ENERGY and EMISSIONS MANAGEMENT PLAN 2019-2024:

A ZERO CARBON Transition

311 brampton.ca

BRAMPTON

Cover art, by Strategic Communications, depicts the Williams Parkway Operations Centre (WPOC) and a solar panel installation. WPOC uses geothermal (earth) energy for heating and cooling. The facility has been designed to achieve 24% better energy performance over ASHRAE Standard 90.1–2010. The City has also installed solar energy systems at numerous municipal facilities.

EXECUTIVE SUMMARY

Brampton, Canada's Flower City, is a rapidly growing community with an average annual population increase of 2.66% since the 2011 Census[1]. This is more than 2.5 times the national average from 2011 to 2016. The population -- 593,638 according to the 2016 Census -- is projected to increase to approximately 1,000,000 by 2040. The municipality's portfolio of facilities is expected to increase alongside its population.

In 2018, Brampton City Council endorsed a bold vision for the City's future to 2040, focusing on sustainability, livability, diversity, and health. The City aims to integrate sustainable living into everything, with the goal of carbon and waste neutrality over the next 25 years.[2] The City of Brampton will adopt the provincial and federal greenhouse gas (GHG) emission reduction targets of 30% and 80% for 2030 and 2050 respectively. Looking towards a zero carbon transition in operations for the City's facilities, the City has set an interim target of 20% GHG emissions reduction by 2024, which is the end year of this plan. Based on data available for the reporting year, the City of Brampton's 2017 GHG emissions have decreased by 13% compared to GHG emissions from a 2010 baseline year.

The following table provides an overview of the City's 2019-2024 CDM Plan.

Table 1: CDM Plan Summary

Mission:	To meet the challenge of a zero carbon transition in alignment with provincial and federal level emission targets
Interim Target:	To achieve a 20% energy reduction target over the 2010 baseline by 2024, the end of the current CDM cycle
Long Term Goal:	To achieve GHG emission reduction targets of 30% and 80% for 2030 and 2050 respectively

Major Successes

• **Energy Conservation:** Over the last five years (2014-2019), a total of 50 energy conservation projects were performed in the City of Brampton
  o These projects have persisting energy savings of **32,088,000 ekWh in total** (17,536,000 kWh electricity, and 1,369,000 m3 natural gas) over the last five years and have the potential to reduce **1,230 tons CO2e of GHG emissions** per year. The simple payback of these projects is estimated to be seven years.
  o Sample projects successfully implemented over this timeframe include: instantaneous water heaters, swimming pool heat recovery, de-stratification fans, high efficiency lighting, and emerging technologies such as REALice heat saver
• **Building Automation System (BAS):** Building Automation Systems have been integrated with our recreation class scheduling software in order to allow for HVAC equipment and lights to be scheduled on alongside bookings for certain areas.
• **Renewable Technology Projects:** Implementation of a number of rooftop solar PV systems that recover electricity costs for the City, located at our fire stations, transit facilities, and community centres
• **Training & Behavioural Energy:** The Energy Management team has conducted multiple Energy Management training workshops over the last five years for City facility operational staff

[1] (Statistics Canada, 2017) https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?Lang=E&Geo1=CSD&Code1=3521010&Geo2=CD&Code2=3521&Data=Count&SearchText=brampton&SearchType=Begins&SearchPR=01&B1=All&TABID=1

[2] (Beasley and Associates, 2018) https://www.brampton.ca/EN/City-Hall/Documents/Brampton2040Vision/brampton2040Vision.pdf

Major Successes

- **Cost Recovery**: A total of $5.8M of costs, from 2014-2019, have been recovered for the City of Brampton through energy conservation, third-party funding, energy procurement, and water rebates:

Program Name	Recovered Cost
Energy Conservation	$ 2,939,000
Renewable Energy	$ 150,000
Utility Funding	$ 955,000
Energy Procurement	$ 1,060,000
Water Rebates	$ 767,000
Total	$ 5,871,000

  - **Third-Party Funding:** There are a number of third party funding sources for energy projects including IESO, Enbridge, and the federal government. The federal government is planning to release an additional $1.01 Billion in funding to the Federation of Canadian Municipalities (FCM) in support of municipality-led sustainability initiatives.
  - **Energy Procurement:** The current strategy uses hedging for natural gas and a blend of hedging and spot market exposure for electricity. This approach has provided budget stability, savings, and rebates.
  - **Water Rebates:** The sanitary and sewer water rebate program by the Region of Peel has provided rebates for purchased water that is diverted from sanitary sewers.

Objective	Actions
1. Minimize Energy and Emissions in Existing Facilities	• Continue to employ innovative energy management practices with the implementation of leading-edge/ emerging energy efficient technologies in city-owned facilities • Continue to implement renewable energy projects including geothermal and solar PV projects where feasible • Continue to collaborate with Building Design and Construction, Facilities, Operations and Maintenance, Fire, Transit, and Recreation to develop and implement individual projects • Continue to foster a culture of conservation with customized training and engagement of facility operators through energy management workshops and challenges. Periodically update training materials based upon staff feedback and changes in energy efficiency practices. • Continue to implement facility recommissioning in city-owned facilities for continuous improvement • Continue to monitor progress towards energy and emission reduction targets using IPMVP protocol and Brampton's Utility Data Management Software (GreenBEAM)
	• Develop a formalized energy management policy • Develop a deep retrofit program seeking to deliver zero carbon or high performance • Develop a set point policy for all city-owned facilities for temperature, humidity, outdoor air, etc. • Update City BAS guidelines to build systems that conserve energy while optimizing operational efficiency and ensuring occupant comfort • Investigate better refrigerant management practices including refrigerant replacements • Investigate optimal future EV charging station locations based on geographic, demographic, and socio-economic impacts

Objective	Actions	
		• Investigate undertaking a portfolio energy analysis for all city-owned facilities to support the achievement of our 2030 energy and emission targets
2. Minimize Energy and Emissions in New Facilities		• Energy use intensity targets will be established for each facility typology to inform the design and construction process • Use energy modelling as a central tool in the integrated design process to evaluate options to deliver zero carbon or high performance facilities • Investigate implementing a performance period requirement to ensure that the operations and maintenance of new construction projects are meeting energy targets • Investigate opportunities for renewable technology implementations during the concept design phase of city-owned facilities
3. Maximize Cost Recovery		• Continue to identify and apply for third-party funding sources including existing IESO and Enbridge Gas funding and new $1.01B in federal funding for municipalities available through the FCM • Continue to participate in the Region of Peel's Sanitary and Sewer Water Rebate Program
		• Expand the use of energy metering as part of M&V to quantify savings for cost recovery • Investigate changes to purchasing by-laws to promote the procurement of ENERGY STAR® office equipment and Cradle to Cradle Certified™ building materials

Ongoing Actions
New Actions

NOTICE TO THE ONTARIO MINISTRY OF ENERGY, NORTHERN DEVELOPMENT AND MINES

To: The Ontario Ministry of Energy, Northern Development and Mines

I hereby confirm the approval of the City of Brampton Energy Conservation and Demand Management Plan (CDM), dated June 28, 2019, on behalf of the City of Brampton's Senior Leadership Team (SLT). This plan, in compliance with Ontario Regulation 507/18, will guide the City's energy conservation and demand management efforts over the period of 2019-2024 and will be revised periodically, as necessary.

Signed,

Date: June 28/19

Al Meneses
Commissioner, Community Services
City of Brampton

ACKNOWLEDGMENTS:

The writing of the plan engaged the City of Brampton's Energy Management Team to provide institutional history and subject matter expertise. The team and contributors to the plan are:

1. Chun Liang (Principal Author)
2. Junaid Iqbal
3. Stefan Bedard
4. Rajdeep Dhother

There were also a number of co-op students that were also part of the writing team: Janet Liu, Jaksana Kananesan, Halbert Ruixuan Yang, and Max Chute.

The team especially thanks Mikkel Marr, Manager of Facilities Services and Operations, and Jasbir Raina, Director of Facilities Operations and Maintenance, for supporting Energy Management at the City Brampton.

The team acknowledges the collaborative efforts of the following divisions and looks forward to the implementation of this plan:

- Facilities Operations and Maintenance
    - Facilities, Services and Operations
    - Facilities Maintenance - with special mention to Nissar Ahamed
    - Asset Management & Capital Planning - with special mention to Sahishnu Shah
- Fire, Transit and Recreation

The team acknowledges Building, Design and Construction (BDC) at the City of Brampton for supporting the integrated design process, parametric analysis and energy targets for new facilities with special mention to Davis Falsarella and Sean Cressman. The team appreciates Todd Porter, Manager of BDC, for supplying renewable systems information and his collaborative efforts on energy management.

The team also thanks Alicia Land, Corporate Communications, for her contributions to the cover and overall readability of this plan.

The Energy Management Team would like to express our gratitude to Alectra, Enbridge, and the Independent System Electricity Operator who are our funding partners.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1.0 - INTRODUCTION

This chapter introduces the energy and emission reduction goals and objectives the City of Brampton (the City) is aiming to reach, along with a brief overview of the structure of this plan. The following sections outline the City's overall vision and plans, as well as federal and provincial policies and how they each relate to the zero carbon transition.

1.1 About City of Brampton

Brampton, Canada's Flower City, is a rapidly growing community with an average annual population increase of 2.66% since the 2011 Census. This is more than 2.5 times the national average from 2011 to 2016. The population -- 593,638 according to the 2016 Census -- is projected to increase to approximately 1,000,000 by 2040. The municipality's portfolio of facilities is also expected to increase alongside its population. In fact, over the next 5 years, it is forecasted that there will be around 19 new facilities or major additions and renovations[3] in the City.

In 2018, Brampton City Council endorsed a bold vision for the City's future to 2040, focusing on sustainability, livability, diversity, and health. The City aims to integrate sustainable living into everything, with the goal of carbon and waste neutrality over the next 25 years.[4]

1.2 Our Challenge

Commitment to Energy and Emissions Management

The City's *Grow Green Environmental Master Plan*[5] is the City's first Environmental Master Plan, approved in May 2014. This plan looks at what the City has done well, where there are gaps, and where opportunities exist to promote sustainability and improve the environmental qualities of the City's landscapes. The plan defines goals, and actions set to achieve these targets, for six areas: people, air, water, land, energy, and waste. The overarching goal for energy is to reduce consumption and manage the impact of energy usage on our environment. This goal, by association, includes the reduction and management of emission-related impacts.

Another guiding document for the evolution of the City is the *Brampton 2040 Vision: Living the Mosaic*[6]. This document presents the vision for what the City will become over the next 20-25 years. Some of the major sustainability and environmental goals stated in this report include:

- Establishment of the Institute for Sustainable Brampton (ISB), a public-private facilitator with the mandate to achieve 'one-planet' living[7] balancing, people, wilderness and wildlife.
    - ISB mandate covers the technical, business, and lifestyle aspects of carbon neutrality, zero waste, circular economy solutions, clean air, water and transportation, localized food production, and renewable energy resilience
- Development of integrated transportation choices and modes, emphasizing walking, cycling, and transit.

[3] This value was determined from the Long-Term Facilities Forecast from the BDC department at the City of Brampton based on November 2017 Forecast.
[4] (Beasley and Associates, 2018) https://www.brampton.ca/EN/City-Hall/Documents/Brampton2040Vision/brampton2040Vision.pdf
[5] (Brampton Grow Green Environmental Master Plan, 2014) https://www.brampton.ca/EN/Business/planning-development/projects-studies/Documents/Environmental%20Master%20Plan/Final%20Documents/Brampton%20IAP_11_10_2014.pdf
[6] (Beasley and Associates, 2018) https://www.brampton.ca/EN/City-Hall/Documents/Brampton2040Vision/brampton2040Vision.pdf
[7] One-Planet Living, a concept developed by Bioregional, a UK based Environmental Charity, is a vision of the world "where everyone, everywhere can live happy, healthy lives within the limits of our planet, leaving space for wildlife and wilderness".

- Design of a new urban core for Brampton (Uptown Brampton) potentially including a car-free precinct, district energy, and other sustainability innovations.
- Regeneration of Brampton's green canopy with the planting of one million trees in the public and semi-public realm of the City

Reducing Energy and Emissions

In its *Preserving and Protecting our Environment for Future Generations: A Made-in-Ontario Environment Plan (2018)*[8], the province of Ontario aims to protect our air, lakes, and rivers and help achieve Canada's goal to reduce 30% of emissions below 2005 levels by 2030.

The reduction goal is aligned with the Federal *Pan-Canadian Framework on Clean Growth and Climate Change*[9] (PCF). The PCF is Canada's climate plan, with a focus on energy-efficient measures, energy reduction measures, and carbon pricing measures to ultimately help meet Canada's international emissions reduction targets and commitments under the Paris Agreement. This plan was developed as part of a collaborative approach between federal, provincial, and territorial governments, and in consultation with Indigenous peoples. The plan "wants to meet or potentially exceed our goal to reduce our GHG emissions by 30% from our 2005 levels, by 2030". Below is a list of a few of the new and upcoming actions that are highlighted in this plan:

- Increasing the uptake of zero-emission vehicles for transportation, and increasing efforts to transition to highly-efficient facilities.
- Promoting homes that can generate as much power as they use, and promoting the use of clean energy.
- Investing in clean energy research and technology development; the Federal government is making these investments, as they are a partner of Mission Innovation
- Using funds from the $2 billion Low Carbon Economy Fund and green infrastructure investments to help interested provinces and territories expand their efforts to improve facility energy efficiency.

In addition to the 30% target, the Government of Canada released its *Greening Government Strategy*[10] in December 2017, which set a target to reduce GHG emissions from federal operations by 40% from 2005 levels by 2030 (or earlier), and 80% by 2050. The Government of Canada will also be an early adopter of the new and existing building standards proposed under the PCF. By succeeding in its mandate, the City can help the federal and provincial governments achieve their goals.

Reporting

The provincial government has created regulation *O. Reg. 507/18: Energy Reporting and Conservation and Demand Management* Plans under the Electricity Act, 1998 for the broader public sector, which is applicable to the City. The requirements of the regulation are quoted below and are similar to the requirements of *O. Reg. 397/11: Energy Conservation and Demand Management Plans* (which was repealed[11]). Broader Public Sector (BPS) agencies are required to prepare a 5-year Conservation and Demand Management (CDM) Plan under this

[8] (Preserving and Protecting our Environment for Future Generations: A Made-in-Ontario Environment Plan) https://prod-environmental-registry.s3.amazonaws.com/2018-11/EnvironmentPlan.pdf
[9] (Pan-Canadian Framework on Clean Growth and Climate Change, 2016) http://publications.gc.ca/collections/collection_2017/eccc/En4-294-2016-eng.pdf
[10] (Treasury Board of Canada Secretariat, 2017)https://www.canada.ca/en/treasury-board-secretariat/services/innovation/greening-government/strategy.html
[11] The Green Energy Act – O.Reg 397/11 was repealed as of January 1st 2019 with Bill 34, Green Energy Repeal Act, 2018

regulation. Section 4 (2) of *O.Reg. 507/18* further specifies that CDM Plans must be composed of the following two components:

> *"1. A summary of the public agency's annual energy consumption and GHG emissions for its operations.*
>
> *2. A description of previous, current and proposed measures for conserving and otherwise reducing the amount of energy consumed by the public agency's operations and for managing the public agency's demand for energy, including a forecast of the expected results of current and proposed measures."*

1.3 About this Plan: The Zero Carbon Transition

Purpose

This plan[12] supports the federal and province emissions targets while providing a transition plan for zero carbon and high-performance facilities. The City's Senior Leadership Team has endorsed the plan and is committed to integrating energy and emissions management into its business and to measure and report the social, environmental, and economic benefits.

Objectives

To meet the challenge of a zero carbon transition, this plan reflects three key objectives:

1. Minimize Energy Intensity
2. Minimize Emissions Intensity
3. Maximize Cost Recovery

The scope of the objectives is for the City's new facilities as well as existing facilities. In addition to recovering costs from energy savings, recovery can also include energy procurement, third-party funding, and water rebates.

Implementation

This plan will be implemented through the support of the Senior Leadership Team, and the efforts of the Facilities, Operations and Maintenance (FOM) and Building, Design and Construction (BDC) departments. While the primary focus is applicable to FOM, the activities of the BDC department have a role in managing energy use and emissions from inception, and a responsibility to demonstrate leadership.

The principles of continuous improvement and innovation are essential to the implementation of this plan. The City has structured its approach to energy management such that it follows an ongoing cycle of planning, implementation, verification, and action that will enable better results over time.

Structure

The next chapter in this plan, Chapter 2.0 - Overview: Meeting the Challenge, discusses the City's overall strategy for minimizing energy and emissions while Chapter 5.0 - Measurement, Verification, and Reporting discusses the criticality of these activities to the action plan while Chapters 3, 4 and 6 form the plan for the three key objectives. Chapters 3-6 are listed below for ease of reference.

- Chapter 3.0 - Minimize Energy and Emissions in Existing Facilities

12 The City of Brampton's first Conservation and Demand Management Plan was published under this former regulation 397/11 in July 2014 and was a five year plan. The new plan continues the work of The City of Brampton's first Energy Conservation and Demand Management (CDM). This past plan aimed to "improve energy efficiency of City owned facilities; foster a culture of conservation within the corporation and community and to demonstrate leadership in sustainable operations."

- Chapter 4.0 - Minimize Energy and Emissions in New Facilities
- Chapter 5.0 - Measurement, Verification, and Reporting
- Chapter 6.0 - Maximize Cost Recovery: Procurement, Third Party Funding, and Sanitary/Sewer Water rebates

Energy Management Policy

The City is committed to the continuous improvement of corporate-wide energy performance and emissions reduction and will ensure the following activities are implemented to achieve the energy management team's objectives to minimize energy and emissions, as well as provide value for money for the City's mosaic of residents:

- Set energy performance targets based on municipal, provincial, and federal plans
- Evaluate the energy performance of existing facilities at regular intervals for target tracking
- Integrate energy matters in building design and construction to ensure new facility targets are met
- Encourage energy awareness and training for City staff including current trends, best practices, and government policies to create a culture of conservation and efficiency
- Develop and maintain a policy to procure energy efficient products to reduce energy consumption and costs
- Procure reliable sources of energy at competitive rates to reduce cost risk
- Update external stakeholders, such as the provincial government, on the City's conservation and demand management plans
- Report on progress towards performance and targets to executive management on a regular basis
- Review organizational energy practices on a biennial to triennial basis
- Evaluate new technologies and adopt innovation to ensure facilities operate efficiently and at peak performance

CHAPTER 2.0 - OVERVIEW: MEETING THE CHALLENGE

This chapter provides an overview of the actions that the City has taken to help meet the energy emissions and savings targets and results from the past five years. This chapter begins with a summary of corporate energy use and emissions, followed by a discussion of our accomplishments for energy conservation and efficiency projects, renewable energy projects, and building automation systems. A strategic planning framework that charts a collaborative is presented in the last section.

2.1 Corporate Energy Use

Performance Year Energy Consumption

Ontario Regulation 507/18 requires the City to report annual natural gas and electricity usage of City-owned and/or leased facilities that are heated or cooled for which the City makes energy payments, and which fall within the designated operations. In this report, 2017 has been defined as the performance year since it is compared to the baseline year of 2010 to determine savings. 2010 was selected because it is the earliest year for which a complete set of utility data could be compiled with reasonable confidence. Of the approximate 190+ facilities managed by the City, 101 facilities have reporting requirements that must be met. The City's 2017 energy consumption and GHG emissions report, created to comply with *O.Reg 507/18*, is provided in Appendix A[13].

Energy Profile

This CDM plan is based on energy usage taken from monthly bills for the 2017 calendar year. In 2017, the City consumed 99,928,300 kWh electricity, 7,582,700 m^3 natural gas, and 178,493,300 equivalent kWh energy in total. The 101 facilities that meet *O.Reg 507/18* reporting requirements consumed 133,831,000 ekWh energy, accounting for 75% of the total energy consumption of the City's assets. In 2017, City electricity consumption occupied 56% of total energy consumption and natural gas occupied the other 44%. The energy use data is illustrated in Figure 1 and is not weather normalized to indicate actual use.

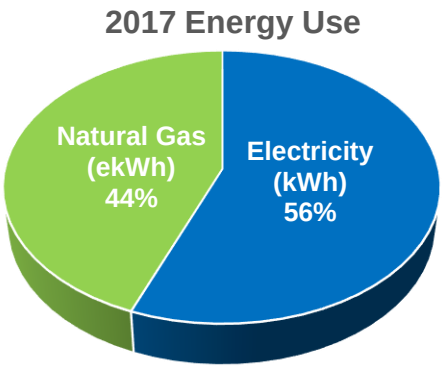

Figure 1 Breakdown of 2017 energy use

The City's electricity and natural gas consumption breakdown for different facility types is shown in Table 8 in Appendix E, and Figure 2. These facility types include corporate[14], fire stations, libraries, parks, recreation centers, transit facilities, and works operations. In 2017, works operations, consisting largely of street lighting, and recreation consumed the largest shares of electricity, with 39% and 35% of total annual energy respectively. Recreation and transit facilities are the top two facility type categories for natural gas consumption, accounting for 50% and 23%, respectively. In total, recreation facilities consumed the highest amount of energy with 42%. Works operations consumed 24%, transit consumed 15%, and corporates consumed 13%. The other facilities used the remaining 6% of City energy.

[13] These values are the raw, unadjusted consumption values reported in the utility bills. The information was recorded in the City's utility data management system.
[14] Corporate facilities are defined as administrative facilities largely consisting of office and operations buildings

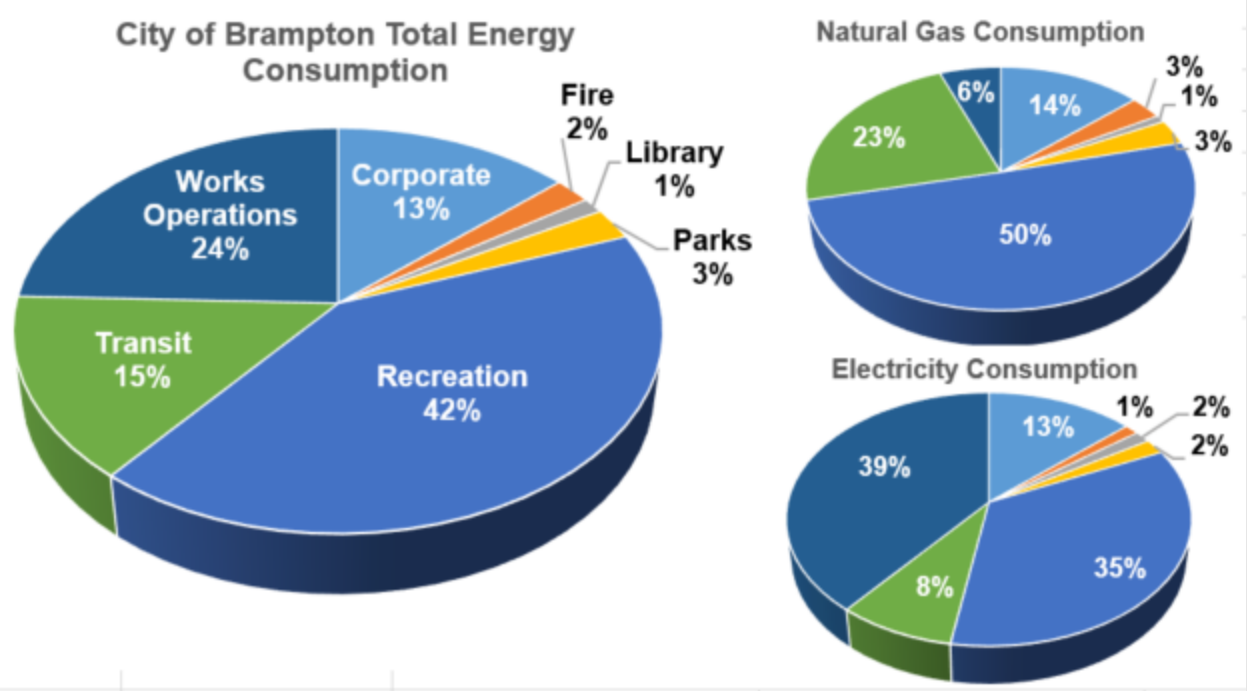

Figure 2 Breakdown of 2017 Total Energy Consumption

For enclosed facilities, which do not include street lights, the 30 most energy intensive facilities consume more than 80% of the total energy use for 2017. These facilities are a major focus for performance improvements as referenced in Chapter 3.0 .

2.2 Corporate Emissions

In 2017, City facilities emitted 18,200 tons CO2e of GHG. The 101 facilities that meet Regulation 507/18 reporting requirements emitted 16,400 tons CO2e, accounting for 90% of the total energy consumption of the City's assets. Electricity use contributed approximately 22% of GHG emissions while natural gas accounted for 78%.

The City's GHG emissions breakdown by fuel type and for different facility types is shown in Figure 3. In 2017, recreational facilities produced the highest amount of GHG, with 8,560 tons CO2e, and accounted for 47% of the total emissions. Transit facilities were in second place, producing 20% of GHG emissions. Other facilities emitted the remaining 33% of GHG emissions.

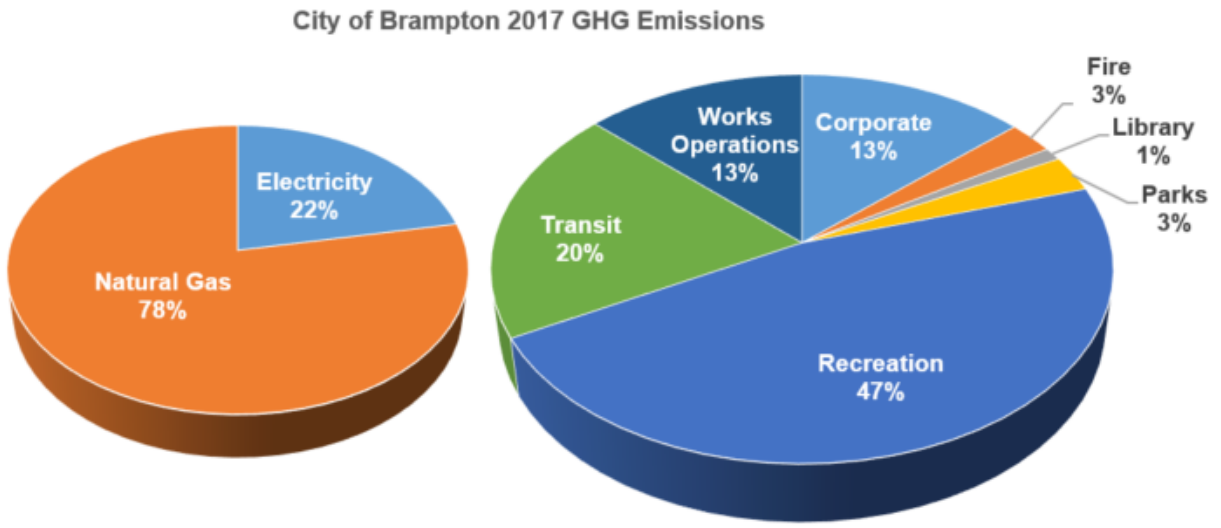

Figure 3 Breakdown of 2017 GHGs emissions

Figure 4 provides a breakdown of the gross floor area and associated GHG emissions for specific facility types. This chart is illustrative of the facility types that require the greatest level of attention in the implementation of our energy and GHG reduction strategies. As shown in this chart, while corporate facilities account for 31% of total gross floor area they only account for approximately 15% of GHG emissions as they are less energy intensive than other facility types such as recreational and transit facilities.

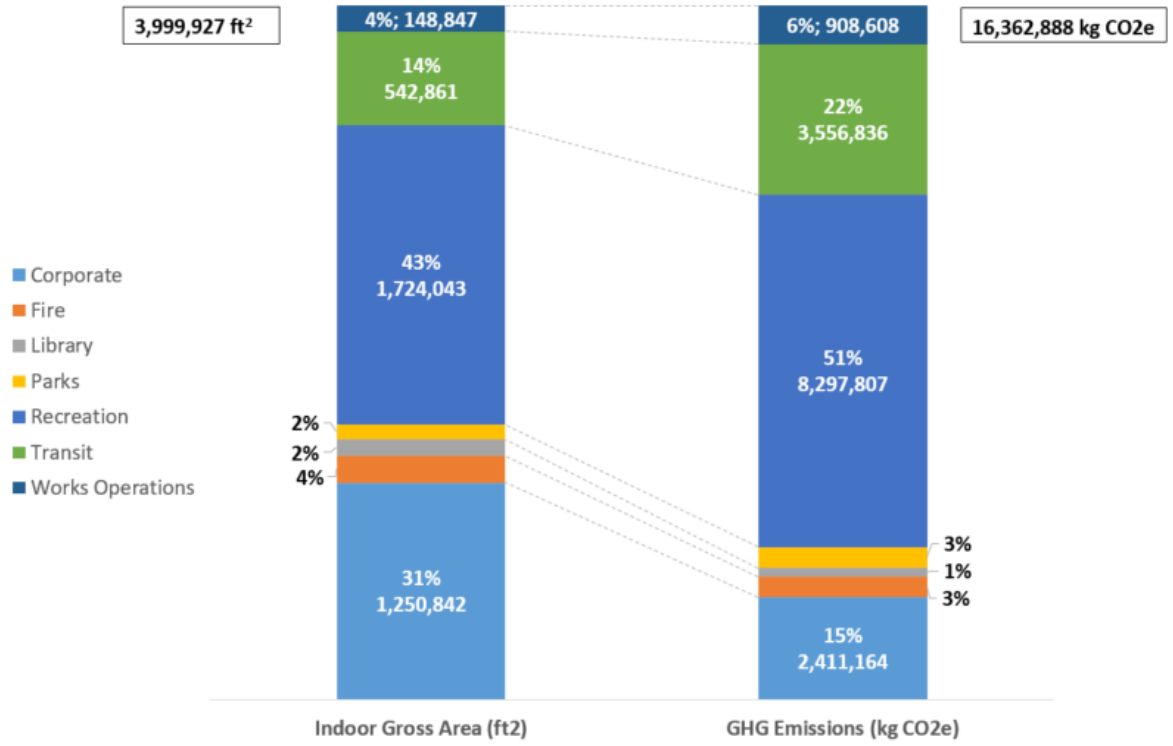

Figure 4 2017 Gross Floor Area vs. GHG Emissions Breakdown[15]

[15] Note GHG emissions shown in this chart differ from overall GHG emissions as these values only reflect the emissions for facilities with indoor gross area values

2.3 Accomplishments

The City has actively worked to reduce its energy and emissions with major achievements in conservation & efficiency and to reduce conventional energy demand. One of the goals stated in the EMP is to reduce energy consumption and manage the impact of energy usage on our environment. The impact of these energy conservation and efficiency projects, along with renewable energy projects, are helping us reach this goal. This section describes our accomplishments with respect to energy efficiency projects, energy awareness training, Building Automation Systems, renewable energy projects, electric vehicle charging station infrastructure, and rebate programs the City is a part of.

Energy Savings Overview

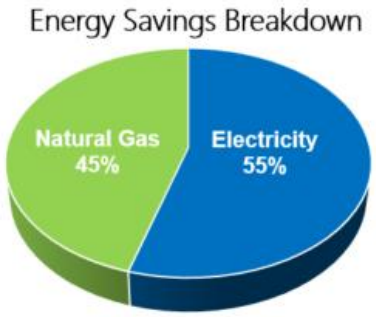

Figure 5 Percentage of natural gas and electricity contributing to energy savings

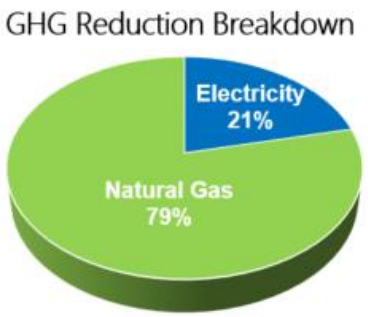

Figure 6 Percentage of natural gas and electricity savings contributing to GHG reduction

As illustrated in Figure 5, natural gas and electricity savings contribute almost an equivalent amount to the total achieved energy savings, with 45% and 55% of the total savings respectively. However, as shown in Figure 6 natural gas savings contribute to 79% of total GHG reduction while electricity savings contributes to the remaining 21%; Natural gas contributes more because of the higher GHG emissions associated with natural gas as compared to electricity generation.

Conservation and Efficiency

Over the last five years, a total of 50 energy conservation projects were performed in the City. From 2014 to 2019, these projects have persisting energy savings of 32,088,000 ekWh in total (17,536,000 kWh electricity, and 1,369,000 m^3 natural gas). These projects have the potential to reduce 1,230 tons CO2e of GHG emissions per year. Table 11 and Table 12 in Appendix F, provide a summary of the environmental benefits of these projects.

The reduction targets from the previous CDM plan were set at the following levels: 5% by 2014, 15% by 2016, and 30% by 2021. For 2014, the previous CDM plan reported a savings 9% above the 5% target based on the energy intensity for all city-owned facilities, including operations not specified in Regulation 507/18. For 2016, the calculated energy intensity savings were 16% as compared to the baseline year of 2010, which is above the target of 15%.

The following figures in Table 2 portray the notable progress observed from the City's completed energy conservation and efficiency projects in the last five years:

Table 2 Summary of Figures from Conservation and Energy Projects from 2014-2019

Conservation and Efficiency Project Data	Figures
Energy Conservation and Efficiency Savings (ekWh)	32,088,000
Energy Cost Savings ($)	2,939,000

Conservation and Efficiency Project Data	Figures
GHGs Avoided (tons CO2e)	3,270
Cars taken off Road	690

The following is a sample list of the projects completed thus far:

a. Instantaneous Water Heaters - Balmoral Recreation Centre: Tankless instantaneous water heaters do not require storage tanks or reheating as they only heat water when it is needed. This system is typically more energy efficient than a storage water heater due to the elimination of continuous standby losses.

b. Swimming Pool Heat Recovery - Cassie Campbell: The heat from pool drain water is recovered to heat supply water going into the pool through a heat exchanger.

c. De-stratification Fans - Sandalwood Transit: When heat is introduced to a facility space, it tends to rise and separate into layers or strata. These fans de-stratify the layers and push the heat to the floor level where the thermostat is usually located for better temperature control (heating equipment cycles less) and occupant comfort.

d. High-Efficiency Lighting – South Fletcher's: A number of high efficiency LED fixtures were installed at South Fletcher's Community Centre in gymnasium, rinks, pool, fitness rooms, office area, and common areas. This was one of the City's largest lighting retrofits for our City-owned facilities.

e. Water Treatment device (REALice): REALice is an easy-install water treatment device for ice arenas. This technology is designed to decrease the viscosity and increase the heat transfer capacity of resurfacing water, which improves circulation and reduces energy required to keep the ice frozen. Two REALice systems have been installed thus far in the City, one at Earnscliffe Recreation Centre and another at South Fletcher's Sportsplex.

The City has also been actively working to reduce energy consumption and to improve energy conservation and efficiency within our facilities. Many projects were implemented over the last five years. The energy saving and GHG emission reduction data of each project was prepared and can be seen in Appendix C.

Energy Awareness Training

Over the last five years, the Energy Management team has conducted multiple Energy Management Training workshops for City employees to raise awareness regarding energy and cost savings. During the workshop, the following topics are discussed: energy basics, ways to reduc energy consumption and increase energy efficiency, new city-wide intiative being taken, and forthcoming new or retrofit projects. A few of the benefits from the Energy Management workshops are given below:

- This training provided employees with a solid foundation on the implementation of capital investment and operational improvements to the way in which City facilities consume energy and has supported reductions reported to date.
- Through these training workshops, we were able to energize and encourage the operational team to reduce facility Energy consumption. Energy savings from behavior interventions are expected to be 10 % or less based on studies[16]

[16] (Mazzi, 2019) This information was obtained from: https://evo-world.org/en/news-media/m-v-focus/867-magazine-issue-4/1131-perspective-on-m-v-behavioral-change-programs-in-commercial-and-industrial-facilities

- These workshops promote employee engagement with around 15-25 participants attending each workshop. The workshop is used as a platform for City emloyees to share ideas and successful energy management projects. A certificate of training is issued for every attendee who has successfully completed the training workshop.

In August 2018, the Energy Management team conducted a Community Energy Reduction Challenge. Over 20 of the City's Community Centres were challenged to conserve energy use for a period of one month. A few of the energy consumption methods used were checking BAS configurations, increasing the temperature setting on their air conditioning equipment, and replacing incandescent lightbulbs with LEDs. The winners received a certificate of award and a prize for team members at their community centre.

Building Automation System (BAS)

The City currently has 46 facilities connected to our central BAS which allows for monitoring and control of these facilities. The BAS allows for scheduling, set point control, and efficient sequence of operations. Through the installation the City has found the following benefits:

- Increased Thermal Comfort: With greater insight into facilities and systems we are able to react more quickly to thermal comfort issues within our facilities.
- Increased Operational Efficiency: These systems give our operations staff insight into building systems from a central location. This leads to more efficient operations as operations teams can make changes from central areas instead of being on site.
- Energy Cost Savings: The City has been able to achieve energy savings from BAS through use of nighttime setbacks, efficient sequences of operations, and allowing for central set-point control;
- Less Equipment Downtime: The BAS allows for more efficient troubleshooting of mechanical issues. This allow our operations staff to respond more quickly to mechanical issues, ultimately leading to less equipment downtime.

Integrations have also been created with our recreation class scheduling software in order to allow for HVAC equipment and lights to be scheduled on alongside bookings for certain areas. Energy Management provides continuous training for our facility operational staff on the efficient use of the BAS. This training has led to a greater understanding of the functionality of these systems. We have begun to implement a BAS audit program with the aim to work with facilities to have them complete annual reviews system wide. Figure 7 is a depiction of City Hall West Tower as seen in the BAS.

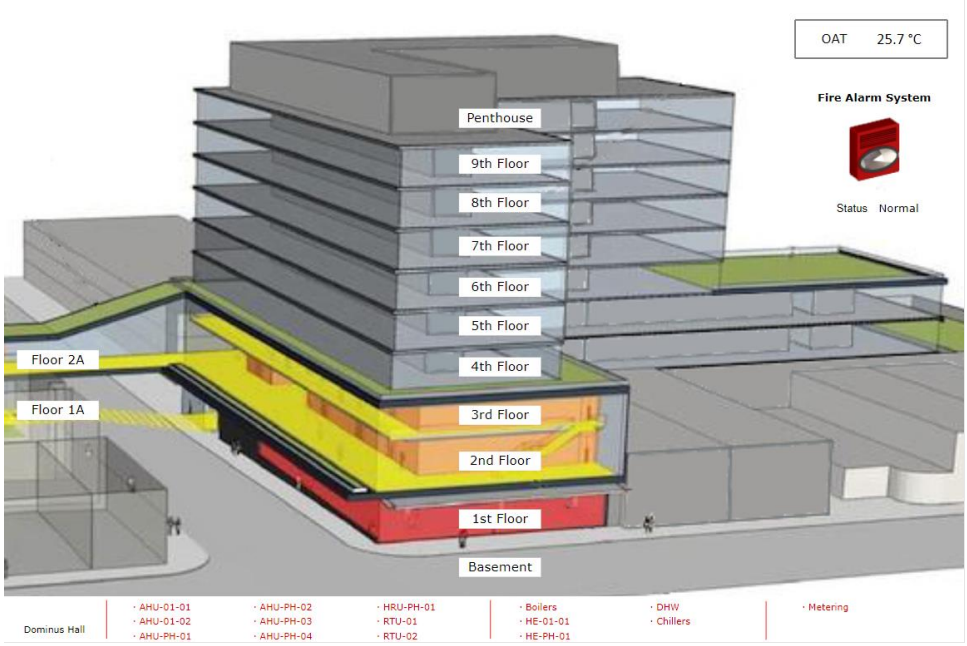

Figure 7 A depiction of City Hall West Tower as shown in our BAS

Renewables

As briefly mentioned at the beginning of this chapter, the City has implemented many renewable energy projects which include, but are not limited to, geothermal systems, solar photovoltaic (PV) systems, and solar thermal systems. The geothermal systems and solar thermal systems both help reduce our natural gas consumption and costs.

The following figures in Table 3 have been estimated based on available data from completed projects, for the period of 2014-2019.

Table 3 Summary of Figures from Renewable Energy Projects from 2014-2019

Renewable Project Data	Figures
Estimated Annual Sum of Geothermal Heating and Cooling Loads (MBtuh):	37,932,000
Total Solar Energy Generation from Solar PV systems (ekWh)	240,000
Total Solar Energy Revenue from Solar PV systems ($):	150,000
Estimated Annual Solar Thermal Energy Production (ekWh):	27,000

The following is a sample list of renewable energy projects completed between 2014-2019:

1. Geothermal Energy: Energy is taken from the earth using an underground piping system and distributed to a building using pumps to heat or cool the facility. There are geothermal systems located at city-owned community centres, fire stations, and operations centres that reduce our natural gas heating and electric cooling costs. Our first-installed geothermal system, which provides heating and cooling, is located at Springdale Library. Figure 8 shows an image of a simple geothermal system (underground piping system) installed for a facility. The thermal energy from the Earth is used to heat the cold water entering the piping system underground, returning hot water that is typically used to heat facilities. The reverse process is true in the summer, with hot water entering the pipes and returning as cold water after being cooled by the Earth. Refer to Table 13 in Appendix F for a summary of the annual cooling and heating loads of our geothermal systems.

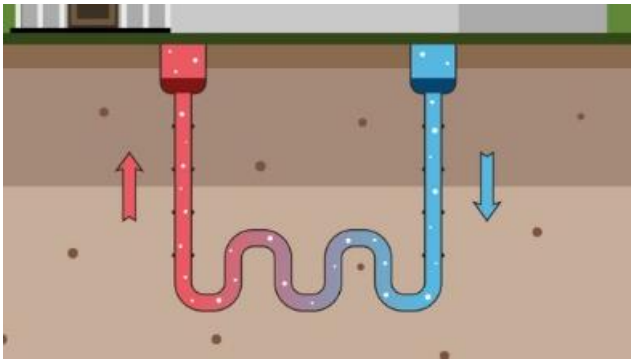

Figure 8 Image of an underground piping system for a geothermal system.

2. Solar Photovoltaic (PV) System: PV systems use panels lined with silicon cells to convert sunlight into electricity. There are PV systems located at fire stations, and transit facilities (bus barns) which reduce our electricity use and cost. Our largest PV system is located at Cassie Campbell Community Centre, a 150kW system with enough power for about 75 homes. Figure 9 shows the FIT Solar PV System installed at Cassie Campbell Community Centre in 2018. Refer to Table 14 in Appendix F for a summary of the total energy and revenue produced from our Solar PV systems from 2014-2019.

Figure 9 Panoramic shot of solar PV system at Cassie Campbell Community

3. Solar Thermal and Solar Wall Systems: Thermal systems use panels to convert sunlight into heat. There are solar thermal systems located at fire station and maintenance facilities that help reduce our natural gas use and costs. Figure 10 is an image taken of the solar collector at the Brampton Apparatus and Maintenance Facility. Refer to Table 17 in Appendix F for a summary of the estimated annual energy produced from our solar thermal systems from 2014-2019. Furthermore, a solar wall system was installed in the Brampton Apparatus and Maintenance Facility in 2017. This system

Figure 10 One of four solar collectors that are a part of the solar thermal system installed at Brampton Apparatus and Maintenance Facility

utilizes solar energy to heat air for indoor ventilation. The annual renewable energy delivered by the system was calculated as 247.7 MWh[17].

4. Solar-powered LED Lighting Systems: These LED lighting systems contain convert solar energy to electricity using solar collectors. The electricity is then stored in a battery and it is supplied to the lights when required. Over twenty LED lights with solar panels, ranging in capacity from 5 to 380 W, have been installed at various facilities including Williams Parkway Operations Centre (WPOC), Brampton library - Four Corners branch, Duggan Park, and other facilities. The solar-powered lights are autonomous and the batteries installed have approximately 4 to 5 days of storage capacity for back-up power. Figure 11 shows the 14 solar lights installed at WPOC. Each light has two solar panels attached, each with a capacity of 190 W.

Figure 11 Solar-Powered Lighting System installed at Williams Parkway Operations Centre

5. Solar PV Carport – Brampton Soccer Centre: Electricity use and costs from electric vehicle (EV) charging stations are reduced using electricity generated from solar panels. The panels are located above the EV charging station, and can also act as a canopy to provide protection from the elements while an electric vehicle is being recharged.

Electric Vehicle (EV) Charging Stations

Since 2015, the City electric vehicle (EV) network has rapidly expanded among city facilities. Currently the City owns and operates 52 electric vehicle charging stations across 15 City facilities. The City has installed electric vehicle charging stations in municipal parking lots across the city to help make electric vehicles more convenient for residents and businesses in the City. The City's electric car charging stations are currently free for public use (normal parking fees apply in pay for use parking lots).

All 52 city-owned stations are Level-2 charging stations, which operate at 208 or 240 V AC and are able to fully charge a vehicle in 4 to 6 hours, depending on the vehicle type. Of the 52 charging stations, 24 stations are "smart" stations. Smart stations are capable of both monitoring usage and accepting real-time payments. There are 28 "dummy" charging stations that have no means of energy use monitoring or cost recovery.

Figure 12 Electric vehicle charging station at Brampton Soccer Centre

EV Charging stations are currently available at the following 15 locations:

- City Hall Parking Garage
- City Hall West Tower Parking Garage
- Rose Theatre Brampton Parking Garage
- Flower City Community Campus

[17] This value was obtained from the annual energy balance calculated by the project's consultant.

- Sandalwood Transit
- Civic Centre
- Williams Parkway Operations Centre
- Fire Station 211
- Brampton Soccer Centre
- Springdale Library
- Nelson Parking Garage
- South Fletcher's Sportsplex
- Fire A&M Facility

Sanitary Sewer Charge Rebate

The Energy Manangement team has successfully maintained the sanitary sewer charge rebate program. This rebate is based on the percentage of water not returned to the sanitary sewer system (i.e. water evaporated from cooling towers or water used for irrigation) and is applied to the sewer portion of the water rate. The sewer surcharge is part of the water rate which includes the cost of treatment of the wastewater that is returned to the sewer system. The locations include irrigated fields, splash pads, and ice rinks. The rebates earned every year help to offset City utility costs. From 2009 to 2018, the program has rebated the City approximately $1.1 million, with a cumulative rebate amount of approximately $767,000 received from 2014-2018. Figure 13 displays the rebate amounts received annually from 2014-2018.

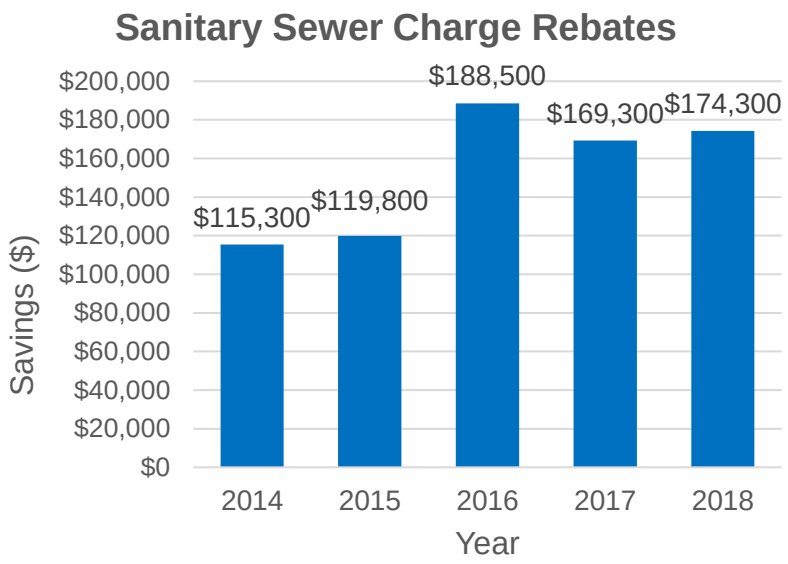

Figure 13 Annual rebate amounts from Sanitary Sewer Charge Rebate Program

Earth Hour

The City recognized Earth Hour on Saturday, March 30, 2019, from 8:30 pm to 9:30 pm by turning off all non-essential lighting and electronic equipment at City facilities. During this time, City facilities achieved an overall reduction of 25%. The City has participated in this global environmental initiative since 2008.

2.4 Strategic Planning Framework

A number of plans and policies with targets and timeframes that frame the planning process for the City's zero carbon transition were reviewed during the creation of this plan as referenced in Chapter 1.0 . To plan and deliver this transition, the framework requires charting a more collaborative path.

Figure 14 illustrates the collaborative chart (note this chart is not an organizational chart) for the Energy Management team in the broader context of the Community Services department. A key planning outcome will be a set of decision making tools that accelerates the transition. An example may be a phasing tool for retrofits to limit overall service disruptions across the City's portfolio of recreation centres.

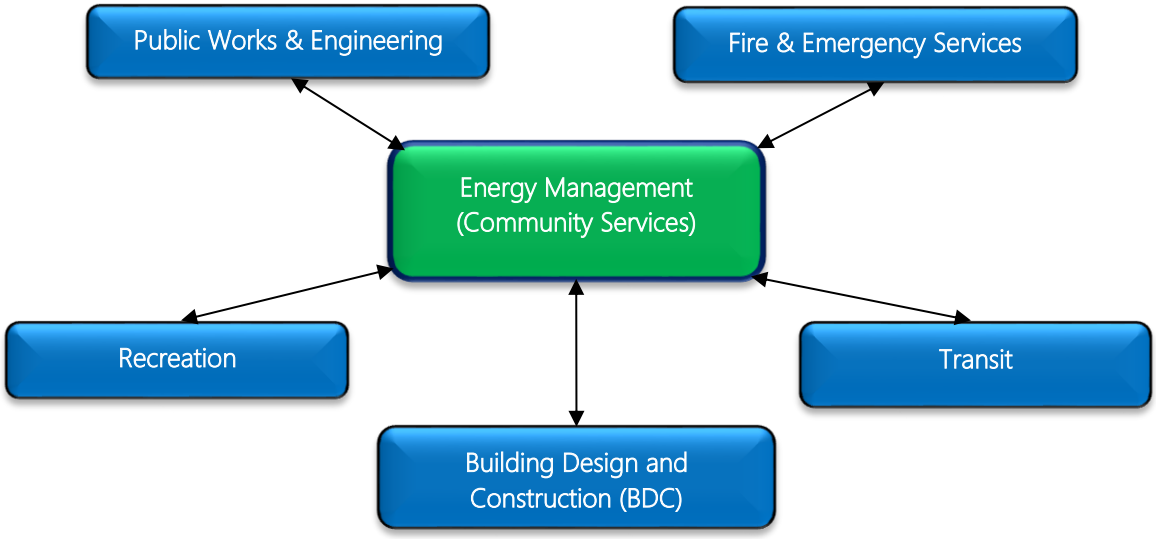

Figure 14 Energy Management Collaboration Chart

The City's Energy Management Team currently consists of an Energy Management Supervisor, Project Coordinators, and students. The Commissioner of Community Services is the senior executive and sponsor of the energy team. Since the bulk of COB's emissions (referenced in Chapter 2.0) come from our existing facilities, the team strategically resides in the Facilities, Operations and Maintenance Division and reports to the Manager of Facilities, Services and Operations.

CHAPTER 3.0 - MINIMIZE ENERGY AND EMISSIONS IN EXISTING FACILITIES

The strategic plan to reduce emissions at existing facilities is introduced in this chapter. The following sections provide information on retrofit programs, building automation systems, the initiation of energy conservation and efficiency projects, employee and community awareness plans, and electric vehicle charging stations.

3.1 Introduction

In order to achieve the emission reduction targets, 20% by 2024, 30% by 2030 and 80% by 2050, it is necessary to understand past and current energy use and their associated emissions. Energy consumption has increased 22% in 2017 compared to 2010, however, emissions in 2017 have decreased by 13% when compared to 2010 emissions. Though the City has acheived almost two-thirds of its 20% emissions reduction target, the City is planning new facilities and major renovations including community centres to its portfolio which may increase its emissions above the 2030 target (see Chapter 5.0 for trend discussion). Emission reductions have resulted from projects mentioned in Chapter 2.3 and from lower emission factors due to the elimination of coal plants in Ontario which used to provide electricity generation. The phase-out of these plants has made significant reductions to the factors.

Since these plants have been phased out, it's unlikely there will be significant emission reductions from Ontario's generation plants (source emissions) in the foreseeable future. Thus, the focus is lowering on-site emissions with a view towards the 80% by 2050 target set by the federal government.

The approach to achieve target reductions for the City-owned facilities is to retrofit existing facilities to improve energy performance to a planned target as well as set energy performance targets for new facilities (see Chapter 4.0 - Minimize Energy and Emissions in New Facilities). Existing facilities will be transitioned to zero carbon[18] or high performance[19] as required to achieve the 80% emissions target.

3.2 High Performance and Zero Carbon Facilities

A deep retrofit program will be developed and implemented to improve energy performance for existing facilities. Since the majority of City-owned facilities will likely operate past the target years of 2024 and 2030 and may operate beyond 2050, the success of this program for existing facilities will significantly contribute to the near term emissions targets. The program will use phased implementation in conjunction with existing asset management and state of good repair programs for increased efficiencies. As indicated in Chapter 2.0 , the 30 most energy intensive facilities are responsible for over 80% of the City's energy use and the focus will be on this subset of facilities where feasible. The stepwise approach when designing retrofits for energy intensive facilities--and also new facilities as further discussed below--is to reduce energy demand, specify efficient HVAC and lighting systems, and deploy renewable technologies (see Chapter 4.3 for the renewable strategy).[20] When specifying HVAC systems, the use of systems that recover heat where possible is also recommended as part of this pathway to high performance, which is illustrated below in Figure 15.

[18] A zero carbon building is defined as one that is highly energy-efficient and produces onsite, or procures, carbon-free renewable energy in an amount sufficient to offset the annual carbon emissions associated with operations.

[19] High-performance buildings deliver a significantly better energy-efficiency performance than that required by building codes

[20] This approach was designed based on recommendations from the Whole Building Design Guide by the National Institute of Building Sciences, https://www.wbdg.org/design-objectives/sustainable/optimize-energy-use *(The WBDG Sustainable Committee, 2018)*.

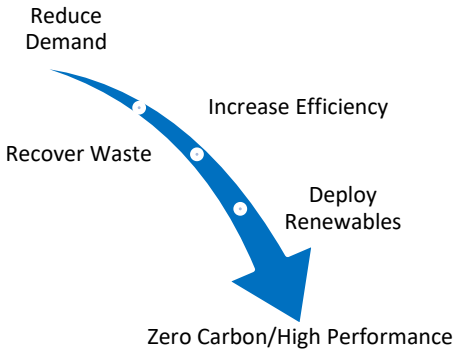

Figure 15 Illustration of the pathway to high performance

A key part of this deep retrofit program is commissioning the energy conservation measures after they are implemented in the City's existing facilities. The Building Commissioning Association defines three different types of commissioning: recommissioning[21], retro-commissioning[22] and ongoing commissioning[23]. While the definitions (provided below) of these three types can include many activities, the primary objective of these three different types of commissioning is to ensure the persistence of energy performance over the life of the facility.

3.3 Building Automation Systems (BAS)

Energy Management is currently leading updates to the City's BAS Guidelines. This process includes extensive stakeholder consultation and review of existing systems. This feedback from users will be vital in determining the requirements of future systems. The goal is to continue to build systems that conserve energy while optimizing operational efficiency and ensuring occupant comfort.

BAS integration with other systems is another planning consideration. An example of a possible future integration is the connection of BAS alarms with a Computerized Maintenance Management System (CMMS). The plan is to develop BAS guidelines in a way that allows for future integration with other systems. Two possible benefits of this integration may be better alarming to improve response times to failures and the tracking of equipment runtimes to facilitate predictive maintenance.

Another planned initiative is the investigation of a BAS analytics tool. This would allow for further insight into the equipment usage, and energy savings and would allow for more advanced fault detection compared to our existing systems. This would lead to more streamlined troubleshooting of mechanical issues.

[21] Recommissioning is the periodic re-implementation of the existing building commissioning (EBCx) process, either following a regular schedule (every three to five years, typically), when a building's performance degrades or if there is a significant change to its occupancy or use. Note: The EBCx process investigates, analyzes and optimizes the performance of building systems by identifying and implementing low- or no-cost and capital-intensive facility improvement measures, and ensures their continued performance. The EBCx process helps make building systems perform interactively to meet current facility requirements, and supports continuous improvement of system performance over time.

[22] Retro-commissioning is the application of the commissioning process to an existing building that has not previously undergone the commissioning process.

[23] Ongoing commissioning is the application of commissioning related process activities on an ongoing or continuous basis to ensure that the CFR is being met and to support the continuous improvement of system performance.

3.4 Energy Conservation and Efficiency

In addition to planning a deep retrofit program to implement high performance and zero carbon facilities, there are also individual conservation and efficiency projects for facilities that are planning to undergo changes due to state of good repair, programming, and tenant fit-ups. Energy Management collaborates with Building Design and Construction, and Facilities, Operations and Maintenance to develop and lead these individual projects. Some smaller projects are also initiated in order to comply with changing regulations (one such example is Regulation 463/10 for Halocarbon regulations and Reg. 143/16 regarding GHG emissions).

Refrigerant Management

According to *Drawdown*, a book[24] on the 100 most substantive solutions to global warming, the management and destruction of refrigerants which are used in refrigerators and air conditioners can reduce emissions and scientists estimate that the Kigali accord[25] will reduce global warming by one degree Fahrenheit.

One of the ways to manage refrigerants is to replace refrigerants with low-warming HFCs/new cooling agents/non-HFC substances. In addition to meeting phaseout regulations, the City is investigating newer refrigerants with lower global warming potential and some of these newer refrigerants also reduce energy consumption according to manufacturer data.

3.5 Operational Savings and Employee Awareness Training Plan

Figure 16 Image of presenter and participants from an Energy Management Training Workshop

The Energy Management team has conducted multiple Energy Management training workshops for City employees over the last five years. Figure 16 is a picture from an Energy Management Workshop. The objectives of these workshops have been discussed in Chapter 2.3. The Energy Management team has been receving feedback from surveys distributed to the participants and is committed to continuously improve our future workshops. The team is working to make the annual workshops more engaging and interactive and will work to customize the workshops as per the needs of the attendees and provide information on requested discussion topics. The frequency of the workshops may increase based on such factors as technology changes, funding policy, energy markets, and other externalities. The team plans to continue to raise awareness on energy and cost savings as well as provide current ideas and recommendations on how attendees can make more energy efficient changes in their day-to-day work.

The Energy Management team is planning to conduct an Energy Reduction Challenge again this year in the fall and may continue this challenge on an annual basis based on year-to-year outcomes of the Challenge. The

[24] Drawdown is a book that provides substantive solutions to global warming, describing how it works, the pathway to adoption, relative costs, savings, and its impacts. Project Drawdown is a world-class research organization and focuses on determining viable global climate solutions to potentially stop global warming and have a decline in GHGs in the atmosphere. (Drawdown, 2019) For more information, visit https://www.drawdown.org/

[25] The Kigali Amendment to the Montreal Protocol requires its participating parties to phase down the consumption of hydrofluorocarbons (HFCs). HFCs are used in refrigerators and air conditioners, but they are powerful GHGs that are a serious threat to our climate. Canada ratified the Kigali Amendment and it entered into force on January 1st, 2019. (Government of Canada, 2018) For more information, visit https://www.canada.ca/en/environment-climate-change/services/sustainable-development/strategic-environmental-assessment/public-statements/canada-agree-control-hydrofluorocarbons.html.

Energy Management team plans to investigate ways to build on the success of previous challenges, including increases engagement with facility operators and providing customized reports on consumption data for each facility.

3.6 Set Point Policy

The City has already implemented set points for temperature, humidity and outdoor air through BAS schedules at many of our facilities (Chapter 2.3) with the objectives to minimize energy use and enhance occupant comfort. The Energy Management team continues to monitor this scheduling in coordination with facility operators and will investigate any other changes that can meet these objectives. The team will investigate formalizing scheduling at a policy level based on stakeholder consultation (Chapter 3.3).

3.7 Electric Vehicle (EV) Charging Station Infrastructure

From an infrastructure planning standpoint, there are a number of EV charging station improvements that the City plans to investigate in the near future to address two business needs: operations and maintenance, and cost recovery. This may include exploring upgrades to current non-networked stations to allow for monitoring and real-time payment processing as a means of cost recovery.

Continued expansion of the current EV charging network is necessary to meet our sustainability goals, and the Energy Management team is committed to investigate the strategic and optimal placement of future charging stations to maximize their usage. The site placement of future charging stations will take multiple factors into consideration including but not limited to: existing and predicted EV market share, geographic concentration of EV purchasers, charging demand, traffic flow and patterns, accessibility, health and safety impacts, and local distribution grid impacts.

The Energy Management team Supervisor is also an active member of the *Peel LEV Strategy Working Group*, representing the City as a Municipality Lead. This working group was created by the Toronto and Region Conservation Authority (TRCA) to focus on developing and prioritizing a set of Municipal actions to accelerate EV adoption within the Region of Peel. The City will continue to take an active role in carrying out the research initiatives of this group.

CHAPTER 4.0 - MINIMIZE ENERGY AND EMISSIONS IN NEW FACILITIES

This chapter introduces the City's integrated design process, and energy targets for new facilities. The following sections outline the energy modelling tools that will be used to evaluate design options based on a planned target. The commissioning process for quality assurance, and the strategy and process for implementing renewable energy systems in new facilities are also discussed in these sections.

4.1 New Facility Energy Targets

The other piece of the plan to meet our targets, as referenced in Chapter 3.0 , is to design new facilities that are zero carbon or high performance. Energy targets will be established during the integrated design[26] process for each facility typology to inform the design process. These typology targets will drive the energy design of the facility and contribute to the overall energy and emissions reduction targets. The use of energy targets is proposed, rather than LEED minimum requirements, to account for the facility's utilization and to reinforce the City's commitment to operational energy efficiency performance over design performance criteria. This approach differs from LEED in which the simulated energy use of a new construction facility is measured in comparison to a building code baseline model. The use of energy modelling to quickly evaluate options and their interactive effects provides a more cost-effective pathway to achieve these targets. To illustrate the many options produced by the modelling, a visualization tool called a parallel coordinates plot is pictured in Figure 17. Note that this figure is strictly for illustrative purposes and not based on actual modelling results.

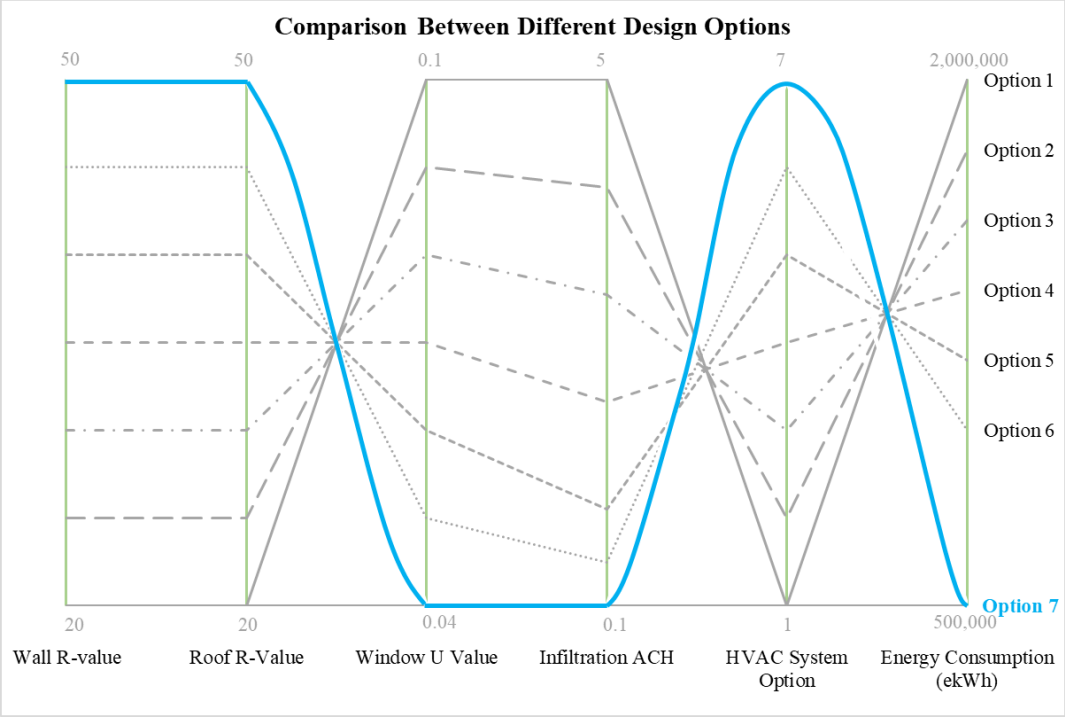

Figure 17 Illustrative Parallel Coordinates Plot

[26] The American Institute of Architects defines Integrated Design as an "approach that integrates people, systems, business structures, and practices into a process that collaboratively harnesses the talents and insights of all participants to optimize project results, increase value to Owner, reduce waste, and maximize efficiency through all phases of design, fabrication, and construction."

Once design, development, and construction are complete for both new and retrofit projects, there are two key activities that must be completed to ensure compliance with targets during operations. These are commissioning, and measurement and verification (M&V), which are discussed in Chapter 4.2 and Chapter 5.0 .

4.2 Commissioning

As mentioned in Chapter 3.2, commissioning is crucial to the success of energy conservation measures in existing facilities and the same applies to the commissioning of new facility projects. According to the Building Commissioning Association, the commissioning process is a quality-focused process for enhancing the delivery of a project and includes verifying and documenting that the facility and its systems and assemblies are planned, designed, installed, tested, operated and maintained to meet the Owner's Project Requirements. The City is currently managing the third party review of commissioning for new facilities to ensure project requirements are met from planning to operations & maintenance by the commissioning agent and project team. The City may investigate implementing a performance period requirement to ensure that the operations and maintenance of the project are meeting energy targets. Figure 18 depicts a scan of a diffuser to determine supply air temperature.

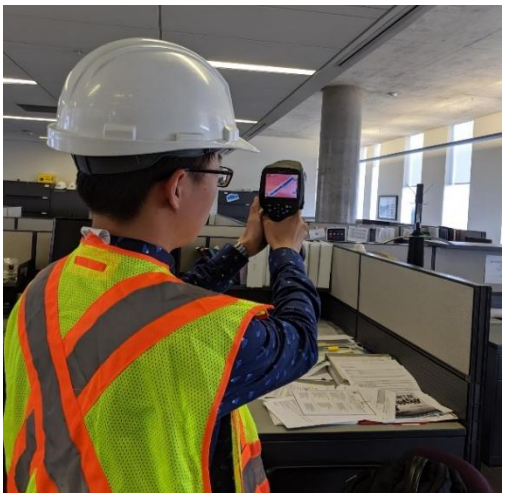

Figure 18 Temperature Scan of Linear Diffuser

4.3 Renewable Energy

As referenced in Chapter 3.2, the addition of renewable energy is strategically done after reducing demand and specifying HVAC and lighting measures. Since energy use has been reduced after taking these actions, renewable energy systems can be tailored and often reduced in size for the specific project facility which usually leads to capital cost savings. This stepwise process applies to both new and existing facilities with more flexibility for new facilities during the concept design phase.

CHAPTER 5.0 - MEASUREMENT, VERIFICATION, AND REPORTING

The measurement, verification, and reporting of energy savings is a crucial step to a zero carbon transition. The following sections describe the performance impacts, the monitoring process with GreenBEAM[27], and the past and future energy and emission trends and targets, respectively.

5.1 Performance Impacts

As first referenced in Chapter 2.1, 2010 was chosen as the baseline year against which future energy and emission performance will be compared. For planning purposes, it is important that baseline data be accompanied by data describing actual assets and current service levels, so that future changes in energy use can be understood in the context of any changes to facilities and activities. For this reason, the Energy Management Team is planning to establish procedures to log operating changes and other events that could impact energy performance.

5.2 Monitoring

The City needs to monitor progress toward its energy targets which are measured against the 2010 baseline. It has a web-based database to manage utility billing, named GreenBEAM. It also needs to monitor progress on a year-over-year basis, both for regulation 507/18 (see Chapter 1.2) and for its regular budgeting, business planning, and continuous improvement processes. This monitoring process is data-intensive and could be very time-consuming if conducted manually; for this reason, the City has implemented a sophisticated data management and analysis tool called GreenBEAM. GreenBEAM offers automated acquisition and analysis of monthly utility data, thereby reducing administrative time and effort.

GreenBEAM offers many benefits: reduces administrative effort in the entry and tracking of 6,000+ bills (including gas, electricity and water), allows for forecasting of energy costs for budgeting purposes, benchmarking, and M&V.

Benchmarking

Another tool for monitoring and evaluating energy use is benchmarking the City's facilities. In essence, benchmarking is the practice of comparing the facilities' energy performance and can be done internally, against other city facilities, and externally, against neighbouring municipalities. Through benchmarking the energy intensity data of COB facilities against the data of BPS[28] facilities, an indication of how facilities are performing can be provided. With weather normalization, the energy efficiency of facilities in different cities under the same classification can be compared to each other, which is helpful to identify a facility's potential conservation opportunity.

Table 4 Benchmarking 2016 Energy Intensity by Operation Type[29]

Operation Type	BPS Median Energy Intensity (eWh/HDD/sqft)	Brampton Mean Energy Intensity (eWh/HDD/sqft)	Mean Energy Intensity Values for BPS Municipalities
Administrative Offices	5.80	7.51	6.91
Community Centres	4.99	10.77	6.87
Cultural Facilities	5.07	5.45	5.86

[27] GreenBEAM, short for Green Brampton Energy Asset Manager is the City's adopted name for our Utility Data Management System Software. Note, this a third-party software tool.
[28] (Government of Ontario, 2018) https://www.ontario.ca/data/energy-use-and-greenhouse-gas-emissions-broader-public-sector
[29] Since the mean energy intensity values can be affected by extreme values, median values were taken as benchmarks in order to reduce the data skew from data outliers.

Operation Type	BPS Median Energy Intensity (eWh/HDD/sqft)	Brampton Mean Energy Intensity (eWh/HDD/sqft)	Mean Energy Intensity Values for BPS Municipalities
Fire Stations	5.38	9.03	8.01
Gyms and Indoor Courts	7.93	11.04	9.68
Indoor Ice Rinks	7.84	7.02	9.04
Indoor Recreational Facilities	7.30	13.73	10.42
Performing Arts Facilities	6.78	11.49	7.10
Public Libraries	5.53	6.25	6.63
Storage Facilities	5.73	10.17	7.26

Table 4 demonstrates that most facility types in the City did not perform well compared to the majority of BPS facilities. However, compared to the mean energy intensity from BPS municipalities, certain types of facilities in the City had higher energy efficiency such as cultural facilities, indoor ice rinks, and public libraries. Operation types with lower energy efficiency include indoor recreational facilities and community centres. Figure 19 compares the energy intensity values of indoor recreation facilities in the City (shown in blue) with BPS median values (shown by the red line).

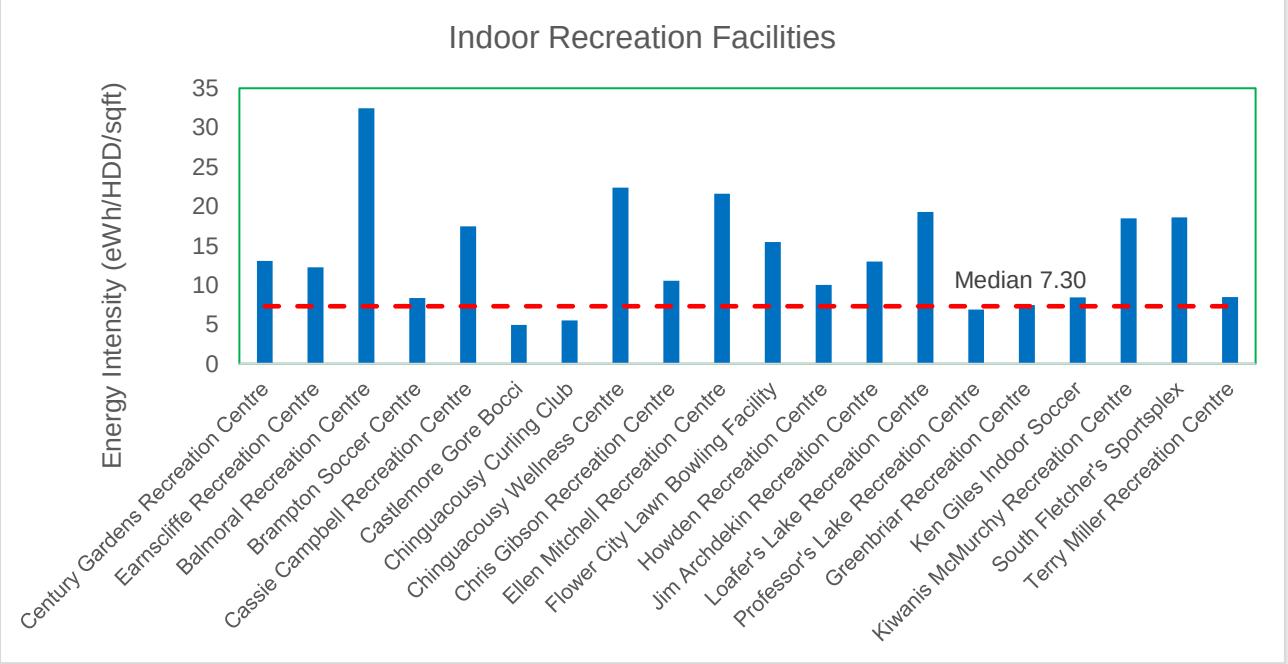

Figure 19 Benchmarking of COB indoor recreation facilities against BPS facilities

This chart reflects the energy efficiency of each facility and it can be seen that some facilities such as Castlemore Gore Bocci and Chinguacousy Curling Club have better energy performance while some operations, especially Balmoral Recreation Center, had lower energy performance as compared to the majority of BPS facilities. Balmoral Recreation Center is an old facility that likely has a poorly performing building envelope, which makes the indoor

heating and ventilation inefficient, thereby increasing the facility's energy needs. The City plans to partially demolish this facility in 2020.

Moreover, additional factors such as hours of operation, and facility occupancy can also influence the energy intensity values. Comparison between the City and BPS facilities for other operation types are shown in Appendix D.

Trends

Apart from the BPS regulation, this report also analyzes the energy consumption data of all City facilities from 2010-2017, to compare consumption on an annual basis to a 2010 base year. To account for weather impacts, energy consumption analyzed in this report has been weather normalized to the base year[30]. Figure 20 shows the change in energy consumption and GHG emissions from 2010 to 2017. During this period, the gross area of all city facilities increased by 42%, from 2,788,000 ft^2 to 3,955,000 ft^2. As gross floor area increased, total energy consumption increased, from 114,885,000 ekWh in 2010 to 133,513,000 ekWh in 2017. GHG emissions decreased from 18,700 tons CO2e to 16,300 tons CO2e, and energy intensity decreased year over year due to conservation measures and decreasing emission factors. In 2017, energy intensity decreased by 18% compared to 2010, and GHG emissions per unit area decreased by approximately 39%. Facility performance indicators from 2010 to 2017 are shown in Table 9 and Table 10 in Appendix E.

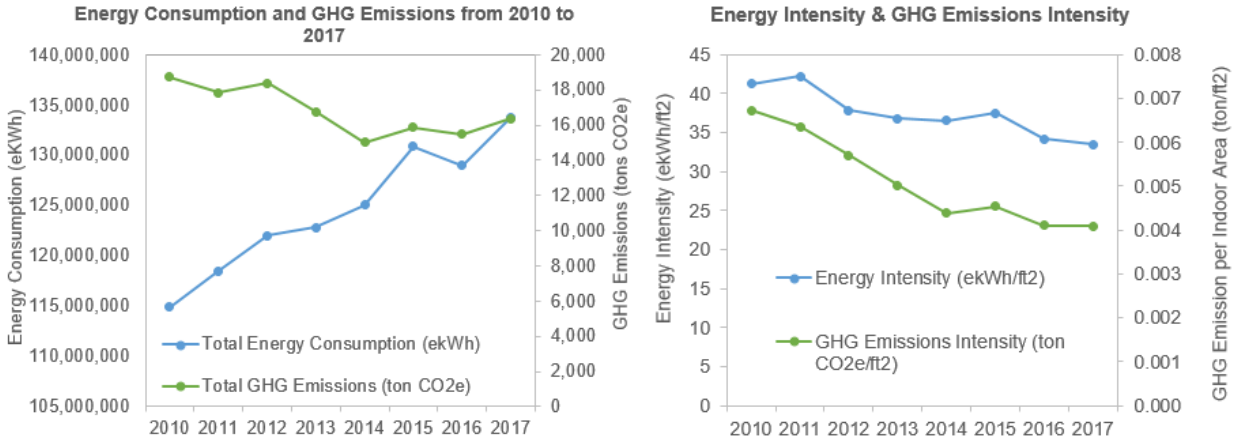

Figure 20 Energy consumption and GHG emission trends from 2010 to 2017

5.3 Energy and Emissions Targets

The provincial and federal governments have set emissions reduction targets of 30% by 2030 and 80% by 2050 respectively (using a 2005 baseline). To align with these agencies, the City's reduction target for emissions is 30% by 2030 and 80% by 2050 (using a 2010 baseline). The selection of 2010 as the baseline year is due to the availability of data, and using this year also creates a more stringent target since energy use has increased from 2005 to 2010.

As shown in Figure 20, energy consumption has trended up while GHG emissions have trended down. One main reason for this opposite trend is the number of facilities in operation have increased and the emission factor for electricity generation has decreased (0.00014 ton CO2e/kWh in 2010 to 0.00004 ton CO2e/kWh in 2017). A second chart to adjust for growth in floor space over time is also shown in Figure 20, represented by energy and

[30] The weather data has been taken from the nearest weather station located at Toronto Pearson Airport, which is approximately 15km away from Brampton.

GHG intensity values. These area based intensity trends indicate a decrease in both energy and GHG emissions per unit area.

While intensity trends are useful to measure against increased facilities and service levels, the challenge as referenced in Chapter 1.0 is meeting absolute targets which are 30% and 80% emission reductions by 2030 and 2050 respectively. The City's 2017 emissions have decreased by 13% when compared to 2010 emissions.

As part of the CDM implementation plan, the Energy Management team plans to develop projections for energy consumption and GHG emissions by 2030 based on our baseline energy data, extrapolation of our facility stock, future energy needs, and various scenarios of our achievable energy savings potential for new and existing facilities. The Energy Management team will investigate undertaking a portfolio energy analysis for all city-owned facilities to support the achievement of our energy targets. As part of this analysis, ongoing and future action items identified within this plan would be quantified for their estimated impacts upon energy intensity and GHG emissions. This analysis would explore the changes to forecasted GHG emissions in 2030 associated with increasingly aggressive actions to reduce energy demand and for the deployment of energy conserving measures such as: performing deep energy retrofits, the replacement of natural gas with electricity, and the implementation of renewable energy technologies. It is likely that this analysis would focus upon the City's top 30 facilities, which account for over 80% of the City's energy consumption.

5.4 Measurement and Verification (M&V)

Energy target tracking is built on a foundation of M&V[31] that is completed not only on a facility level with GreenBEAM (as referenced in Chapter 5.2), but also at the facility system level. One option to compare measured energy use before and after project implementation is facility system-level metering. This type of system-level metering may take the form of permanent electricity and natural gas sub-meters. The metering will be included as part of the deep retrofit program for existing facilities, where required. The metering can also quantify the savings for the purposes of cost recovery, one of the objectives of this plan. Thus, the City will expand the use of energy metering as part of M&V to quantify savings for cost recovery.

[31] According to the International Performance Measurement and Verification Protocol (IPMVP), M&V is the process of using measurement to reliably determine actual savings created within an individual facility by an energy management program. Savings cannot be directly measured since they represent the absence of energy use. Instead, savings are determined by comparing measured use before and after implementation of a project, making appropriate adjustments for changes in conditions.

CHAPTER 6.0 - MAXIMIZE COST RECOVERY: PROCUREMENT, THIRD PARTY FUNDING, AND SANITARY/SEWER WATER REBATES

This chapter describes the strategies and programs the City uses to recover costs. The following sections provide information on the City's procurement strategies, third party funding programs and opportunities, and water rebate programs.

6.1 Procurement

Office Products

To recover operating costs for office products such as monitors and copiers, the Energy Management team will investigate changing the Purchasing by-law such that it specifies ENERGY STAR® equipment. Once a facility transitions to zero energy use by using less heating and cooling energy, the receptacle or plug load energy use will become a larger part of the energy end-use pie thus creating a greater need to reduce energy consumption in this end use.

While changing building materials may not necessarily recover costs, they play a large role in mitigating carbon emissions and/or lowering VOCs for improved air quality. Some examples are: flooring, shades, and fabric that are Cradle to Cradle Certified™ or that have Environmental Product Declarations (EPDs). The team will also investigate the specification of these materials in the Purchasing by-law, some of which may already be done through projects that are pursuing the LEED-NC rating system.

Energy

Local Authority Services (LAS) is a service provider for Ontario municipalities and the BPS as part of the Association of Municipalities of Ontario (AMO). The City is currently a member of two of the LAS programs offered – the LAS Natural Gas Procurement Program and the LAS Electricity Procurement Program. These programs are based on the concept of hedging and focus on budget stability and predictable commodity costs for the program members[32]. With the method of hedging[33], if the estimated price is lower than the average price for the year, this could result in significant savings due to high energy consumption from City facilities.

Benefits

Budget stability – The LAS Natural Gas program provides fixed commodity pricing, which simplifies annual budgeting. The Electricity program offers predictable commodity costs as well.

Rebates – The Natural Gas program offers rebates on an annual basis (November 1st to October 31st). This generally occurs when the forecasted price at the beginning of the year is higher than the actual price of natural gas at the end of the year.

Figure 21 shows the City's annual[34] cost savings from rebates and the LAS Enrollment Program for natural gas and electricity, respectively from 2014-2018.

[32] (LAS, 2019) Please visit LAS website for more information: https://las.on.ca/
[33] Commodity hedging, such as in the purchase of electricity or natural gas, is a forward purchase intended to offset risks arising from future fluctuations in energy market pricing. (Definition obtained from LAS) (LAS, 2019)
[34] The annual savings for the electricity program are based on the calendar year. The annual values for the natural gas program are based on the program year, such that 2014 is the period of November 1st, 2013 to October 31st, 2014. The 2018 values for the natural gas savings were not available at this time.

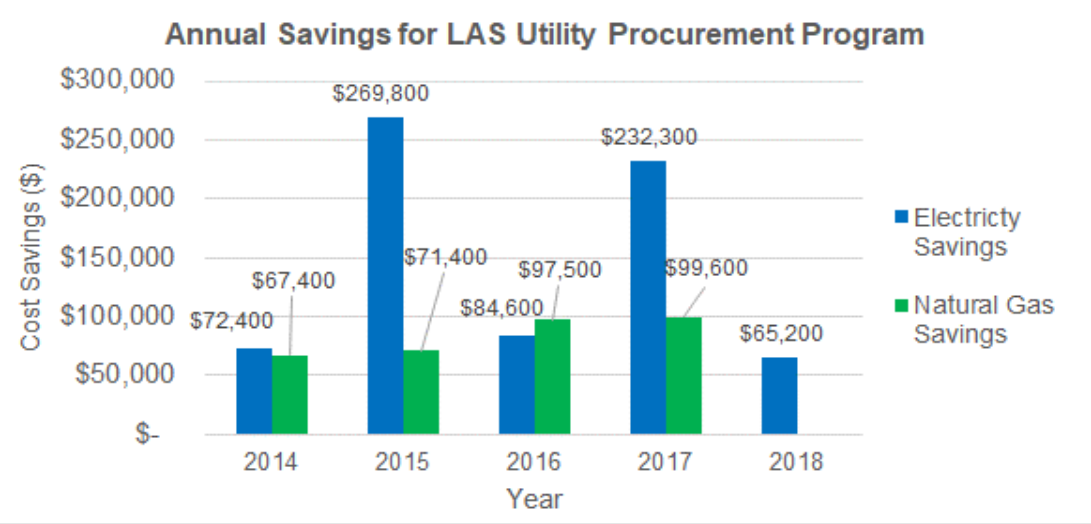

Figure 21 Cost savings from LAS Utility Procurement Programs

Federal Carbon Tax

Natural gas costs have been affected by the federal carbon tax, created in hopes of reducing GHG emissions. This is a tax charged when fuels that release carbon, including natural gas and propane, are produced, distributed, and used. Ontario also had an initiative to reduce GHG emissions that started in 2017, called the Cap-and-Trade Pollution pricing program but it was removed in July 2018. Recently, a federal fuel charge came into effect on April 1st, 2019 for provinces and territories that do not have their own sufficient emissions pricing plan. The federal carbon pollution pricing system was implemented in Ontario[35]. As of April 2019, there is a charge of $20/ton CO2e of GHG emissions, which will gradually increase by $10/ton CO2e every year (from April), increasing to a rate of $50/ton CO2e in April 2022[36]. The current impact of the federal carbon tax on the City's procurement strategy is under investigation. Since it affects fuel producers and distributors, the effects on strategy may be minimal. The City will continue to conduct strategy reviews at regular intervals and reviews may also be triggered by changes in government policy and/or energy markets.

6.2 Third Party Funding

The City intends to leverage existing and upcoming third-party funding programs in order to meet our stated goal to maximize cost recovery. This section provides an overview of some of the funding programs the Energy Management team has identified to help catalyze the City's zero carbon transition.

The following list of programs includes those that are currently in operation, as well as new programs and top-up funding for existing programs that will be made available through the Government of Canada's *Budget 2019*.

Provincial Funding

- IESO Save on Energy Funding[37]

[35] (Government of Canada, 2019) https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/ontario.html
[36] This information was obtained from LAS. (LAS, 2018) https://www.las.on.ca/InteractWithUs/Blog/The-LAS-Blog/December-2018/Canada%E2%80%99s-Federal-Carbon-Pricing-System.aspx
[37] (Independent Electricity System Operator, 2019) https://www.saveonenergy.ca/For-Business-and-Industry/Programs-and-incentives/Retrofit-Program/Retrofit-portal

- Enbridge Gas Distribution Funding[38]
    - Fixed Incentive Program, Commercial custom retrofit program, RunitRight Program

Federal Funding

- Gas Tax Fund (GTF) [39]
- Green Infrastructure Fund (GIF) [40]
- Federation of Canadian Municipalities (FCM)
    - Green Municipal Fund (GMF), Municipalities for Climate Innovation Program (MCIP)[41], Municipal Asset Management Program (MAMP)
- New Building Canada Fund, Provincial-Territorial Infrastructure Component: National and Regional Projects (PTIC-NRP)[42]
- Zero-Emission Vehicle Infrastructure Program (ZEVIP)[43]

For some of the existing programs mentioned above, such as the Save on Energy Retrofit program, the City is an active program participant. Throughout the CDM cycle of 2019 to 2024, the City will continue to take an active role in exploring and applying for incentive opportunities as they are made available through various provincial and federal agencies.

6.3 Sanitary/Sewer Water Rebate Program

Another cost recovery stream is the sanitary sewer charge rebate program, as referenced in Chapter 2.3. The Energy Management team will continue to maintain and optimize this significant cost recovery program with the following actions:

- Continue to explore and investigate new sites for the potential rebates
- Complete reports for Region of Peel including process analysis of water source and effluent discharge
- Collect and document monthly water meter readings
- Submit wastewater charge appeal summary forms and supporting meter readings to the Region of Peel on an annual basis
- Calculate annual cost savings

[38] (ENBRIDGE GAS INC., 2019) https://enbridgesmartsavings.com/business-energy-management
[39] The Federal Gas Tax Fund, Infrastrtucture Canada (2019). (The Federal Gas Tax Fund, 2019) Available online: https://www.infrastructure.gc.ca/plan/gtf-fte-eng.html
[40] Green Infrastructure, Infrastrtucture Canada (2019). (Infrastructure Canada, 2019) Available online: https://www.infrastructure.gc.ca/plan/gi-iv-eng.html
[41] Municipalities for Climate Innovation, Federation of Canadian Municipalities (FCM (2019). (Federation of Canadian Municipalities, 2019) Avilable online: https://fcm.ca/en/programs/municipalities-climate-innovation-program
[42] 2014 New Building Canada Fund: Provincial-Territorial Infrastructure Component National and Regional Projects, Infrastructure Canada (2019). (Infrastructure Canada , 2017) https://www.infrastructure.gc.ca/plan/nrp-pnr-prog-eng.html
[43] (Natural Resources Canada, 2019) https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-transportation-and-alternative-fuels/zero-emission-vehicle-infrastructure-program/21876

APPENDIX A: CITY OF BRAMPTON ENERGY CONSUMPTION & GHG EMISSIONS IN 2017 PER ONTARIO REGULATION 507/18

Table 5 List of energy use for City of Brampton facilities based on Reg. 507/18

Operation Name	Facility Address	Postal Code	Gross Floor Area (ft2)	Hours of Operation	Electricity (kWh)	Natural Gas (m3)	Construction Year
Administrative offices and related facilities, including municipal council chambers							
129 Glidden	129 Glidden Road	L6W 3L9	64,362.00	98	667,228.75000	82,799.58000	1974
55 Queen St.	Corporate Training Centre	L6W 2A8	8,348.00	40	73,849.27000	10,980.04000	1900
Brampton Cemetery - Admin	10 Wilson Ave	L6Y 4R2	1,249.00	67	0.00000	3,781.61000	2014
By-Law Enforcement Williams Parkway Administration	485 Chrysler Dr	L6S 6G3	6 ,193.88	40	172,291.20000	6,940.52000	1999
Cemetery Office. Bldg	10 Wilson Ave.	L6V 1T5	750.00	40	6,554.33000	1,088.44000	1910
Chinguacousy Park Parks Building	9050 Bramalea Rd	L6S 6G7	3,185.00	63	24,809.61000	0.00000	1970
City Hall	2 Wellington St. W	L6Y 4R2	196,316.00	60	2,967,099.47000	173,054.99000	1990
City Hall West Tower	41 George St S	L6Y 2E1	188,924.00	60	2,377,481.22000	135,441.74000	2014
FCCC Dorm D-Sports Admin Offices	8950 McLaughlin Rd	L6Y 5T1	7,515.59	102	82,589.04000	14,864.37000	1960
FCCC Dorm E-Sports Admin Offices	8930 McLaughlin Rd	L6Y 5T1	7,523.00	102	67,146.76000	14,097.46000	1960
FCCC Unit 1	8850 McLaughlin Rd, Unit #1	L6Y 2C8	32,514.00	45	509,523.95580	24,369.84451	2005
FCCC Unit 2	8850 McLaughlin Rd Unit #2	L6Y 2C8	26,053.00	45	673,849.11420	32,229.29549	2006
Orenda Parks West Building	115 Orenda Rd	L6W 1V7	7,679.58	40	49,863.82000	25,385.99000	—
Peel Village Clubhouse	29A Hartford Trail	L6W 4K2	2,820.14	50	8,281.32000	6,221.87000	1988
POA Courthouse	5 Ray Lawson Blvd	L6Y 5L7	46,012.00	40	575,465.84000	63,797.01000	2004
Sandalwood Yard Admin Building	120 Sandalwood Pkwy W	L7A 1L2	8,019.00	168	0.00000	10,598.42000	2011
Williams Parkway Admin Building	1975 Williams Parkway East	L6S 6E5	118,111.00	40	1,167,516.24000	170,678.19000	2014

Operation Name	Facility Address	Postal Code	Gross Floor Area (ft2)	Hours of Operation	Electricity (kWh)	Natural Gas (m3)	Construction Year
Ambulance stations and associated offices and facilities							
Ambulance Station - 52 Bramalea Rd	52 Bramalea Rd	L6T 2W8	3,950.00	168	13,864.18000	6,738.94000	1950
Cultural facilities, indoor recreational facilities and community centres, including art galleries, performing arts facilities, auditoriums, indoor sports arenas, indoor ice rinks, indoor swimming pools, gyms and indoor courts for playing tennis, basketball or other sports							
31 Ellen St	31 Ellen St	L6V 1J7	1,872.00	84	3,426.93000	200.28000	—
Alderlea	40 Elizabeth Street S	L6Y 1R1	19,056.00	84	341,670.67000	0.00000	1867
Balmoral Recreation Centre	225 Balmoral Dr	L6T 1V4	17,438.00	90	354,167.94000	90,086.18000	1964
Bovaird House	563 Bovaird Dr E	L6V 3W7	4,362.71	12	15,441.40000	5,035.11000	1900
Brampton Curling Club	46 McMurchy Ave. S	L6Y 1Y4	28,258.00	35	402,174.02000	44,558.32000	1955
Brampton Soccer Centre	1495 Sandalwood Parkway East	L6R 0K2	153,044	84	1,423,744.87000	199,709.77000	2007
Cassie Campbell Recreation Centre	1050 Sandalwood Parkway West	L7A 0K9	168,000.00	105	4,166,789.04000	508,843.03000	2008
Castlemore Gore Bocci	9916 The Gore Blvd	L6T 3Y7	5,646.00	48	34,865.89000	4,688.85000	1994
Central Public School Recreation Centre	24 Alexander St	L6V 1H6	25,930.00	80	225,898.42000	32,747.26000	1916
Century Gardens Recreation Centre	340 Vodden St. E	L6V 2N2	114,904.00	87.5	2,457,332.28000	237,512.70000	1973
Chinguacousy Curling Club	9050 Bramalea Rd	L6S 6G7	35,900.00	117	979,875.07000	24,424.64000	1973
Chinguacousy Park Optimist Club/SkiC	9050 Bramalea Rd	L6S 6G7	19,601.88	123	606,239.80000	0.00000	2012
Chinguacousy Park Tea House	9050 Bramalea Rd	L6S 6G7	3,607	25	28,291.42000	10.94000	1920
Chinguacousy Park Tennis & Curling	9050 Bramalea Rd	L6S 6G7	38,605.00	126	0.00000	211,588.81000	2011
Chinguacousy Wellness Centre	995 Peter Robertson Blvd.	L6R 2E9	43,188.00	106.75	1,042,110.13000	240,230.94000	1998
Chris Gibson Recreation Centre	125 McLaughlin Rd. N	L6X 1Y9	50,341.30	85	1,018,335.22000	64,160.98000	1985
Churchville Community Hall	7752 Churchville Rd	L6Y 0H5	962.00	168	2,081.58000	2,786.89000	1970
Civic Centre	150 Central Park Dr	L6T 2T9	219,852.00	90	3,063,678.19000	293,216.89000	1971
Earnscliffe Recreation Centre	44 Eastbourne Dr.	L6T 3M2	91,637.69	116	1,696,893.30000	187,228.34000	1971
Ebenezer Hall	4494 The Gore Rd	L6P 0R8	2,217.58	40	53,190.86000	0.00000	1900

Operation Name	Facility Address	Postal Code	Gross Floor Area (ft2)	Hours of Operation	Electricity (kWh)	Natural Gas (m3)	Construction Year
Ellen Mitchell Recreation Centre	922 North Park Dr	L6S 3Y5	13,524.02	33.5	239,040.58000	65,912.45000	1985
FCCC Seniors Centre	8870 McLaughlin Rd	L6Y 5T1	25,720.12	73.5	397,238.84000	42,932.27000	2006
Flower City Lawn Bowling Facility	8910 McLaughlin Rd	L6Y 5T1	6,414.68	70	93,254.57000	22,347.11000	2011
Gore Meadows Community Centre	10150 The Gore Road	L6P 0A6	137,527.00	84	1,839,873.24000	324,177.74000	2013
Greenbriar Recreation Centre	1100 Central Park Dr	L6S 2C9	43,527.93	80.5	514,439.92000	55,492.86000	1974
Howden Recreation Centre	150 Howden Blvd	L6S 2G1	22,400.31	68.5	172,560.00000	32,506.01000	1974
Jim Archdekin Recreation Centre	292 Conestoga Dr	L6Y 1Z4	45,919.48	80.5	758,016.35000	79,990.70000	1988
Ken Giles Indoor Soccer	370 Bartley Bull Pkwy	L6W 2L8	29,051.32	105	254,397.79000	54,828.89000	1974
Kiwanis McMurchy Recreation Centre	247 McMurchy Ave S	L6Y 1Z4	43,962.00	105	591,033.26000	181,043.82000	1971
Knightsbridge Senior Ctr	1A Knightsbridge Rd	L6T 4B7	6,391.41	40	58,433.55000	8,686.68000	1979
Loafer's Lake Recreation Centre	30 Loafer's Lake Lane	L6Z 1X9	32,804.00	80.5	547,973.25000	129,293.93000	1980
Memorial Arena	69 Elliot St	L7A 0G2	32,153.28	28	390,503.10000	40,405.03000	1949
Memorial Batting Cages	61 Elliot St	L6Y 1W2	1,181.00	30	1,511.02000	0.00000	2003
Norton Park Place	170 Clark Boulevard	L6T 4A8	12,001.00	60	156,980.64000	41,841.58000	2014
Professor's Lake Recreation Centre	1660 North Park Dr	L7A 0L1	10,953.08	105	260,976.13000	0.00000	1981
Rose Theatre	5 Market Sq. Blvd	L6V 0A3	92,868.70	84	2,103,109.19000	121,244.55000	2006
Snelgrove Senior Ctr	11692 Hurontario St	L7A 1R2	6,755.20	70	79,111.06000	11,863.66000	1990
South Fletcher's Sportsplex	500 Ray Lawson Blvd.	L6S 3J8	172,827.00	106	4,332,321.35000	494,588.17000	1996
Terry Miller Recreation Centre	1295 Williams Pkwy. E	L6T 1E4	60,498.00	98	823,981.46000	88,041.15000	1979
Victoria Park Arena	20 Victoria Crescent	L6S 6G3	34,327.23	0	0.00000	6,024.49000	1967
Fire stations and associated offices and facilities							
Fire Life Safety Ctr.	225 Central Park Dr	L6S 6H1	10,847.00	168	146,020.37000	8,237.02000	2003
Fire Station 201 & HQ	8 Rutherford Rd S	L6W 3J1	13,544.00	168	124,394.18000	25,358.54000	1963
Fire Station 202	280 Bramalea Rd	L6T 4V3	8,358.00	168	88,320.59000	18,181.76000	1984
Fire Station 204	657 Queen Street W	L6Y 5L6	5,583.50	168	16,697.83000	5,619.19000	1976
Fire Station 205	95 Sandalwood Pkwy E	L6Z 4S3	8,239.00	168	120,646.71000	13,392.28000	1978
Fire Station 206	7880 Hurontario St	L6Y 0C7	8,358.00	168	86,327.53000	18,760.51000	1984
Fire Station 207	75 Vodden St E	L6V 4H7	7,194.00	168	89,812.48000	14,883.00000	1987
Fire Station 208	120 Ferforest Dr	L6R 1L3	6,345.41	168	75,248.69000	10,614.67000	1994

Operation Name	Facility Address	Postal Code	Gross Floor Area (ft2)	Hours of Operation	Electricity (kWh)	Natural Gas (m3)	Construction Year
Fire Station 209	2691 Sandalwood Pkwy E	L6R 0K7	9,377.27	168	133,817.55000	15,696.54000	2003
Fire Station 210	10530 Creditview Rd	L7A 0G2	9,125.97	168	94,736.91000	21,997.64000	2003
Fire Station 211	10775 The Gore Road	L6P 0B3	13,756.00	168	167,747.10000	24,593.27000	2014
Fire Station 212	8220 Mississauga Road	L6Y 0C3	11,044.00	168	157,240.12000	22,574.78000	2011
Fire Station 213	4075 Ebenezer Rd	L6P 0S2	8,379.14	168	69,419.41000	22,550.68000	2003
A & M	52 Rutherford Rd	L6W 3J5	39,108	168	53,941.86000	17,422.91000	2017
Other							
Animal Shelter	1945 Williams Pkwy E	L6S 6G3	8,916.00	168	229,008.33000	93,814.47000	1998
Bramalea Transit Terminal (new)	160 Central Park Dr.	L6T 2T9	7,950.00	126	267,399.01000	18,214.76000	2010
Brampton Gateway Terminal	501 Main Street S	L6Y 1N6	4,834.00	126	219,908.80000	9,428.27000	2012
Brampton Heartlake Transit Terminal Lunch room	164 Sandalwood Pkwy E	L6Z 3S4	1,489.00	94.5	324.43000	1,348.26000	2012
Century Gardens Recreation Centre Lawnbowling	342 Vodden Street E	L6V 2N2	3,279.00	84	0.00000	1,574.73000	1973
Chinguacousy Greenhouse	9070 Bramalea Rd	L6S 6G7	12,886.00	168	199,953.78000	117,054.82000	1974
Trinity Common Bus Terminal	164 Great Lakes Dr.	L6R 2K7	918.00	126	68,336.05000	1,020.99000	1999
Parking Garages							
Chinguacousy Park Garage	9050 Bramalea Rd	L6S 6G7	2,625.00	44	0.00000	1,067.45000	1985
Market Sq. Parking	1 Theatre Lane	L6V 0A3	224,905.50	168	505,697.66000	0.00000	1997
Nelson Sq. Parking	2 Diplock Lane	L6X 1R3	99,088.81	168	200,622.51000	0.00000	1991
Public libraries							
Cyril Clark Library	20 Loafers Lake Lane	L6Z 1X9	26,441.96	63	332,960.04000	34,312.16000	2010
Four Corners Library	65 Queen St. E	L6W 3L6	38,936.34	48	656,531.50000	38,432.82000	1991
Mount Pleasant Recreation Centre	100 Commuter Drive	L6S 4B4	29,516.00	105	459,439.81000	0.00000	2011
Storage facilities where equipment or vehicles are maintained, repaired or stored							
Brampton Transit	185 Clark Blvd	L6T 4G6	144,164.15	91	1,581,135.32000	666,494.81000	1979
Brampton Transit Yard Sandalwood Facility	130 Sandalwood Pkwy W	L6Y 5B3	383,505.00	168	5,438,610.45000	1,038,240.68000	2008
County Court Fieldhouse	95 County Court Blvd	L6W 4S3	1,227.79	20	37,931.57000	0.00000	1990
Creditview Fieldhouse	10490 Creditview Rd	L7A 0G2	4,437.61	20	288,840.72000	0.00000	2008

Operation Name	Facility Address	Postal Code	Gross Floor Area (ft2)	Hours of Operation	Electricity (kWh)	Natural Gas (m3)	Construction Year
Duggan Park Fieldhouse	75 Vodden St E	L6V 4H7	1,412.71	20	9,138.16000	0.00000	1987
FCCC Dorm F-Sports Equipment Storage	8970 McLaughlin Rd	L6Y 5T1	7,525.14	50	22,450.82000	8,096.03000	1960
FCCC Park Maintenance Warehouse	8890 McLaughlin Rd	L6Y 5T1	4,391.90	42.5	60,938.36000	17,751.41000	1960
Heritage Theatre	86 Main Street N	L6V 1N7	13,098.00	40	84,896.66000	30,825.55000	1922
Loafers Lake Fieldhouse	30 Loafer's Lake Lane	L6Z 1X9	500.00	20	6,130.46000	0.00000	1985
Orenda Parks Operations	115 Orenda Rd	L6W 1V7	23,682.82	40	42,241.64000	13,391.87000	—
Peel Village Maintenance	29A Hartford Trail	L6W 4K2	1,646.32	50	54,646.38000	0.00000	1988
Rotary Fieldhouse 1	145 Main St S	L6Y 1N2	115.18	20	1,632.43000	0.00000	—
Sandalwood Yard Sand Garage	120 Sandalwood Pkwy	L7A 1L2	80,654.00	168	1,269,934.71000	251,174.07000	2011
Siemens Building	2791 Hwy 7 W	L6X 0G4	41,861.10	72	106,199.73000	0.00000	—
Teramoto Park Queen/Chinguacousy Dep	45 Davis Elm Drive	L6X 0E6	8,530.36	70	241,417.87000	22,870.64000	2012
Williams Parkway Works Operation	1945 Williams Pkwy E	L6S 6G3	60,599.00	168	827,134.34000	177,125.37000	1974

APPENDIX B: CITY OF BRAMPTON ENERGY CONSUMPTION OF FACILITIES EXCLUDED BY REG. 507/18

Table 6 List of energy use for City of Brampton facilities excluded by Reg. 507/18

Operation Name	Facility Type	Facility Address	Electricity (kWh)	Natural Gas (m^3)
10981 Torbram Rd	Corporate		5594	0
19-21 Stafford (Storage)	Corporate	19-21 Stafford Rd	6955	9038
31-33 Stafford (Storage)	Corporate	31-33 Stafford Rd	5507	10069
Centennial Recreation Centre	Corporate	80 Mary St	1056	0
COB Parking lot (Former BCC Terminal)	Corporate	200 Clark Blvd	56755	0
Brampton Cemetery - Utility Shed	Parks	10 Wilson Ave	13526	0
Chinguacousy Park	Parks	9030 Bramalea Road	0	6794
Countryside Dr. Waterfall	Parks		472	0
Eldorado Parks Shed	Parks	8520 Creditview Rd	3094	0
Landscape Dr. (Fountain)	Parks		10981	0
Park Flower Beds	Parks		19557	0
Park Lights	Parks		620198	0
Pond at Armani Lane	Parks		9852	0
Royal West Pond	Parks	2 Royal West Dr	4156	0
Sequi Centennial Park	Parks	11367 BRAMALEA RD	11202	0
Springbrook Pond 2	Parks	Ingleborough Dr	7494	0
Springdale Central Community Park	Parks		33196	0
Stoneylake Ave Water Fountain	Parks		27574	0
Water Fountain	Parks	Various Locations	24452	0
Baseball/Sportsfield	Recreation	Various Locations	385209	0
Blue Oak (Sandringham)	Recreation		8720	0
Bocci - Linkdale Rd	Recreation		1079	0
Bocci - St John's Park	Recreation		767	0
Brampton Theatre School	Recreation	76 Main St N	28764	2514
Chinguacousy Park Mini Golf & Snack Bar	Recreation	9050 Bramalea Rd	481964	0

Operation Name	Facility Type	Facility Address	Electricity (kWh)	Natural Gas (m^3)
Chinguacousy Park Scorebox Baseball	Recreation	9050 Bramalea Rd	82715	0
Chinguacousy Skating	Recreation	9030 Bramalea RD	0	14645
Countryside Park Ball Diamond	Recreation	11333 Bramalea	235653	0
Eldorado Park Pavillion	Recreation	8520 Creditview Rd	42819	0
Eldorado Pool Changehouse	Recreation	8520 Creditview Rd	16156	0
FCCC Parking Lot Lights	Recreation		70350	0
Gage Park Bandshell	Recreation	45 Main St S	373216	0
Powerade Ctr	Recreation		4019352	0
Tennis Location	Recreation		73278	0
Brampton Sign at Westcreek	Sign		528	0
Central Fleet Sign	Sign		965	0
Signs	Sign		1056	0
ZUM Bus Shelters	Transit	Various Locations	615776	0
Bus Shelters	Transit		11041	0
Mount Pleasant GO Clock Tower	Transit	100 Commuter Drive	52104	0
Street Lighting	Works Operations		36099994	0
Traffic Control	Works Operations		856021	0

APPENDIX C: COMPLETED ENERGY CONSERVATION PROJECTS FROM 2014 TO 2019

Table 7 Summary of Projects done in the last five years 2014-2019

Year	Project Location	Description	Annual Electricity Savings [kWh]	Annual Natural Gas Savings [m3]	Annual Energy Savings [ekWh]	Annual GHG Reductions [ton]
2014	Soccer Centre	Class 7 BAS integration	121,486	5,881	183,563	15.96
	Sport Fields	New BAS DDC	170,423	0	170,423	6.82
	Chris Gibson Phase 2	New BAS DDC/ CIMCO	131,600	2,343	156,332	9.69
	Memorial Arena	Install Vending/Snack Misers	3,328	0	3,328	0.13
	Memorial Arena	Install Occupancy Sensors	6,178	0	6,178	0.25
	Various locations	Install Occupancy Sensors	29,906	0	29,906	1.20
	Terry Miller Phase 2	New BAS DDC	31,163	0	31,163	1.25
	McMurchy	Pool LED lighting	49,778	0	49,778	1.99
	Earnscliffe Recreation Center	Pool/Rink LED Lighting	147,816	0	147,816	5.91
	Total		**691,678**	**8,224**	**778,487**	**43.19**
2015	Chris Gibson	Pool/Rink LED Lighting	100,710	0	100,710	4.03
	South Fletchers & Clark Transit	Rinks LED lighting	956,975	0	956,975	38.28
	Jim Archdekin	Pool/Rink LED Lighting	69,440	0	69,440	2.78
	Earnscliffe, Loafers Lake	Pool LED Lighting	60,772	0	60,772	2.43
	Ken Giles	LED Lights	57,020	0	57,020	2.28
	Brampton Soccer Centre	Lobby Lighting Integration To BAS	31,045	0	31,045	1.24
	Victoria Park Arena	New Heating System	0	24,000	253,333	45.31
	Brampton Soccer Centre	Lighting Rewiring/Install Sensors in Change Rooms	37,248	0	37,248	1.49
	City Hall	Stairway Lighting Upgrades	20,632	0	20,632	0.83

Year	Project Location	Description	Annual Electricity Savings [kWh]	Annual Natural Gas Savings [m3]	Annual Energy Savings [ekWh]	Annual GHG Reductions [ton]
	South Fletchers	Ammonia Desuperheater Recovery	184,666	24,549	443,794	53.74
	Civic Centre	Library Lighting Phase I	40,000	0	40,000	1.60
	Total		**1,558,508**	**48,549**	**2,070,970**	**154.00**
2016	Sandalwood Transit	Garage Lighting Retrofit	660,000	0	660,000	26.40
	Brampton Curling Club	Arena Lighting Retrofit	23,000	0	23,000	0.92
	Memorial Arena	Arena Lighting Retrofit	125,000	0	125,000	5.00
	Ching. Curling Club	Arena Lighting Retrofit	57,000	0	57,000	2.28
	Green Briar Arena	Arena Lighting Retrofit	55,600	0	55,600	2.22
	Century Garden	Arena Lighting Retrofit	175,000	0	175,000	7.00
	Terry Miller	Arena Lighting Retrofit	33,500	0	33,500	1.34
	Sandalwood and Ken Giles	HVLS Fans	0	112,647	1,189,052	211.21
	Pathway Lighting Phase 1	Parks	24,360	0	24,360	0.97
	Pathway Lighting Phase 2	Parks	13,533	0	13,533	0.54
	Various locations	Building Envelop Sealing Measures Phase I	0	117,720	1,242,600	220.73
	129 Glidden, Professor's Lake, Earnscliff, Wellness	Exterior lighting retrofit	30,032	0	30,032	1.20
	Green Briar Arena & Century Gardens	Upgrade Ice Rink Controller with CIMCO system	69,790	0	69,790	2.79
	Bramalea Terminal	Lighting Retrofit	11,700	0	11,700	0.47
	Southfletcher	Ice Rink CIMCO system	34,895	0	34,895	1.40
	Total		**1,313,410**	**230,367**	**3,745,062**	**484.47**
2017	Various locations	Building Envelop Sealing Measures Phase II	0	50,000	527,778	93.75

Year	Project Location	Description	Annual Electricity Savings [kWh]	Annual Natural Gas Savings [m3]	Annual Energy Savings [ekWh]	Annual GHG Reductions [ton]
	Clark Transit	New BAS	237,000	54,208	809,196	111.82
	Earnscliff	Reallce	167,083	25,375	434,930	54.59
	Southfletcher	Reallce	99,611	18,950	299,639	39.76
	Clark Transit	HVLS Fans	0	20,667	218,148	39.02
	Cassie Campbell, Soccer Centre & Wellness Centre	LED Lighting Upgrade	725,764	0	725,764	29.03
	Total		**1,229,458**	**169,200**	**3,015,454**	**367.98**
2018	Cassie, Soccer Center, Gore Meadows & Wellness	HVLS Fans	0	72,721	767,611	137.30
	Fire Stations and Knightsbridge Senior Centre	Lighting Retrofit	296,203	0	296,203	11.85
	Clark Transit	Exterior lighting retrofit	48,326	0	48,326	1.93
	Jim Archdekin	Ice Rink CIMCO system	84,350	0	84,350	3.37
	Cassie Campbell Recreation Centre	Pool waste water heat recovery unit	82,596	7,946	166,470	18.31
	Total		**511,475**	**80,667**	**1,362,960**	**172.76**
2019	Market Square Parking and City Hall	All Lighting in Market Square and P3 & P4 Lighting in City Hall	278,878	0	278,878	11.16
	Memorial Arena	Retrofit Lighting to LED (Wall packs)	2,260	0	2,260	0.09
	South Fletchers	Retrofit Lighting to LED	322,526	0	322,526	12.90
	Terry Miller and Ellen Mitchell	Retrofit Lighting to LED	58,622	0	58,622	2.34
	Total		**662,286**	**0**	**662,286**	**26.49**

APPENDIX D: BENCHMARKING

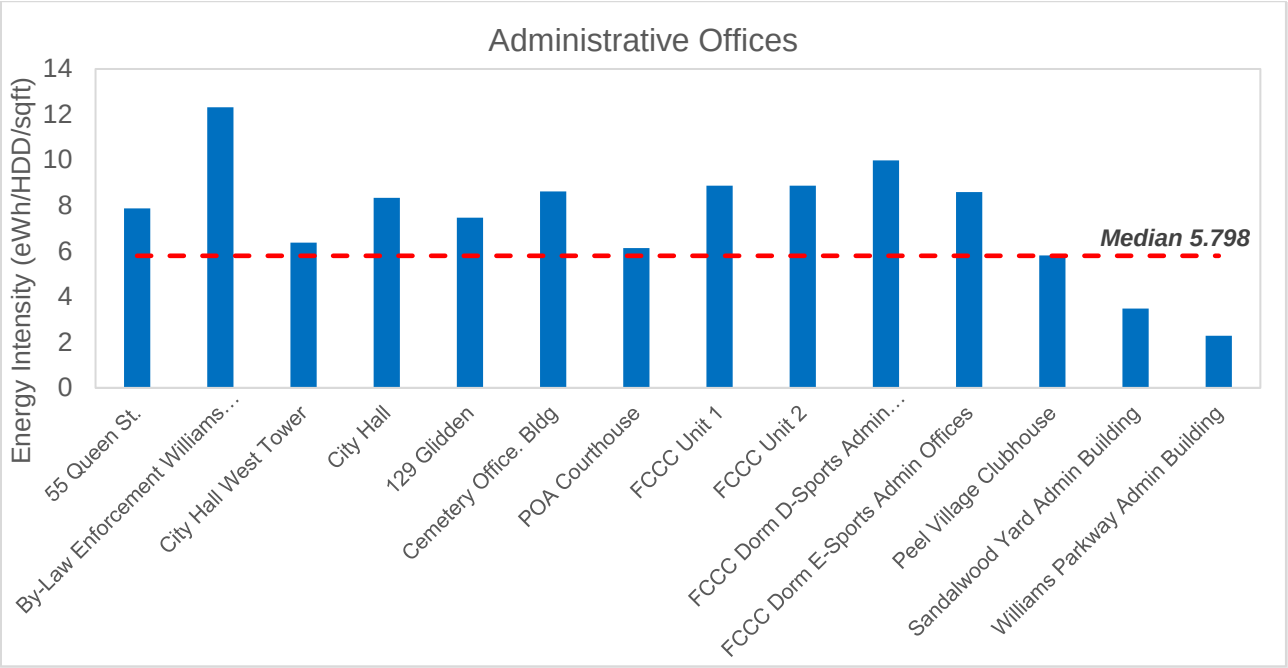

Figure 22 Benchmarking of COB administrative offices against BPS facilities

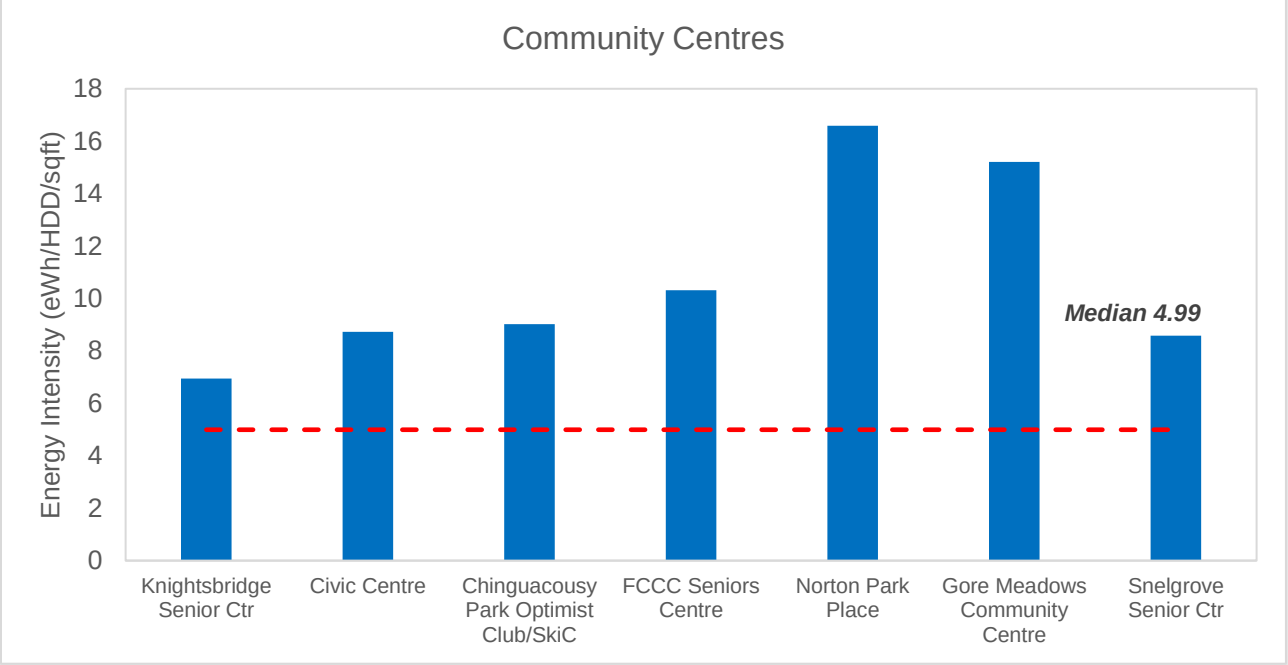

Figure 23 Benchmarking of COB community centres against BPS facilities

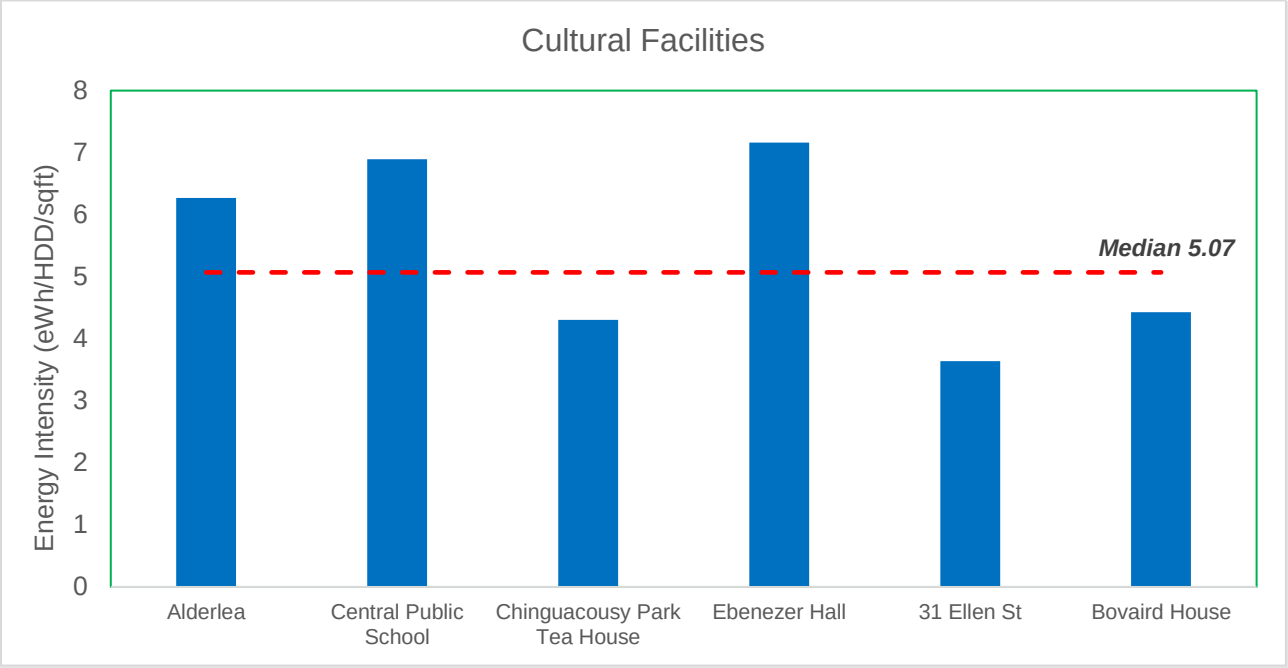

Figure 24 Benchmarking of COB cultural facilities against BPS facilities

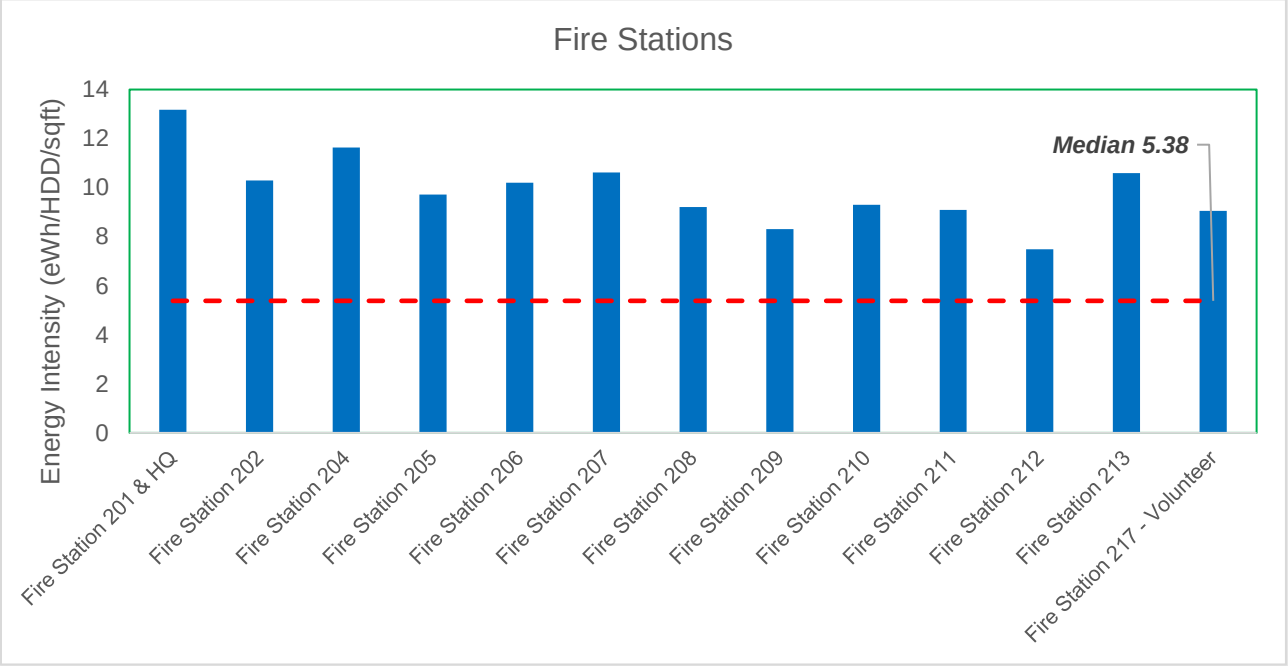

Figure 25 Benchmarking of COB fire stations against BPS facilities

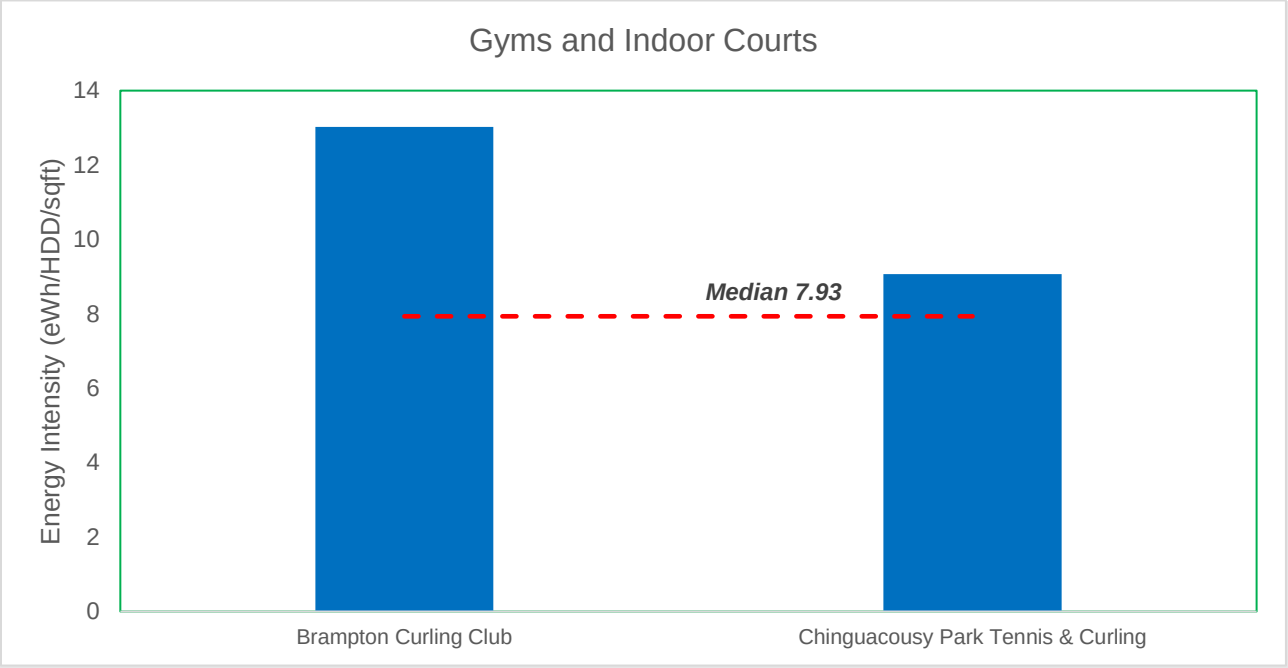

Figure 26 Benchmarking of COB gyms and indoor courts against BPS facilities

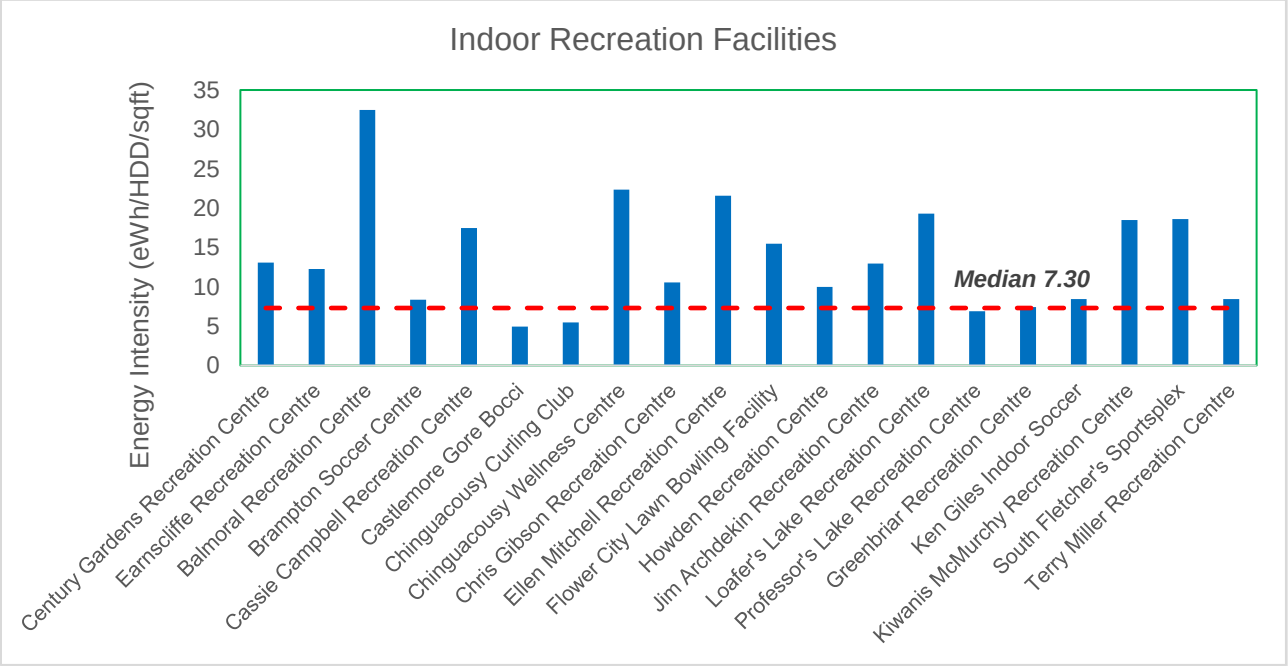

Figure 27 Benchmarking of COB indoor recreation facilities against BPS facilities

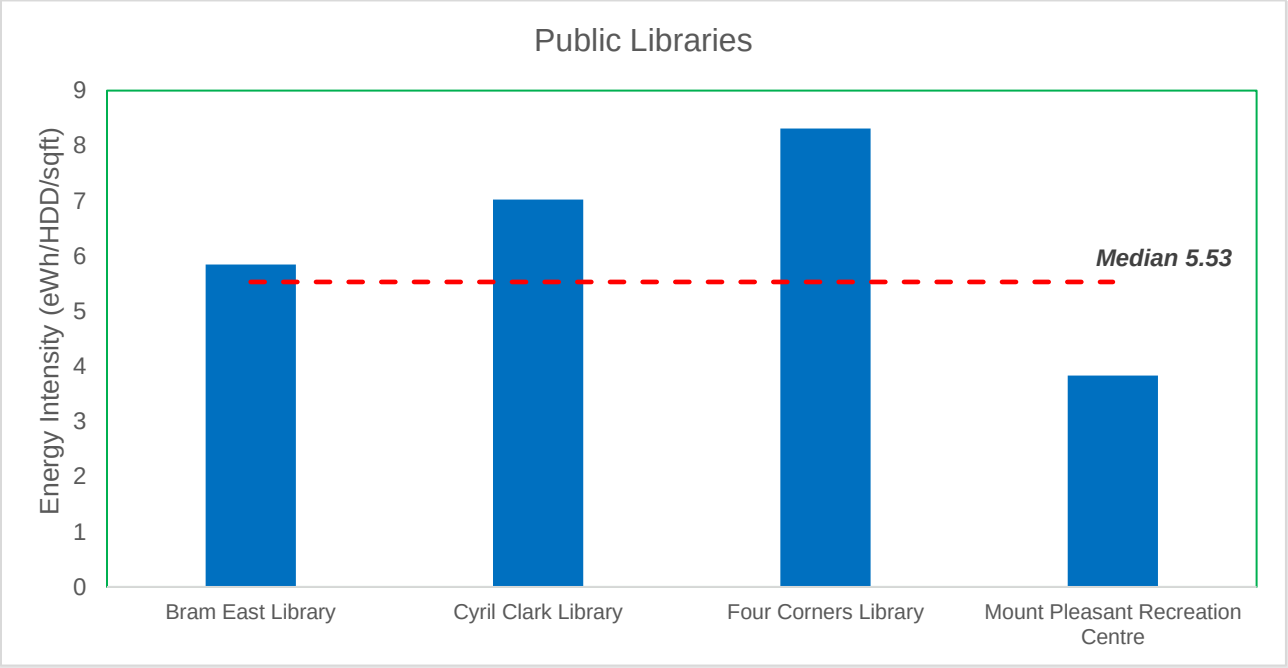

Figure 28 Benchmarking of COB public libraries against BPS facilities

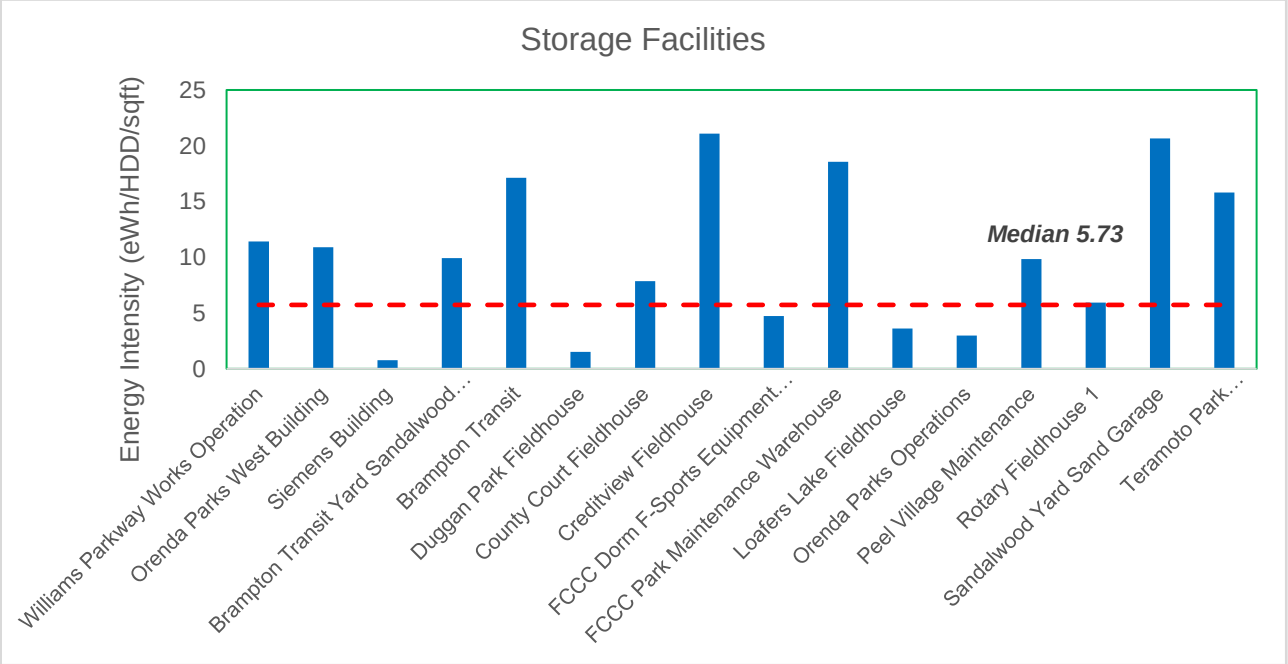

Figure 29 Benchmarking of COB storage facilities against BPS facilities

APPENDIX E: ENERGY CONSUMPTION AND TREND DATA

Table 8 Annual Electricity, Natural Gas, and total energy consumption by Facility Type (2017)

Facility Type	Electricity (kWh)	Natural Gas (m3)	Total (ekWh)
Corporate	13,386,200	1,025,600	24,012,700
Fire	1,289,600	234,400	3,718,600
Library	1,448,900	72,700	2,202,700
Parks	1,903,600	251,000	4,504,500
Recreation	34,591,200	3,825,200	74,224,900
Transit	8,255,600	1,734,700	26,229,500
Works Operations	39,053,100	438,900	43,600,600
TOTAL[44]	99,928,300	7,582,700	178,493,300

Table 9 Facility performance indicators from 2010 to 2017

Year	Total Gross Floor Area (ft2)	Percent of Change (%)	Energy Intensity (ekWh/ft2)	Percent of Change (%)	GHG Emission per Gross Area (ton/ft2)	Percent of Change (%)
2010	2,787,717	-	41.21	-	0.0067	-
2011	2,806,509	0.67	42.23	2.46	0.0064	-5.53
2012	3,224,723	15.68	37.85	-8.17	0.0057	-15.19
2013	3,335,532	19.65	36.82	-10.67	0.0050	-25.30
2014	3,421,082	22.72	36.55	-11.31	0.0044	-34.79
2015	3,487,735	25.11	37.52	-8.96	0.0045	-32.43
2016	3,732,183	33.88	34.53	-16.22	0.0041	-38.45
2017	3,955,146	41.88	33.76	-18.09	0.0041	-38.69

Table 10 Total energy and GHG emission from 2010 to 2017

Year	Electricity Consumption (kWh)	Natural Gas Consumption (m3)	Total Energy Consumption (ekWh)	Percent of Change (%)	Total GHG Emission (ton)	Percent of Change (%)
2010	50,251,425	6,238,108	114,885,212	-	18756.6	-
2011	51,192,864	6,496,936	118,508,397	3.15	17839.0	-4.89
2012	53,127,241	6,651,275	122,041,898	6.23	18401.6	-1.89
2013	54,888,802	6,554,241	122,798,080	6.89	16765.5	-10.62
2014	54,675,796	6,791,970	125,048,211	8.85	15010.3	-19.97
2015	56,164,164	7,208,579	130,853,109	13.90	15856.4	-15.46
2016	55,772,143	7,053,649	128,855,842	12.16	15456.5	-17.59
2017	55,660,953	7,513,831	133,512,657	16.21	16314.9	-13.02

[44] The total values may not add up due to rounding

APPENDIX F: ACCOMPLISHMENTS DATA

Energy Conservation and Efficiency Data

Table 11 Project numbers, energy savings and GHG reduction for different project types

Project Type	Number of Projects	Annual Electricity Savings [kWh]	Annual Natural Gas Savings [m3]	Annual Energy Savings [ekWh]	Annual GHG Reduction [ton]
Lighting Retrofit	29	4,512,740	0	4,512,740	181
BAS	5	691,672	62,432	1,350,676	146
HVLS Fans	3	0	206,035	2,174,810	388
CIMCO system	3	189,035	0	189,035	8
Building Envelope Sealing Measures	2	0	167,720	1,770,378	314
Reallce	2	266,694	44,325	734,569	94
Other	6	306,674	56,495	903,010	119
sum	50	5,966,815	537,007	11,635,219	1,249

Table 12 List of major projects of each project category

Project Type	Major Projects	Annual Energy Savings [ekWh]	Annual GHG Reduction [ton]
Lighting Retrofit	South Fletchers & Clark Transit	956,975	38
	Cassie Campbell, Soccer Centre & Wellness Centre	725,764	29
	Sandalwood Transit	660,000	26
	South Fletchers	322,526	13
BAS	Clark Transit	809,196	112
	Soccer Centre	183,563	16
HVLS Fans	Sandalwood and Ken Giles	1,189,052	211
	Cassie, Soccer Center, Gore Meadows & Wellness	767,611	137
	Clark Transit	218,148	39
CIMCO system	Jim Archdekin	84,350	3
	Green Briar Arena & Century Gardens	69,790	3
Building Envelop Sealing Measures	Various locations	1,242,600	221
	Various locations	527,778	94
Reallce	Earnscliff	434,930	55
	Southfletcher	299,639	40

Project Type	Major Projects	Annual Energy Savings [ekWh]	Annual GHG Reduction [ton]
Other	South Fletchers	443,794	54
	Victoria Park Arena	253,333	45
	Cassie Campbell Recreation Centre	166,470	18
	Various locations	29,906	1

Energy Conservation Projects

Through Table 11, the five main project categories are lighting retrofit, BAS, HVLS fans, CIMCO system, and Real Ice. Projects under these five categories occupied more than 84% of total projects and account for 90.6% of annual Energy saving according to Figure 30. The remaining eight projects save the other 9.4% energy each year. Among these categories, lighting retrofit projects has the highest number (29) and 38.79% of annual energy savings are achieved by these lighting projects.

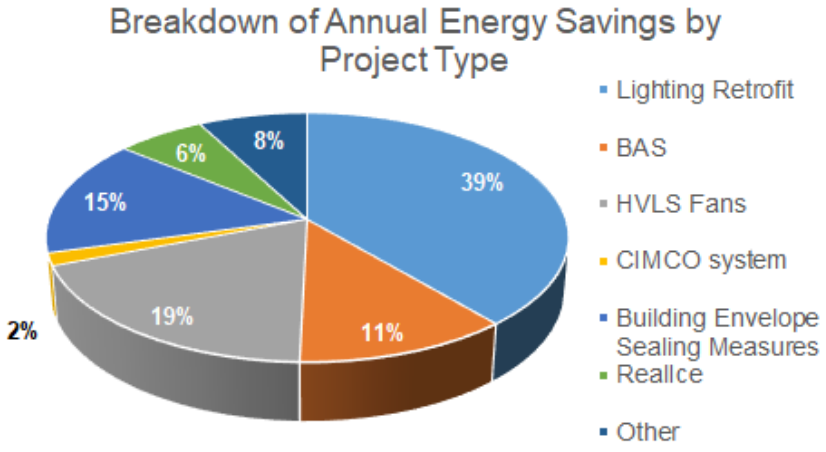

Figure 30 City of Brampton's annual energy savings by project type

Figure 31 illustrates the breakdown of annual GHG reduction between energy conservation projects. Two project categories, HVLS Fans and Building Envelope Sealing Measures contribute to 56% of annual GHG reduction and are estimated savings.

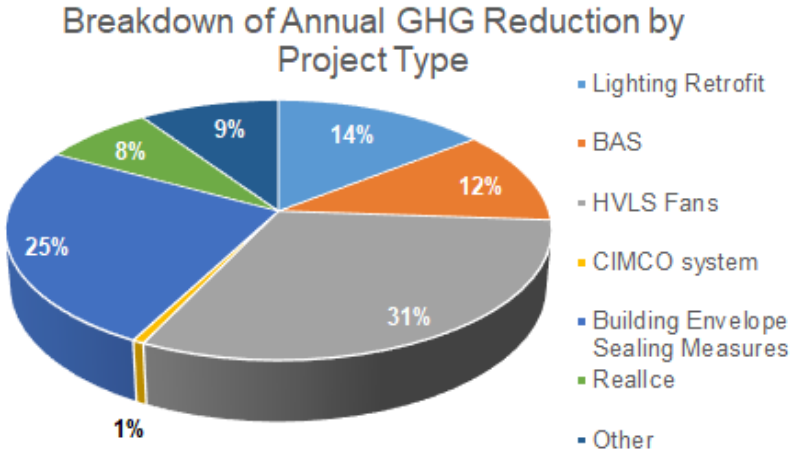

Figure 31 City of Brampton's annual GHG reduction by project type

Figure 32 illustrates the electricity and natural gas savings of different project categories. All energy saved by lighting retrofit and CIMCO system projects are electricity while HVLS Fans and building envelope sealing projects only save natural gas.

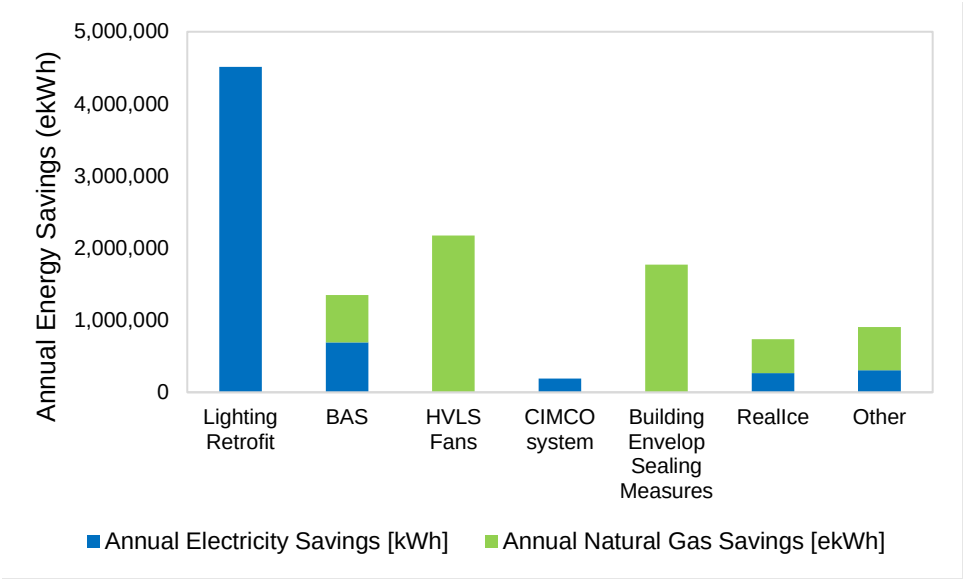

Figure 32 Electricity and natural gas saving of different project categories

Renewable Energy Data

Geothermal Systems

Table 13 provides a summary of annual cooling and heating loads from our geothermal systems.

Table 13 Annual cooling and heating load data from Geothermal systems in the City

Facility	Date Installed[45]	Annual Cooling Load (MBtu)[46]	Annual Heating Load (MBtu)[46]
Springdale Library & Neighbourhood Park	2017	9,460,800[47]	
Williams Parkway Operations Centre - Phase 2	2017	766,900	514,300
Williams Parkway Operations Centre - Phase 1	2015	6,718,900	5,378,600
Alderlea	2013	4,990,500	4,126,800
Fire Station 212	2010	2,184,900	2,041,500
Ebenezer Hall	2010	679,700	1,068,700

[45] The date installed was estimated from the date of when the system was first used (estimated from the utility data from our Data Management system)
[46] These values are the rounded cooling and heating capacities, respectively, obtained from the projects' consultants, design criteria/reports, manufacturers engineering guides, and/or reference drawings.
[47] *This value is the total capacity of the heat pumps, provided by this project's consultant.*

Solar PV Systems

Table 14 provides a summary of the total energy and revenue produced from our solar PV systems between 2014 and 2019.

Table 14 City of Brampton's Completed Solar Photovoltaic Project Generation and Revenue from 2014-2019

Facility	PV System Capacity (kW)	Year Completed	Energy Produced (kWh)	Total Revenue
Clark Transit[48]	10	2012	57,500	$ 51,600
Fire Station 205[48]	10	2012	35,100	$ 21,300
Sandalwood Transit[49]	10	2013	68,500	$ 61,200
Cassie Campbell Community Centre[50]	150	2018	82,600	$ 19,800

Figure 33 displays a summary of the energy generated from each MicroFIT (10 kW capacity) Solar PV system from 2014-2019.

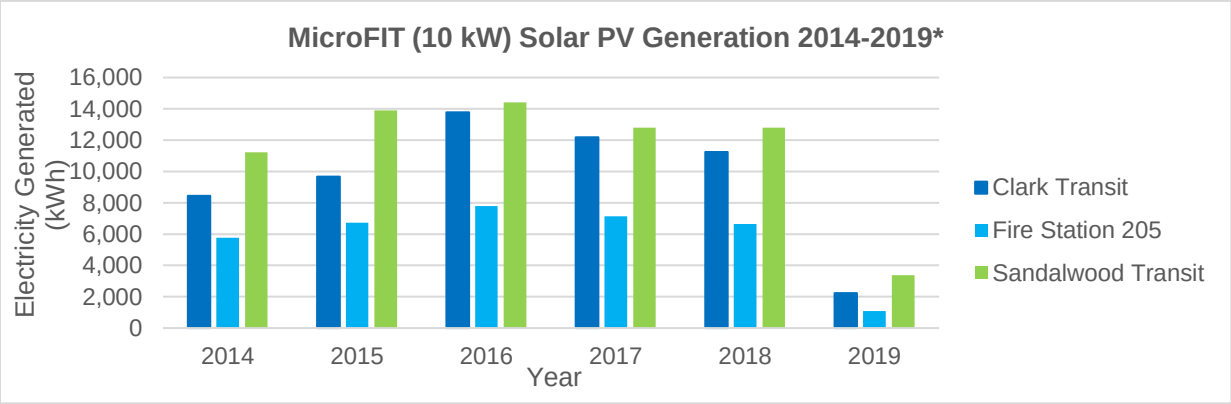

Figure 33 Graph displaying MicroFIT (10 kW) Solar PV energy generation from 2014-2019
**Data given until April 2019 (refer to Table 15 notes for specific end dates)*

Figure 34 displays the energy generated from the FIT (150 kW capacity) Solar PV system located at Cassie Campbell Community Centre from 2018-2019.

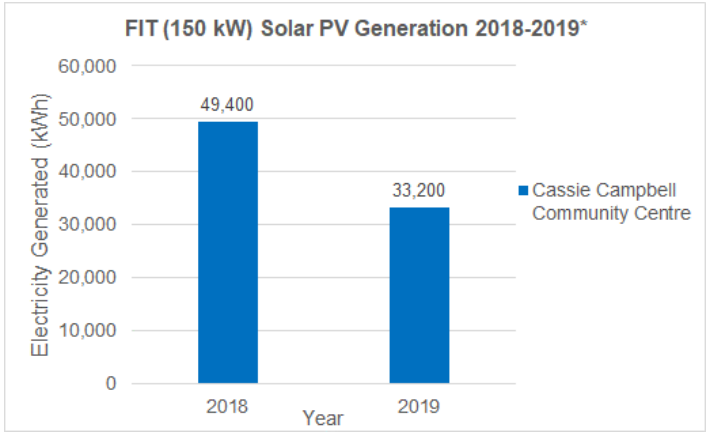

Figure 34 Graph displaying FIT (150 kW) Solar PV energy generation from 2018-2019
**Data given from Aug 21st, 2018 until March 31st, 2019*

[48] Data provided for the period of Jan 1, 2014 to Apr 12, 2019 (obtained from the City's utility data management software and/or utility bills)
[49] Data provided for the period of Jan 1, 2014 to Apr 30, 2019 (obtained from the City's utility data management software and/or utility bills)
[50] Data provided for the period of Aug 21, 2018 to Mar 31, 2019 (obtained from the City's utility data management software and/or utility bills)

Solar PV System Annual Data

Table 15 provides a summary of the energy generated annually from the all completed solar PV systems on a site-by-site basis from 2014-2019. Notes total values may appear to not add up due to rounding.

Table 15 City of Brampton's Completed Solar Photovoltaic Energy Generation on an annual basis

Solar PV Energy Generation (kWh) from 2014 - 2019							
Facility \ Year	2014	2015	2016	2017	2018	2019	Total
Clark Transit	8,450	9,660	13,770	12,180	11,250	2,230[1]	57,560
Fire Station 205	5,770	6,730	7,780	7,120	6,640	1,080[1]	35,140
Sandalwood Transit	11,210	13,890	14,410	12,800	12,790	3,370[2]	68,500
Cassie Campbell Community Centre	N/A	N/A	N/A	N/A	49,420[3]	33,220[4]	82,640
Total	25,440	30,290	35,960	32,120	80,120	39,910	243,850

Notes: [1]Data given until Apr 12th, 2019
[2]Data given until Apr 30th, 2019
[3]Data given from Aug 21st, 2018
[4]Data given until Mar 31st, 2019

Table 16 provides a summary of the total annual revenue from the all completed solar PV systems on a site-by-site basis from 2014-2019. Notes total values may appear to not add up due to rounding.

Table 16 City of Brampton's Completed Solar Photovoltaic Revenue on an annual basis

Solar PV Revenue from 2014 - 2019							
Facility \ Year	2014	2015	2016	2017	2018	2019	Total
Clark Transit	$ 7,590	$ 8,680	$ 12,380	$ 10,940	$ 10,070	$ 2,000[5]	$ 51,680
Fire Station 205	$ 3,510	$ 4,120	$ 4,750	$ 4,340	$ 4,010	$ 650[5]	$ 21,390
Sandalwood Transit	$ 9,720	$ 12,510	$ 12,970	$ 11,520	$ 11,510	$ 3,030[6]	$ 61,290
Cassie Campbell Community Centre	N/A	N/A	N/A	N/A	$ 11,910[7]	$ 7,970[8]	$ 19,890
Total	$ 20,820	$ 25,320	$ 30,110	$ 26,810	$ 37,520	$ 13,660	$ 154,270

Notes: [5]Data given until Apr 12th, 2019
[6]Data given until Apr 30th, 2019
[7]Data given from Aug 21st, 2018
[8]Data given until Mar 31st, 2019

Solar Thermal System

Table 17 gives a brief summary of the annual energy production from the solar thermal projects mentioned above.

Table 17 Annual Energy Production from Solar Thermal Projects

Facility	Installation Date[51]	Annual Energy Production (ekWh)[52]
Brampton Apparatus and Maintenance Facility	2017	8,300
Fire Station 211	2014	8,300
Fire Station 212	2010	10,500

[51] These dates are the dates the systems were first used, estimated from the utility data from our GreanBEAM.

[52] These values were calculated using RETScreen Expert, a Clean Energy Management Software. These values were estimated using the collector aperture area, collector gross area, number of collectors, thermal losses, optical efficiency and additional system information obtained from the product submittal.