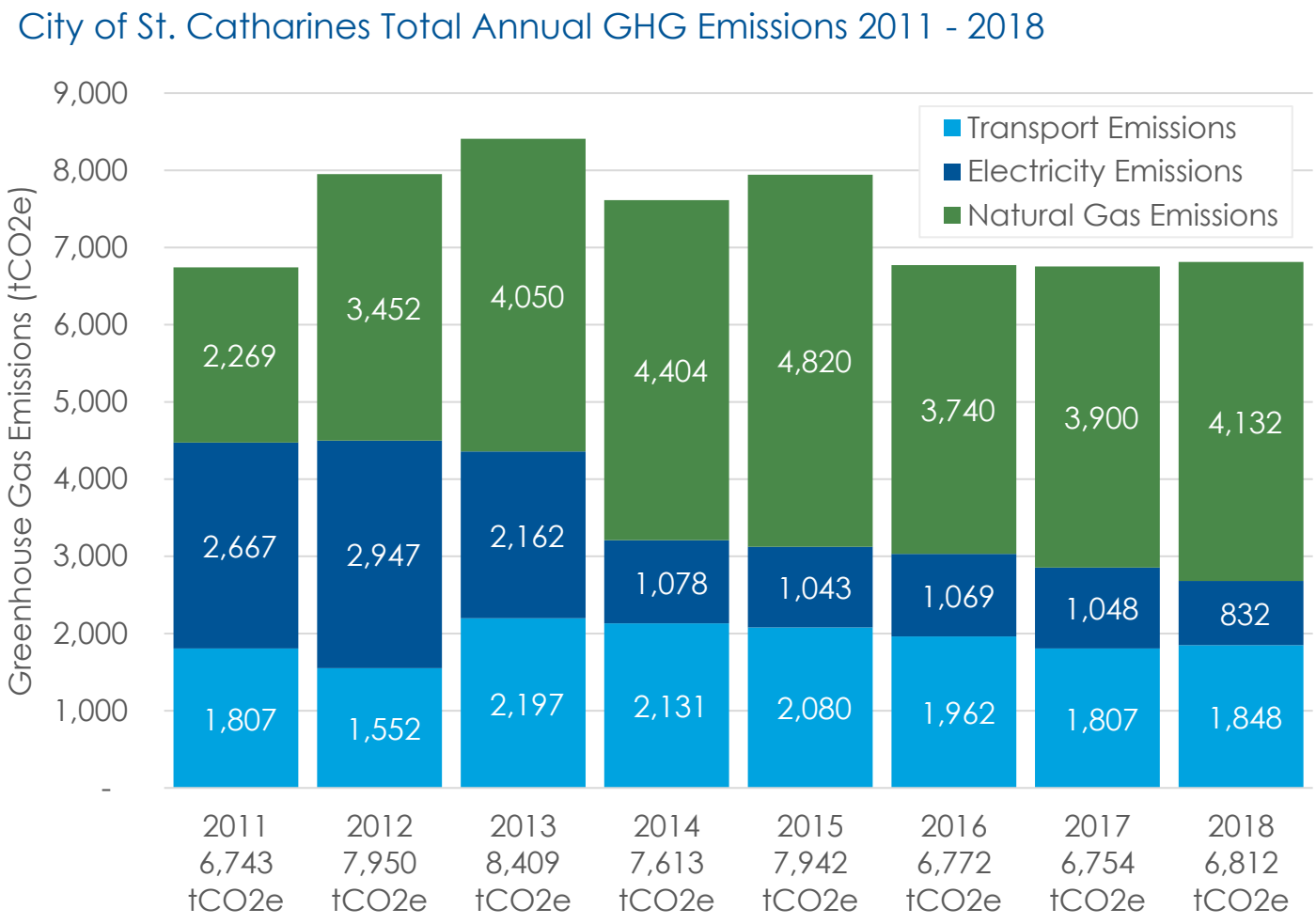

Figure 3: City of St. Catharines Corporate Greenhouse Gas Emissions 2011 – 2018

[3] Transport fuel consumption data was not available for Fire Service prior to 2014. However, since the fuel consumption was consistent year over year, the Fire Service fuel consumption for 2011 – 2013 was assumed to be similar to 2014.

Energy Use Intensity

The growth of the building inventory puts increasing energy demands on the City. Typically, cities with a larger number of assets consume more energy, and in general, larger buildings tend to consume more energy. Instead of looking at the absolute energy consumption, Energy Use Intensity (EUI) is an industry accepted metric used to define the total equivalent kilowatt-hours per unit of floor area. This allows the data to be normalized based on total floor area, which has changed since the 2011 baseline. For the City, this allows it to compare its performance against the 2011 baseline, while controlling for the increase in the number of assets. EUI data also can be used in a process called 'benchmarking' which allows the performance of a portfolio, or individual buildings to be compared to other building portfolios, or to other buildings of similar type and geographical location.

Figure *4*, below shows the City's EUI since the 2011 baseline year. The energy consumption used in the EUI calculation includes all corporate energy consumption, which includes buildings, street lights, traffic lights, park lighting, water pumping facilities, and corporate fleet. Since 2011, the EUI across the City's building portfolio peaked in 2014, where it declined steadily until 2018. The 2018 EUI is 15% lower compared to 2011.

Energy Intensity 2011 - 2018

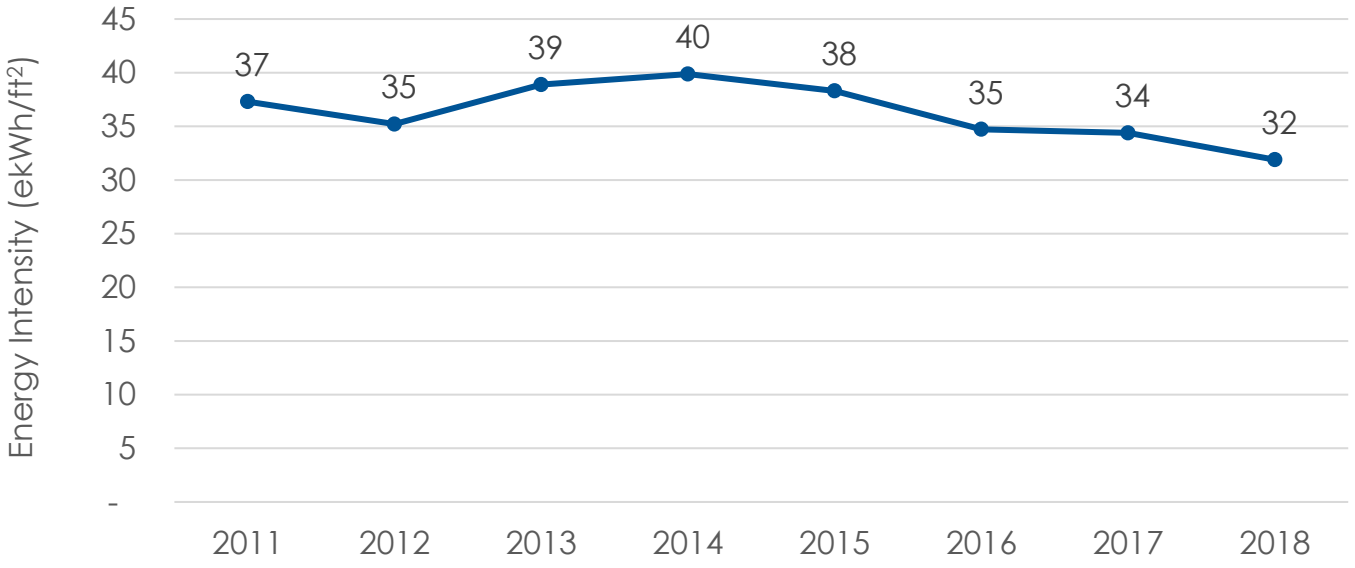

Figure 4: City of St. Catharines Energy Intensity 2011 – 2018

Meridian Centre

Figure 5, on the next page shows the energy intensity on a per building basis across the City's assets. Highlighting the buildings on an energy intensity basis allows the identification of the high-energy consuming buildings relative to their size. These buildings have the most potential energy savings. As expected, buildings with highly energy intensive activities (e.g. pools, arenas), have higher EUI's. Generally, older buildings also tend to have higher EUI's since these buildings were not built with the same level of insulation as today, and would typically have less efficient lighting, and heating, ventilation and air conditioning (HVAC) systems.

Energy Intensity per Building (ekWh/ft^2) - 2018

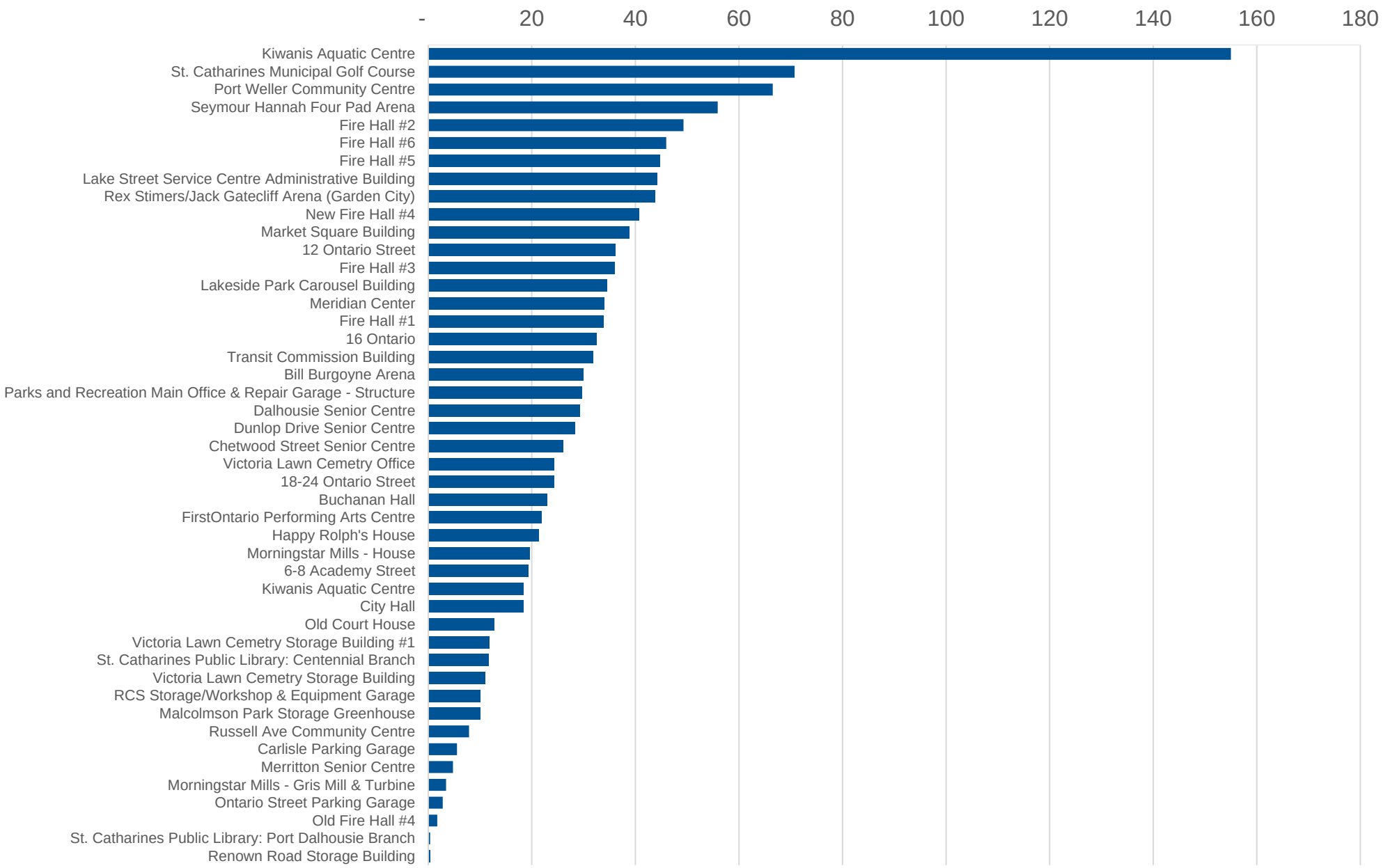

Figure 5: Energy intensity per building across the City of St. Catharine's assets - 2018

Greenhouse Gas Emissions Intensity

Figure 6, below shows the City's GHG emissions intensity since the 2011 baseline year. Similar to the EUI calculation, all corporate emissions have been included. Since 2011, the GHG intensity across the City's portfolio has fluctuated due to increased natural gas use, while being offset by reductions in the electricity emissions factor in Ontario. The City's GHG intensity started to fall in 2014, corresponding to the elimination of coal from Ontario's electricity supply mix. The 2018 GHG intensity is 25% lower compared to 2011.

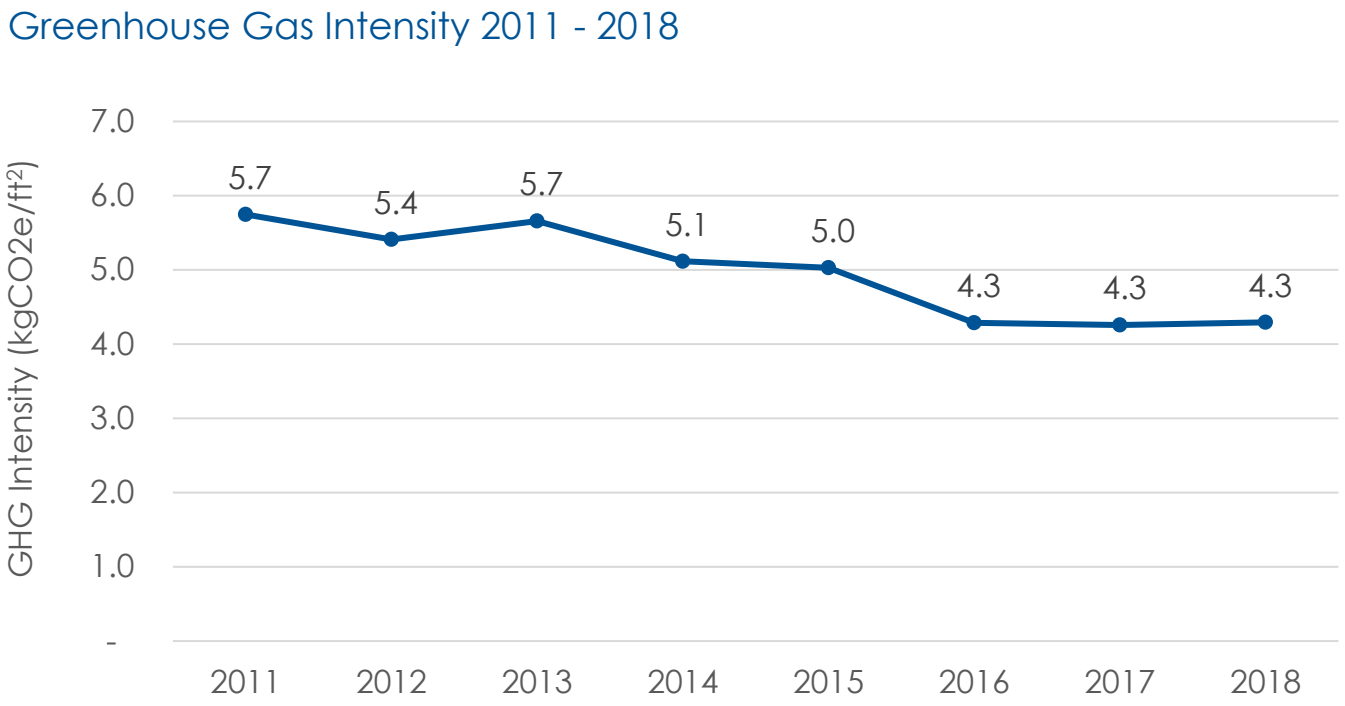

Figure 6: City of St. Catharines Greenhouse Gas Intensity 2011 – 2018

Energy Benchmarks

In 2014, public sector organizations were required to develop five-year energy management plans, and annually report their energy use and GHG emissions. For some municipalities who had been incorporating energy management into their operations, this became a way to showcase successful initiatives, and highlight the progress they were making in reducing their energy consumption and GHG emissions.

By reviewing the progress that other similarly sized municipalities have made, the City can benchmark its own progress against other municipalities, identifying potential areas for improvement and celebrate the City's successes. The other Ontario municipalities that were included in the comparison[4], along with their total building energy consumption, population, and square footage compared to St. Catharines are shown in Table 3, below:

Table 3: City of St. Catharines Building Portfolio Benchmarks

Municipality	Population (2016)	Energy Consumption (ekWh)[5] (2016)	Building Area (ft^2)	Energy Performance ($ekWh/ft^2$) – All Buildings	Energy Performance ($ekWh/ft^2$) – No Garages
Kitchener	233,222	50,404,467	2,530,861	19.9	27.6
Cambridge	129,920	25,695,374	975,778	26.3	26.3
St. Catharines	133,113	37,766,388	1,367,248	27.6	33.9
Waterloo	104,986	36,832,617	1,305,447	28.2	33.0
Kingston	123,798	52,020,536	1,727,067	30.1	30.1
Niagara Falls	88,071	23,670,332	720,014	32.9	32.9
Guelph	131,794	53,435,138	1,600,724	33.4	41.9
Windsor	217,188	106,893,493	2,843,068	37.6	41.9
Oshawa	159,458	37,443,649	870,711	43.0	43.0
Barrie	141,434	61,567,983	1,487,412	43.9	43.9
Thunder Bay	107,909	79,350,694	1,470,665	54.0	54.0

[4] Note: Due to the nature of the O.Reg 507/18 reporting system, there may be some differences in how City's categorized and reported their building area, or energy consumption, which may introduce some error associated with the energy performance shown in the tables.
[5] At the time of writing, 2016 represented the latest available data.

Compared to the other municipalities, St. Catharines has one of the lowest energy intensity's across entire building portfolio's, however this can partly be attributed to the high proportion (23%) of low energy intensive parking garages in the City compared to others. If we remove parking garages from the EUI calculation, the City's EUI would be 34 ekWh/ft^2, in the mid-range compared to other cities.

Looking at the data another way, Table 4, below, shows the City's building energy performance separated by building type compared to 1) average of all other similar buildings, and 2) the average of the top quartile performing buildings. Compared to the top quartile performing buildings, we can identify several building types where the City's energy performance could be improved. It should be noted that significant improvements in energy efficiency are required to move the City's building portfolio into the top quartile.

Table 4: City of St. Catharines Building Type Benchmarks

Building Type	Energy performance (ekWh/ft^2)			% Reduction to be top quartile
	City of St. Catharines	Benchmark (All)	Best in Class (Top 25%)	
All Buildings	27.6	34.2	-	
Indoor swimming pools (St. Catharines Kiwanis Aquatic Centre)	155.0	56.0	33.3	79%
Storage Facilities[6]	19.6	24.0	5.2	73%
Cultural facilities	23.2	19.0	8.1	65%
Fire stations	33.9	31.0	15.8	53%
Administrative offices	28.8	26.4	13.7	52%
Parking Garages	4.2	3.0	2.0	51%
Indoor sports arenas	42.6	37.6	22.4	47%
Community centres	15.4	24.8	10.4	32%

[6] These are storage facilities where equipment or vehicles are maintained, repaired or stored and includes: Transit Commission Building, Victoria Lawn Cemetery Storage Buildings, PRCS Storage/Workshop, Malcolmson Park Greenhouse, Renown Road Storage Building etc.

Energy, GHG and Energy Cost Model

St. Catharines, like most Ontario municipalities, is challenged with significant budgetary pressures due to increasing costs and limited levels of capital funding. In terms of energy supply and pricing, in 2018, the City spent approximately $5.4 million on corporate energy. This is up by 21% compared to 2011 levels. Energy costs were actually highest in 2017 at almost $6.3 million, a 41% increase compared to 2011 levels, but thanks to significant investment in energy efficiency measures such as the LED Street Lighting project, a significant reduction in energy consumption and costs was seen in 2018.

In future years, Ontario's electricity and natural gas rates are predicted to increase. This will have a major impact on the City's ongoing operating costs associated with energy use, which makes energy conservation and demand management even more important to help mitigate these rising costs.

Without proper planning, rising energy costs, combined with an expanding building portfolio, may lead to significant challenges for the City to reach its long-term energy, and GHG reduction goals. Modelling allows the City to assess future scenarios to see how they impact energy consumption, costs, and GHG emissions going forward, and determine what actions will be needed to reach its long-term goals. Without an active energy management plan, corporate energy costs are expected to climb to over $6.6 million by 2025, over $9.0 million by 2040, and to $11.1 million by 2050.

There are several key assumptions that needed to be made when developing the model. These assumptions are based on an analysis of historical trends, and gleaned from current policies, and planning documents. The assumptions also have an eye towards future policy or technology developments based on the long-term goals of the broader region, province, and country. These assumptions are summarized in Appendix A.

Figure 7 on the following page shows the projected energy consumption and costs until 2050. Total energy consumption is projected to rise to over 53 million ekWh, with energy costs rising to over $11 million by 2050. GHG emissions are expected to rise to 5,373 tCO_2e by 2025, 5,940 tCO_2e by 2040, and 6,150 tCO_2e by 2050, this amounts to a 10%, 20% and 25% increase compared to the 2011 baseline respectively.

Projected Energy Consumption and Cost

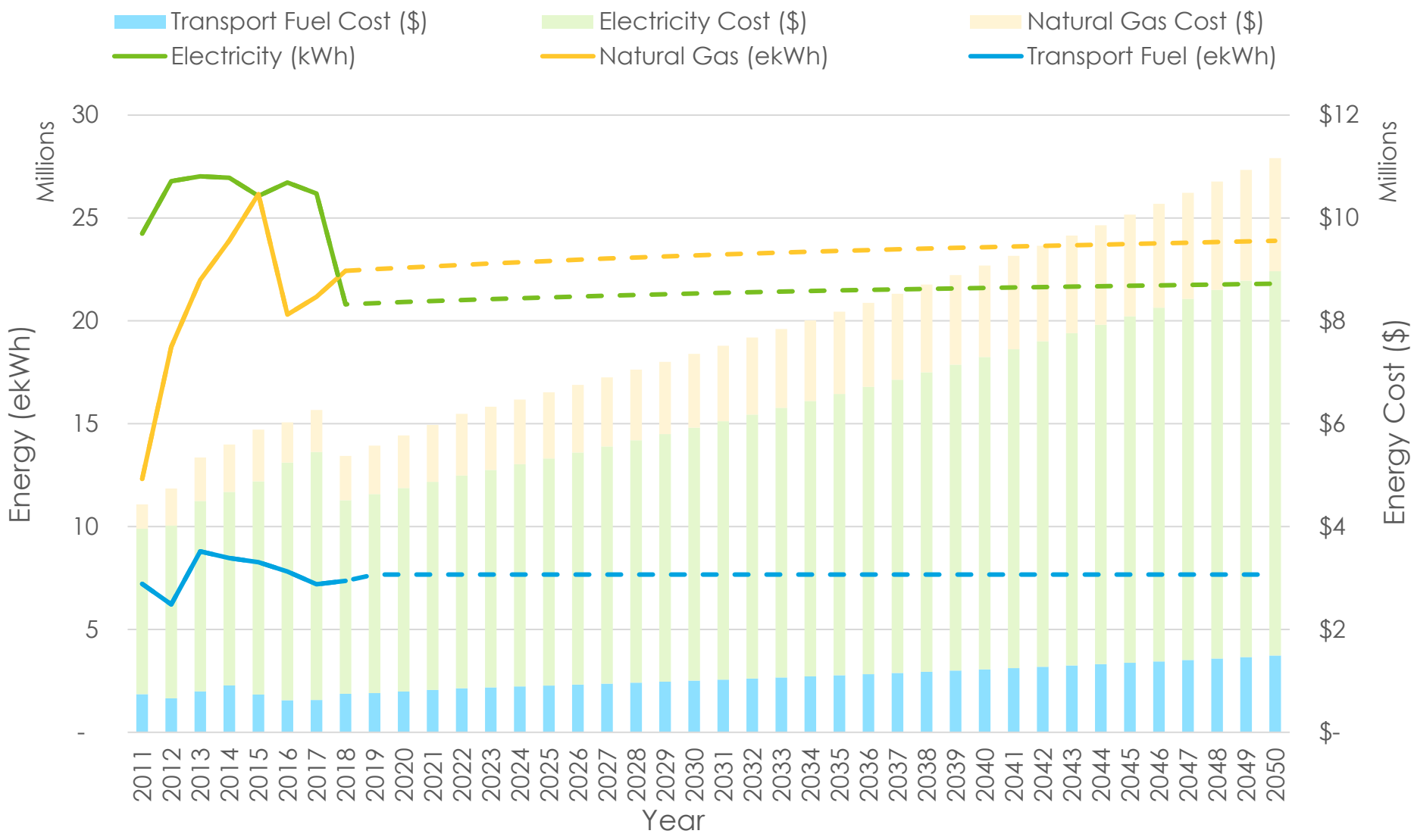

Figure 7: Project Business as Usual Energy Consumption and Cost

GOALS AND TARGETS

The City has been actively addressing energy consumption, and GHG emissions. Initiatives such as retrofitting of streetlights and traffic signals to LED's, installation of high efficiency mechanical equipment, and new construction initiatives implemented in the last five years have helped to significantly offset rising overall energy consumption and costs due to portfolio expansion, and rising utility rates.

The City has identified the following energy and GHG intensity goals compared to the 2011 base year:

- 30% reduction in corporate energy intensity by 2030 (ekWh per ft^2)
- 40% reduction in corporate GHG intensity by 2030 (tCO_2e per ft^2)

Market Square Building

CONSERVATION AND DEMAND MANAGEMENT MEASURES

The sections below outline the City's current and past energy conservation and demand management strategies, as well as short-term strategies to be implemented over the next five years.

Previous and Current Energy Efficiency Initiatives

The City has undertaken several past initiatives in a committed effort to reduce its energy consumption and continues to implement energy efficiency measures.

1. LED Street Lighting Conversion

Since 2015, the City has undertaken a multiphase retrofit of streetlights and traffic signals across the City. This effort is expected to be complete in 2019 when almost all will have been converted. This project has already resulted in a significant reduction in City electricity consumption. The City saw an annual savings of 5.6 million kWh, a 54% energy reduction in 2018 for street lighting compared to the 2011 baseline. This is equivalent to the annual electricity consumption of almost 600 households. In addition, the City has been able to access over $1 million in incentives to support this work.

Testing of one of the new LED street lights

2. Interior and Exterior LED Lighting Conversions

Across the City's building portfolio, various interior and exterior lighting retrofits have been completed since 2014. The projects are varied and have included:

- Replacement of Metal Halide (MH) fixtures with fluorescent T5 or LED equivalents;
- Replacement of High Intensity Discharge (HID) fixtures with LED equivalents;
- Replacement of fluorescent T8 lighting with LED equivalents;
- Replacement of High Bay lighting with LED equivalents; and
- Replacement of exterior High Pressure Sodium and MH lighting with LED fixtures.

These retrofits were performed at several buildings across the City's portfolio, including:

- City Hall
- Meridian Centre
- St. Catharines Kiwanis Aquatic Centre
- Seymour-Hannah Sports and Entertainment Centre
- Dunlop Community Centre
- Lock #3 Museum
- Bill Burgoyne Arena
- Merritton Centennial Arena
- Jack Gatecliff and Rex Stimers Arena
- Lake Street Service Centre

These lighting retrofits not only provide electricity savings and result in GHG emission reductions; they also result in peak demand reductions and improves lighting quality. In total, these projects resulted in an annual energy savings of almost 1 million kWh, and annual cost savings of over $110,000. This is equivalent to the annual electricity consumption of over 100 households.

An additional LED lighting retrofit project is currently underway at the Ontario Street Parking Garage.

3. Installation of Ice Rink Controller at Seymour-Hannah Sports and Entertainment Centre

In 2015, the refrigeration controller at the Seymour-Hannah Sports and Entertainment Centre was upgraded to include floating head pressure control. The new controller allows the system to automatically start, stop and modulate the required refrigeration capacity, maintaining the ice surface when in use, and raising the ice temperature during unoccupied hours. This leads to running maximum refrigeration only when required. This measure resulted in an annual electricity savings of almost 400,000 kWh, and annual cost savings of over $45,000.

4. St. Catharines Kiwanis Aquatic Centre HVAC VFD Controls and Upgrades

In 2017, Variable Frequency Drives (VFD) were installed, and the Building Automation System (BAS) was upgraded at the St. Catharines Kiwanis Aquatic Centre. These measures allow for much greater control of the building's HVAC system, which has allowed building operators to regulate operation of the system to ensure that comfortable conditions are maintained while occupied, and to minimize energy use while unoccupied. This measure has resulted in an annual electricity savings of over 475,000 kWh, and annual cost savings of over $54,000.

5. Various HVAC Upgrades across the building Portfolio

Since 2011, an additional 11 projects focused on HVAC systems have been completed across the City's buildings. These have included measures such as:

- Installation of energy efficient unitary AC units
- Installation of Variable Frequency Drives
- Installation of Airco Saver units
- Installation of energy efficient rooftop ventilation units
- Replacement of an air-cooled chiller with a more efficient water-cooled chiller

In total, these measures resulted in an annual electricity savings of over 60,000 kWh, and annual cost savings of over $7,000.

6. Maintenance Equipment Electrification

The City is currently piloting the use of electric battery powered power tools to replace the current equipment used for various repair and maintenance tasks across the City.

If the pilot is successful, the City plans to replace applicable equipment with electric equivalents, while outfitting City vehicles, and facilities with the necessary charging equipment to support the initiative.

This initiative was suggested by one of the City's staff members who brought it up to the City's fleet manager.

City Staff Removing a Tree Stump

Proposed Energy Efficiency Initiatives

The City has identified several initiatives to either directly reduce energy consumption, or to support a broader culture of energy efficiency across the organization, which are detailed in the following section.

Embedding a Culture of Energy Management

For the CDMP to be successful, and for the City to reach its long-term energy and GHG goals, there needs to be a shift in corporate culture to embed energy management into day-to-day decisions and processes. Efforts to do this can be organized across the following four key areas along with some key practices. Some of these are reflected in the measures identified in the remainder of this section to be completed during the course of the CDMP.

Table 5: Key practices to embedding energy management into organizational culture

Key Practices	Description
Fostering Commitment	• Strive to build and reinforce the importance of energy management while supporting and encouraging City staff who are making efforts to embed energy management.
Clarifying Expectations	• Establish rules, and procedures, with the goal of clarifying staff expectations regarding energy management. The aim is to integrate energy management into the core of the City's strategies and processes, equip and encourage City staff via training and incentives, and measure, track, and report on progress.
Building Momentum for Change	• Develop new ideas to bring the City closer to its energy management goals.
Instilling a Capacity for Change	• Create the necessary structures and supports that will form a foundation for future changes.

Organizational Measures

Organizational measures in energy conservation can be identified as policies, procurement strategies and design standards that assist with potential energy savings for the City. These measures may not have a direct impact in reducing energy consumption at the City, but they are vital to ensuring the success of the CDMP. The following are some of the organizational measures that the City should consider to achieve its energy related goals.

1. Formation of a formal cross departmental team

Various departments at the City will play a crucial role in the development and successful implementation of the CDMP. Without the collaboration and effort of these various departments, the successful implementation of the CDMP and the achievement of energy targets will be difficult.

2. Energy and costs are considered across the entire building or equipment lifecycle

Development of guidelines for City staff to consider energy consumption, and utility costs across the entire lifecycle during the decision-making process, or the planning and design stages for new buildings, new equipment, or energy efficiency measure.

3. Establishment of a Green Reserve Fund

With continued pressures on capital budgets, it is important that a funding model be established to ensure the necessary capital needed for implementation of the CDMP is available over the next five years and beyond. Without a dedicated account, or annual allocation, it would be very easy for other capital priorities to take precedent over the measures identified in this plan.

A revolving loan fund is recommended as a possible financing approach, which involves a pool of capital that will provide financing for implementation of energy conservation measures identified in this CDMP, which will result in ongoing utility savings, operational savings, and one-time incentive payments from local utilities. These savings and incentives are tracked and used to replenish the fund for the next round of investments. The reinvested funds will then be used in addition to the annual capital budget funding.

In the CDMP financial model, the assumption was made that the reserve fund will only service projects completed in this five-year CDMP period. It is assumed that the fund will likely continue to be utilized after 2025, however the requirements of the next CDMP funding period are not yet known.

Seymour-Hannah Sports and Entertainment Centre

New Buildings

4. Energy efficiency standards for buildings

The best time to maximize the energy performance of a building is during the design phase. Identifying energy efficiency as a priority prior to the design phase of building construction can ultimately save costs and be more effective in ensuring the best design, materials, and construction methods are selected. The City will strive to develop and implement progressively higher minimum energy efficiency standards for new buildings where feasible. These standards will look to go beyond meeting the minimum Ontario Building Code requirements and could include Net Zero Energy Buildings.

5. Commissioning

Commissioning is a quality assurance process for new construction, or major renovation projects that begins with pre-design and continues through design, construction, and early operation. Commissioning is intended to ensure that building systems and equipment have been designed, installed, and tested to perform in accordance with the design intent.

The City will look to commission new buildings, major renovations, and additions in a manner that will ensure energy performance requirements are met after construction.

Fleet, and Equipment

6. Develop a strategy for electric vehicles, equipment and alternative fuels.

In 2018, gasoline and diesel consumption represented 15% of the City's corporate energy consumption and almost 30% of the City's corporate GHG emissions. With a typical vehicle replacement cycle of 10 years, the choices the City makes as part of this plan will set the course towards reaching its energy conservation goals. Conversion from petroleum fuels to electric energy for transportation represents a significant opportunity for reducing greenhouse gas emissions and the cost of vehicle operation for the City, as well as the broader community. However, the current availability of certain vehicle types limits widespread adoption for the City fleet. By the end of the plan, more than 50% of the City's vehicle fleet will have needed to be replaced, however plug-in hybrid electric (PHEV), or battery electric vehicle (BEV) replacements are currently only available for less than 20% of those vehicles. The City will continue to explore and develop a strategy to facilitate adoption of EV's or alternative fuel vehicles within the municipal fleet. The strategy could incorporate several initiatives such as:

1. Convert appropriate light duty municipal fleet vehicles to EVs or alternative fuel vehicles upon their scheduled replacement dates;
2. Monitor opportunities for electrification or use of alternative fuels for heavy-duty municipal fleet vehicles;
3. Install and operate corporate and public EV charging stations throughout the City;
4. Promote the environmental and economic benefits of EV use to residents and monitor uptake of EVs locally;
5. Consider battery operated tools in lieu of gas-powered equipment and hand tools where appropriate;
6. Ready local infrastructure for increasing EV charging demand; and
7. Determine demand for EV charging among municipal employees commuting to work.

When developing this strategy, it is recognized that there are constraints on acquiring new vehicles as they are purchased through an Equipment Reserve Fund, which is limited in its funding. In order to fund the purchase of electric or alternative fuel vehicles, increased annual funding to the reserve may be required.

One of the City's 10 hybrid electric vehicles

Existing Buildings and Equipment

7. Retro Commissioning Policy and Plan

There is a significant amount of energy that can be saved in most buildings from relatively simple repairs and careful calibration of energy systems and controls. Over the course of its operation, the energy performance of a building will gradually degrade. Small changes in how building components and systems interact, neglected maintenance, and suboptimal management of energy systems by staff all can contribute to losses in efficiency over time. Retro-commissioning is the process of diagnosing these problems and implementing low-cost solutions for them. Retro-commissioning is recognized as one of the most cost-effective energy efficiency improvements the owner of an existing building can make and can lead to an average energy savings of 16% in whole building energy savings. The City will strive to develop a retro commissioning plan to improve the energy performance of the City's existing building portfolio and look to routinely perform retro commissioning on all buildings.

8. Technical Measures

Through the completion of energy audits across 11 of the City's highest energy consuming buildings, several energy conservation measures have been identified to be completed over the next five years and beyond. They include low cost measures that City staff can look to implement, and larger energy conservation measures.

The following section describes some of the projects that the City will look to undertake, while a full list is provided in Appendix B.

Interior and Exterior LED Lighting Retrofits

The City will strive to retrofit interior and exterior lighting fixtures in City buildings to LED based technology. Some building areas have already undergone retrofits, however most buildings offer the opportunity to replace the existing fluorescent and incandescent based lamps with their LED based equivalents. This will improve color rendering and lighting quality, provide energy savings and reduce peak demand of the building. It is expected that staff and facility users will experience a noticeable improvement in light quality in the retrofitted areas.

Enhancement of Capital Projects

Before the end of the five-year CDMP, it is expected that major components (building envelope and/or HVAC) in several buildings will reach the end of their useful life and will have to be replaced. During this time, these capital projects will be evaluated for the opportunity to significantly upgrade and enhance their performance. Focus will be placed on moving from code compliant or typical thermal performance and air tightness requirements, towards high performance components.

The incremental cost between a typical component replacement and a high-performance replacement is relatively small and will look to be considered in all future financial analysis of capital projects.

High Efficiency Condensing Boilers (Heating and Domestic Hot Water)

Condensing boiler technology represents today's industry standard method of generating heat in the most economical and clean way possible. Typical thermal efficiencies of atmospheric (non-condensing, standard efficiency) boilers is 80%, with a reduced efficiency over the lifetime of the equipment. Whereas, condensing boilers are characterized by having thermal efficiencies of over 90%, and up to 96%.

Passive De-Aerator System for Resurfacing Water at Ice Rinks

In order to achieve acceptable ice quality for skating, small impurities (dissolved gases/air bubbles) must be removed from the water used to resurface the ice. Traditionally, this has been achieved by heating the water to near boiling point before applying it to the ice surface. At City rinks, this currently requires the input of thermal energy in the form of natural gas. Today, technologies exist that can passively remove water impurities using little to no energy, allowing the use of cold water for ice resurfacing. Technologies utilize an induced vortex flow, forcing gas bubbles in the water to collect in a chamber where they expand and gather into larger bubbles and are released. This would result in energy savings associated with the heating of the water, in addition to electricity savings associated with the ice rink refrigeration system, due to a lower cooling load after resurfacing and the ability to increase the ice rink slab temperature. The City will continue to look at the feasibility of installing these systems at City rinks.

Seymour-Hannah Sports and Entertainment Centre

Electric vehicle charge station located at City Hall

Tracking and Monitoring

9. Assessment of current energy data availability and resources

In order to ensure that the City continues to work towards meeting its energy goals, it is important to have access to up-to-date utility data at an appropriate level of granularity in a form that would make it easy to analyze and compare year over year energy performance. This will allow for greater insight into the performance of specific energy conservation measures, allow for deeper energy analysis, and allow the City to track progress towards its energy and GHG goals. Based on preparing the CDMP, the current system is not adequate. The City may want to assess the current energy data needs, whether the staff resources are adequate to manage and collect the data, and investment into an energy management software would be justified. The City will also look to work with the utilities to determine what support can be offered in streamlining the data collection process.

Communication and Engagement

10. Staff Engagement Strategy

Staff engagement is an important component in any CDMP to promote adoption of energy efficiency behaviors and to ensure a culture of energy efficiency and sustainability is cultivated. These strategies have shown to be effective, particularly when staff see their peers engaged, when incentives are offered, and when messages are tailored to the values and interests of the building users. Use of trusted information channels and delivery of relevant information face-to-face by respected experts and/or peers increases the effectiveness of outreach efforts. Properly designed and delivered engagement strategies can go a long way in ensuring that building users realize the desired benefits of energy efficiency retrofits. It also offers one of the best chances for long lasting behaviour changes on the part of new or experienced staff.

Staff Engagement Workshops

As part of development of this CDMP, a series of three workshops were conducted with City staff and stakeholders. These workshops looked to help educate participants about current practices and future considerations for the CDMP, identify current initiatives being undertaken that could help achieve the CDMP goals, and identify best practices from staff with respect to energy conservation. These workshops proved invaluable in helping to inform the CDMP, with a wide range of staff attending and contributing their ideas.

Council Chambers

Staff Engagement Program on Energy Efficiency

The City has a general staff engagement program in place (e.g. TeamSTC, Jostle etc.). The City will aim to utilize the momentum from development of the CDMP to develop and launch a staff engagement strategy focused on energy conservation and sustainability. This program could look to:

- Educate staff on the City's current energy performance, and goals;
- Encourage staff to contribute ideas to conserve energy;
- Empower staff to take action to reduce their energy consumption;
- Provide ongoing updates on the City's initiatives and progress towards goals.

The engagement strategy could include a multi layered communication approach that could involve:

- Building off the existing staff engagement program
- Posts on the staff intranet
- Email blasts
- Announcements and presentations during employee appreciation event

Operations Staff and Planning Team Communication

In many organizations, there is often a lack of communication between the operations staff responsible for the day-to-day operation of buildings, and the capital planning department. A lack of communication between these two teams can lead to mistakes and problems in the implementation of projects that could easily be avoided with a more involved and active communication strategy.

One way to initiate this communication to make it a habit and common practice within the City is by implementing a regularly scheduled check-in or update between the two parties. This update could take place on a monthly or bi-monthly basis depending on the status of project implementation. Regular updates and communication should take place more frequently if there is work being planned by the management team, work in progress, or during a post-project phase.

In general, the operations and maintenance team should be involved in the capital planning process, as their input is valuable to the planning and design phase of many different projects. City staff who are responsible for the day-to-day operations of the buildings can identify pitfalls in design and highlight details of a project specific to a building that other staff, and consulting engineers, are not aware of, or overlook. This is very valuable insight to have during the planning phase of a project as it reduces the amount of unforeseen alterations to the design, saving time and money. In addition, including these staff in the early stages of the design process will help with the buy-in and success of the project.

Proposed Renewable Energy Initiatives

As the building industry, and the world, moves away from GHG emitting energy sources and fossil fuels, focus will continue to shift more and more heavily towards renewable energy sources such as solar, hydro, geothermal, biomass, and wind. The City understands that renewable energy will become more and more important to successfully reaching the energy conservation goals that have been set out.

In the long term, continued emphasis and encouragement will be placed on the use of renewable energy sources to generate electricity and thermal energy to be used in City buildings. It is expected that significant advancements in technology and funding programs will be made that will increase the efficiency, decrease the cost and improve the overall business case for these strategies.

Through the energy audits completed, a number of different renewable energy projects have been identified and assessed across the City's' buildings, such as solar PV, solar thermal, building integrated photovoltaic, geothermal, and wind, however based on the City's payback thresholds, none represented an attractive business case by themselves.

Bell Peppers from the St. Catharines Farmers Market

FIVE-YEAR WORK PLAN

This five-year work plan sets a clear course for the City over the next five years. It contains a well thought out and accurate implementation schedule based on an understanding of the investment required. The plan is based on a review of the City's current energy management practices, and energy audits completed at 11 of the City's buildings.

At the end of the five-year plan, the City will have continued to build a foundation of energy management at the City, significantly reduced energy consumption, and significantly reduced GHG emissions from its operations.

The five-year plan involves the implementation of over 60 projects across the City's building portfolio. A minimum investment of just over $1.5 million is needed to implement the five-year work plan.

The projects range from simple measures such as replacing old incandescent lighting with more energy efficient LED fixtures that will start to generate energy savings immediately to replacement of pumps, installation of variable frequency drives, and building control systems. The plan also includes various organizational, policy, and engagement efforts vital to the success of the CDMP and instilling a culture of energy efficiency at the City.

Significant improvements during this time period are critical if the City is to meet its 2030 targets. If the projects in the five-year plan were implemented the following benefits are expected to be realized:

- Over 1.8 million kWh in annual electricity savings;
- Over 125 thousand cubic metres in annual natural gas savings;
- Over 10 thousand litres in annual transportation fuel savings;
- Over $300,000 in annual utility cost savings;
- A total corporate energy intensity reduction of 19% compared to 2011
    - 4% reduction during the planning period; and
- A total corporate GHG intensity reduction of 29% compared to 2011
    - 4% reduction in corporate GHG intensity during the planning period

Figure 8 on the next page shows the expected energy savings and avoided energy costs over the next five years based on the measures identified and the work plan developed.

Appendix B includes a detailed year-by-year outline of the energy management measures included in the work plan.

Projected Energy Consumption and Cost

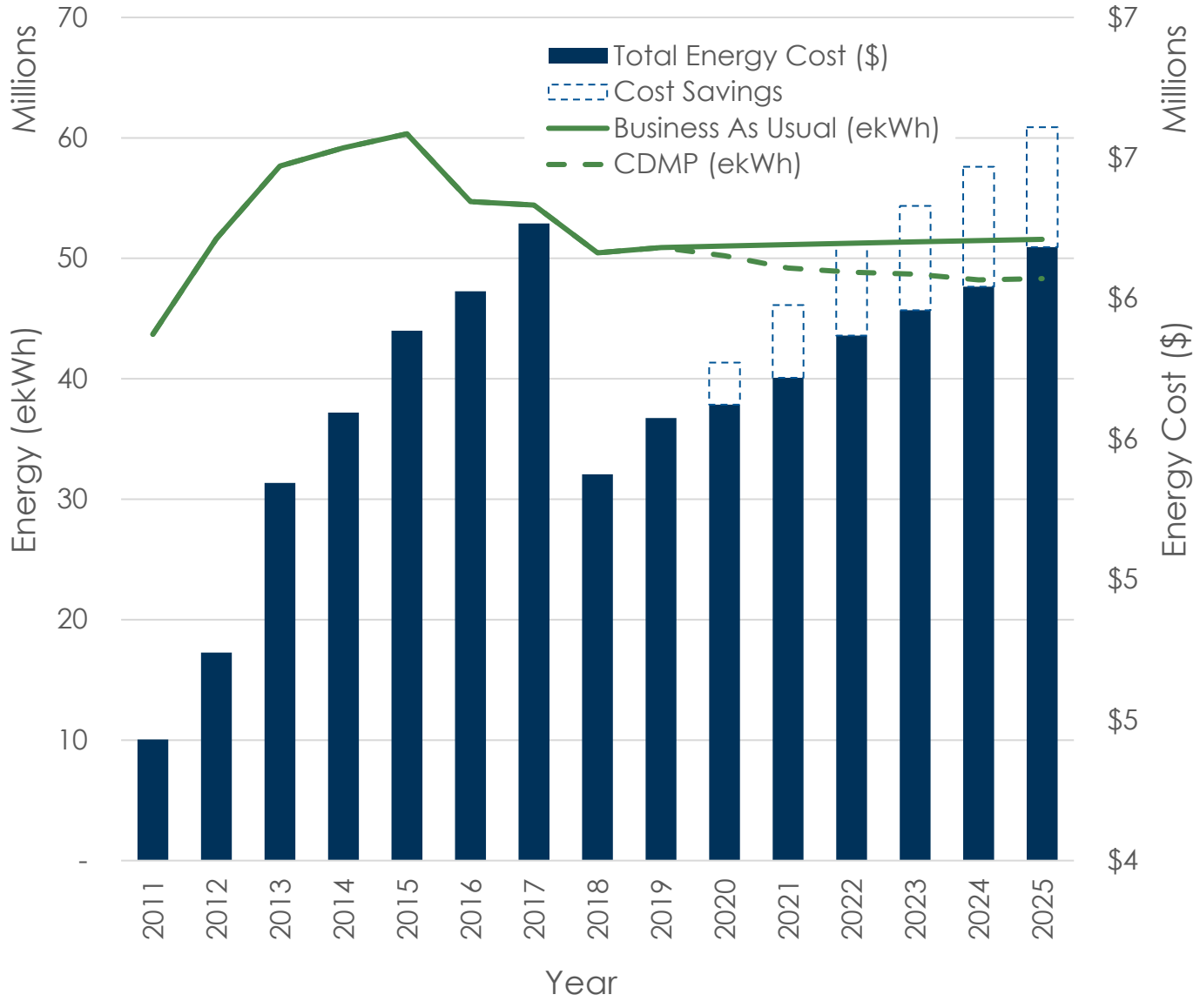

Figure 8: Project Energy Consumption and Costs 2020 - 2025

Table 6 below outlines the expected yearly budget needed to implement the plan, the expected annual energy, cost, and GHG savings, as well as the payback period.

Table 6: Five-year Work Plan Summary

Year	Capital Cost ($)	Annual Savings						Payback Period (Years)
		Electricity (kWh)	Natural Gas (m3)	Water (m3)	Fuel (L)	Cost ($)	GHG (tCO2e)	
2020	$329,818	787,623	-	-	2,126	$100,544	315	3.3
2021	$325,261	382,417	69,818	-	2,126	$73,484	292	4.4
2022	$303,421	285,838	15,826	-	2,126	$43,584	54	7.0
2023	$295,591	223,820	2,912	5,575	2,126	$48,209	95	6.1
2024	$287,130	166,339	37,762	3,914	2,126	$44,200	139	6.5
TOTAL	$1,541,220	1,846,037	126,318	9,489	10,630	$310,022	894	5.0

Exhibit at the St. Catharines Museum and Welland Canals Centre

LONG TERM STRATEGIES

This section outlines the City's long-term strategies, which will continue after the five-year planning horizon covered by this plan.

Energy Efficiency Initiatives

11. Identification and implementation of new conservation measures

The City had energy audits completed for 11 of the highest energy consuming buildings in its portfolio. Those buildings represented over 85% of the energy consumption across City buildings in 2018.

In order to continue to identify, design and implement energy conservation measures, the City will look to ensure resources are available to continue to identify, and implement energy conservation measures at the City. The City will also look to complete additional engineering studies or analysis of potential energy conservation measures where needed.

12. Redevelopment, Revitalization, or Removal of City Buildings

The City's building portfolio includes several buildings that are currently, or that will soon reach the end of the typical lifespan of a building. At that time, a development decision will have to be made regarding whether to redevelop, revitalize, or remove the site. Along with considering the needs of the City, and its residents, the decision will aim to consider the current and future energy performance, costs and GHG emissions of each site. The City will look to consider the long-term impacts of each development option by taking a more holistic and life cycle view of the sites.

St. Catharines City Hall

Tracking and Monitoring Progress

13. Annual Energy Analysis

On an annual basis, the City should consider conducting energy analysis for its building portfolio using weather-normalized data. Weather normalization is important, as it can be very difficult to know if a building is operating efficiently when weather can play such a large factor in energy consumption. Weather normalization allows for a like-to-like comparison of energy consumption for different time periods with differing weather conditions, enabling the City to track a building or portfolio's relative performance over time without worrying about the impact of varying outside air temperatures. Weather normalized energy data can be used to quickly and easily understand if an increase or decrease in energy consumption is the result of operational changes or temperature changes.

This analysis will allow the City to compare the energy consumption across its portfolio year to year and verify the projected energy savings from the energy projects that were implemented. Tools are available to assist the City in completing this annual energy analysis exercise including RETScreen, and EnergyStar Portfolio Manager.

14. Real-time tracking and monitoring for all new buildings, and major renovations/retrofits

Real-time utility tracking and monitoring systems allow for more accurate measurement and verification of the success of future energy efficiency measurements, while also allowing for additional benefits such as: alarm functionality when consumption is abnormal, and the ability to diagnose equipment and control problems remotely.

These systems could be incorporated into new buildings and major renovations or retrofits, which will allow for better energy tracking and monitoring. There are several hardware and software options available, however each differ in terms of their capabilities, features, and cost. Before investing in a system, the City will need to consider several factors when deciding on a solution.

15. Real-time building level data for existing buildings

Moving towards interval meters on all electrical services and pulse outputs on gas and water meters would allow for better tracking of energy and utility consumption for the City's larger facilities. The City could assess the metering needs of each building in order to ensure each building is appropriately metered and where there is a need to replace or add new meters, the City will do so. The City may also want to investigate options for an energy management system to be used to track and analyze building energy and water use.

16. Measurement and verification (M&V) requirements for all new major projects

Measurement and Verification (M&V) is an objective process for quantifying energy savings achieved through the implementation of energy conservation measures. The process involves measuring and verifying pre and post-implementation energy use and adjusting for any differences in conditions such as weather. In order to ensure that the energy and cost savings of all major future energy efficiency projects are captured, the City will aim to make it a requirement during the procurement process that M&V activities be included as part of the scope of work. This will ensure that the City can verify the actual energy savings from energy conservation measures, which can be used to support reporting on the City's progress towards its energy goals.

17. Utility Tracking System or Energy Management Software

With over 46 major facilities and sites across the City, 44 natural gas accounts, and 148 electricity accounts, the effort required to track invoices and maintain a utility database is large. The City will look to investigate the possibility of enrolling in a third-party utility tracking software or energy management software.

In addition to eliminating the hours of staff time required for manual transcription of utility data, the implementation of a software solution has additional benefits such as:

- Streamlining of BPS reporting preparation;
- Reducing or eliminating manual transcription errors;
- Identifying billing and metering errors;
- Identifying water main breaks in facilities through winter months, helping to avoid damage to structures and huge unchecked water bills;
- Forecast energy consumption and costs;
- Allows sharing of key utility data between departments and individuals;
- Can generate energy analysis graphs and reports that can be made available to managers of facilities; and
- Improves transparency, collaboration and awareness

There are several software solutions available, however each differ in terms of their capabilities, features, and cost. Over the long term, the City will investigate the possibility of utilizing a third-party utility tracking software or energy management software.

CONCLUSION

This plan has been developed in order to meet Ontario Regulation 507/18 requirements. It has looked to identify the current and proposed measures for managing energy consumption across the City's corporate energy consumption, provide a forecast on the expected energy and cost savings from those measures, and provide an update on the results achieved since the previous energy management plan.

In total, the City has reduced its annual energy consumption by over 7.5 million ekWh of energy. The equivalent to the annual energy consumption of almost 800 households.

Through the successful implementation of this CDMP, the City is expected to reduce its annual energy consumption by an additional 3.3 million ekWh of energy.

In order to meet the City's 2030 goals of a 30% reduction in energy intensity and a 40% reduction in GHG intensity compared to 2011, a significant shift in the City's current corporate culture surrounding energy management and GHG emissions will also be required.

APPENDIX A – FORECASTED CONSUMPTION AND GHG EMISSIONS MODEL ASSUMPTIONS

Category	Assumption
Energy Consumption	
Size of City's building portfolio	• The rate of growth of the City's building portfolio between 2011 and 2018 was very high, and future growth is not anticipated to be that high based on current population projections for the City. A lower rate of growth was assumed (1/4 the growth rate of 2011 – 2018)
New Building Code Energy Efficiency Requirement	• Net zero energy requirement for all new buildings by 2030 • 15% reduction every 4 years in building energy code energy efficiency requirements
Building Energy Consumption	• Progressive shift away from natural gas usage for new buildings
Transport Fuel Energy Consumption	• Similar levels of fuel consumption going forward. Assumed the average consumption level from 2011 – 2018 for future years
Energy and Utility Costs	
Carbon Pricing	• Federal carbon tax set to $10 and set to increase to $50 by 2022. The rate increases outlined below have included this pricing into the utility rate model
Electricity Rates	• 2% - 3% annual increase
Natural Gas Rates	• 2% - 9% annual increase
Transport Fuel Rates	• 2% - 4% annual increase
Emission Factors	
Greenhouse Gas Emission Factors	• The electricity emission factor is assumed to stay the same as 2018 in the model • The natural gas emission factor is assumed to stay the same as 2018 in the model

APPENDIX B – DETAILED FIVE-YEAR WORK PLAN

Year 1											
Building or Priority Area	Energy Conservation Measure	Capital Cost [$]	Annual Utility Savings					Annual GHG Reduction	Simple Payback [years]	Incentive [$]	Adjusted Payback [years]
			Electricity [kWh]	N. Gas [m3]	Water [m3]	Fuel [L]	Utilities [$]	tCO2e			
Bill Burgoyne Arena	Interior Lighting Retrofit	$17,088	38,140	-	-	-	$5,157	15	3.3	$3,814	2.6
Bill Burgoyne Arena	Install Low-E Ceiling Over ice	$50,000	72,924	-	-	-	$7,927	29	6.3	$7,292	5.4
St. Catharines Kiwanis Aquatic Centre	Interior Lighting Retrofit	$31,288	94,073	-	-	-	$14,757	38	2.1	$3,381	1.9
St. Catharines Kiwanis Aquatic Centre	Outdoor Lighting Retrofit	$19,700	28,667	-	-	-	$4,015	11	4.9	$1,425	4.6
Seymour-Hannah Sports and Ent. Ctr.	Interior Lighting Retrofit	$148,443	502,079	-	-	-	$60,385	201	2.5	$25,104	2.0
Seymour-Hannah Sports and Ent. Ctr.	Outdoor Lighting Retrofit	$57,700	51,740	-	-	-	$5,624	21	10.3	$4,195	9.5
Organizational	Formation of a formal cross departmental 'Energy Team'	-	-	-	-	-	-	-	-	-	-
Organizational	Development of a Staff engagement strategy on energy efficiency	-	-	-	-	-	-	-	-	-	-
Organizational	Establishment of a Green Reserve Fund	-	-	-	-	-	-	-	-	-	-
Tracking and Monitoring	Establish M&V requirements and scope to be included in procurement documents	-	-	-	-	-	-	-	-	-	-
Fleet	Replacement of light duty vehicles with EV	$5,600	-	-	-	2,126	$2,679	5	2.1	-	-
	Total	$329,818	787,623	-	-	2,126	$100,544	315	3.3	$45,211	2.8

St. Catharines

Year 2											
Building or Priority Area	Energy Conservation Measure	Capital Cost [$]	Annual Utility Savings					Annual GHG Reduction	Simple Payback [years]	Incentive [$]	Adjusted Payback [years]
			Electricity [kWh]	N. Gas [m3]	Water [m3]	Fuel [L]	Utilities [$]	tCO2e			
Carlisle Street Parking Garage	Interior Lighting Retrofit	$24,695	42,469	-	-		$5,199	17	4.8	$2,123	4.3
Firehall 4	Interior Lighting Retrofit	$3,240	27,962	-	-		$3,302	11	1.0	$1,398	0.6
City Hall	Interior Lighting Retrofit	$38,605	52,937	-	-		$7,733	21	5.0	$5,294	4.3
City Hall	Outdoor Lighting Retrofit	$6,000	4,920	-	-		$541	2	11.1	$492	10.2
St. Catharines Museum and Welland Canals Centre	Interior Lighting Retrofit	$21,844	63,973	-	-		$7,037	26	3.1	$6,397	2.2
St. Catharines Museum and Welland Canals Centre	Motion Sensors on Interior Lights	$2,000	7,776	-	-		$855	3	2.3	$778	1.4
Lake St Service Ctr.	Interior Lighting Retrofit	$122,076	112,162	-	-		$22,529	45	5.4	$11,216	4.9
Lake St Service Ctr.	Outdoor Lighting Retrofit	$21,200	16,052	-	-		$2,341	6	9.1	$1,449	8.4
Seymour-Hannah Sports and Ent. Ctr.	RealICE Technology	$80,000	54,167	69,818	-		$21,269	155	3.8	$15,889	3.0
Tracking and Monitoring	Assessment of current energy data and management practices										
Fleet	Development of an electric vehicle strategy	-	-	-	-		-	-	-	-	-
Fleet	Replacement of light duty vehicles with EV	$5,600	-	-	-	2,126	$2,679	5	2.1	-	-
	Total	$325,261	382,417	69,818	-	2,126	$73,484	292	4.4	$45,037	3.8

Year 3											
Building or Priority Area	Energy Conservation Measure	Capital Cost [$]	Annual Utility Savings					Annual GHG Reduction	Simple Payback [years]	Incentive [$]	Adjusted Payback [years]
			Electricity [kWh]	N. Gas [m3]	Water [m3]	Fuel [L]	Utilities [$]	tCO2e			
Bill Burgoyne Arena	Install Timers on Infrared Heaters	$2,000	-	3,294	-		$726	6	2.8	$494	2.1
Meridian Center	Interior Lighting Retrofit	$221,421	227,504	-	-		$33,757		6.6	$11,375	6.2
Bill Burgoyne Arena	ReallCE Technology	$40,000	29,167	6,266	-		$4,551	24	8.8	$3,857	7.9
Meridian Center	ReallCE Technology	$40,000	29,167	6,266	-		$4,551	24	8.8	$3,857	7.9
Organizational	Development of energy efficiency standards for new buildings or major renovations	-	-	-	-		-	-	-	-	-
Organizational	Development of a commissioning policy for new buildings and major renovations	-	-	-	-		-	-	-	-	-
Fleet	Replacement of light duty vehicles with EV	$5,600	-	-	-	2,126	$2,679	5	2.1	-	-
	Total	$303,421	285,838	15,826	-	2,126	$43,584	54	7.0	$19,582	6.5

Year 4											
Building or Priority Area	Energy Conservation Measure	Capital Cost [$]	Annual Utility Savings					Annual GHG Reduction	Simple Payback [years]	Incentive [$]	Adjusted Payback [years]
			Electricity [kWh]	N. Gas [m3]	Water [m3]	Fuel [L]	Utilities [$]	tCO2e			
Seymou-Hannah Sports and Entertainment Centre	Domestic Water Fixture and Toilet Retrofit	$53,565	-	1,865	4,289		$14,355	4	3.7	$0	3.7
City Hall	Domestic Water Fixture and Toilet Retrofit	$16,530	-	1,047	1,286		$4,270	2	3.9	$0	3.9
Centennial Library	Interior Lighting Retrofit	$92,063	105,191	-	-		$14,133	42	6.5	$5,260	6.1
Centennial Library	Photocells on Interior Lights for Control	$4,000	16,080	-	-		$1,748	6	2.3	$0	2.3
Centennial Library	Building Integrated Photovoltaic for Atrium	$48,360	18,500	-	-		$2,035	7	23.8	$0	23.8
FirstOntario Performing Arts Centre	Interior Lighting Retrofit	$74,273	78,924	-	-		$11,104	32	6.7	$10,718	5.7
St. Catharines Museum and Welland Canals Centre	Outdoor Lighting Retrofit	$5,800	4,555	-	-		$501	2	11.6	$456	10.7
St. Catharines Museum and Welland Canals Centre	Photocell on Outdoor Lights	$1,000	570	-	-		$63	0	15.9	$57	15.0
Organizational	Development of retro commissioning policy and plan	-	-	-	-		-	-	-	-	-
Organizational	Procurement guidelines for lifecycle cost analysis during decision making	-	-	-	-		-	-	-	-	-
Fleet	Replacement of light duty vehicles with EV	$5,600	-	-	-	2,126	$2,679	5	2.1	-	-
	Total	$295,591	223,820	2,912	5,575	2,126	$48,209	95	6.1	$16,491	5.8

Year 5											
Building or Priority Area	Energy Conservation Measure	Capital Cost [$]	Annual Utility Savings					Annual GHG Reduction	Simple Payback [years]	Incentive [$]	Adjusted Payback [years]
			Electricity [kWh]	N. Gas [m3]	Water [m3]	Fuel [L]	Utilities [$]	tCO2e			
Multiple Buildings	Address Infiltration Levels through Envelope Sealing Measures – Exterior Doors	$11,300	-	14,957	-		$2,917	29	3.9	$0	3.9
Other Buildings	Interior and Exterior LED Lighting Retrofit	$112,000	145,043	-	-		$19,859	58	5.6	$7,252	5.3
Lake St Service Center	Domestic Water Fixture and Toilet Retrofit	$19,300	-	405	639		$2,442	1	7.9	$0	7.9
Firehall 4	Domestic Water Fixture and Toilet Retrofit	$5,585	-	453	322		$1,145	1	4.9	$0	4.9
Centennial Library	Domestic Water Fixture and Toilet Retrofit	$8,720	-	387	369		$1,286	1	6.8	$0	6.8
St. Catharines Kiwanis Aquatic Centre	Domestic Water Fixture and Toilet Retrofit	$14,550	-	470	482		$1,883	1	7.7	$0	7.7
Meridian Center	Domestic Water Fixture and Toilet Retrofit	$36,825	-	562	586		$2,030	1	18.1	$0	18.1
Museum	Domestic Water Fixture and Toilet Retrofit	$7,725	3,180	-	251		$1,161	1	6.7	$0	6.7
FirstOntario Performing Arts Centre	Domestic Water Fixture and Toilet Retrofit	$17,325	-	208	443		$1,488	0	11.6	$0	11.6
Bill Burgoyne Arena	Install Controls for Arena Exhaust Fans	$3,000	3,175	-	-		$345	1	8.7	$0	8.7
City Hall	Install Occupancy Controls for Cold Vending Machines	$500	2,219	-	-		$244	1	2.0	$222	1.1
Meridian Center	Install Occupancy Controls for Cold Vending Machines	$500	2,219	-	-		$241	1	2.1	$222	1.2
Seymour-Hannah	Install Occupancy Controls for Cold Vending Machines	$1,500	6,657	-	-		$724	3	2.1	$666	1.2

Year 5											
Building or Priority Area	Energy Conservation Measure	Capital Cost [$]	Annual Utility Savings					Annual GHG Reduction	Simple Payback [years]	Incentive [$]	Adjusted Payback [years]
			Electricity [kWh]	N. Gas [m3]	Water [m3]	Fuel [L]	Utilities [$]	tCO2e			
City Hall	Insulate Accessible Distribution Pipes	$300	1,368	-	-		$150	1	2.0	$0	2.0
Centennial Library	Replace Heating Loop Pumps with Variable-Speed Pumps	$2,000	1,534	-	-		$167	1	12.0	$0	0.0
St. Catharines Kiwanis Aquatic Centre	Pool Water Heat Recovery	$37,000	-	6,912	822		$4,702	13	7.9	$1,037	7.6
St. Catharines Kiwanis Aquatic Centre	Replace the DHW Recirculation Loop Pump with Intelligent Pump	$4,500	318	10,871	-		$2,700	21	1.7	$0	1.7
Lake St Service Center	Replace the DHW Recirculation Loop Pump with Intelligent Pump	$4,500	626	2,537	-		$716	5	6.3	$0	6.3
Fleet	Replacement of light duty vehicles with EV	$5,600	-	-	-	2,126	$2,679	5	2.1	-	-
	Total	$287,130	166,339	37,762	3,914	2,126	$44,200	139	6.5	$9,398	6.3

Five-Year Total	$1,541,220	1,846,037	126,318	9,489	10,630	$310,022	894	5.0	$135,720	4.5