ATTACHMENT 1

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FIGURES

Executive Summary

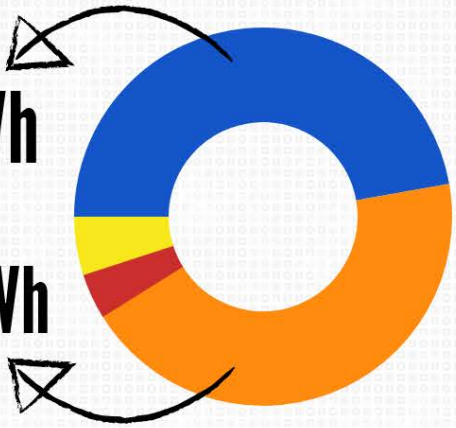
The City of Vaughan Corporate Energy Management Plan (EMP) 2019-2024 summarizes energy conservation results and recommends short-term (i.e., 2024 and 2030) and long-term (i.e., 2050) targets for continued energy savings and reductions in greenhouse gas (GHG) emissions. The summary of the 2019 EMP is provided on Pages 3 to 7. The recommendations provided in the EMP are summarized on Page 8.

CORPORATE ENERGY AT A GLANCE

Executive Summary of the
2019 Corporate Energy Management Plan

BASELINE
2013

HOW DID WE USE ENERGY?



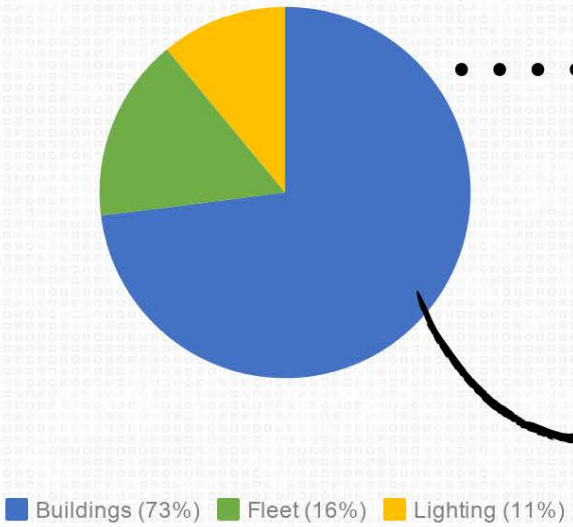
46,427,581 kWh

of electricity used (2013)

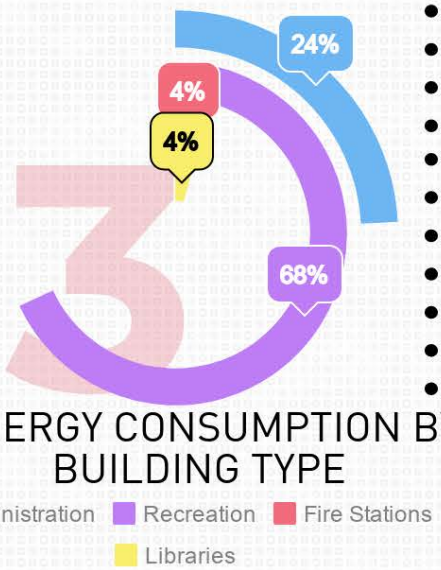
43,228,914 ekWh

of natural gas used (2013)

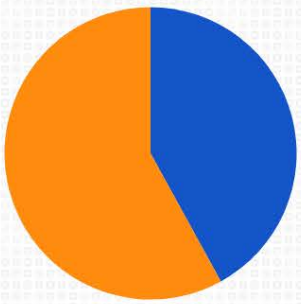
WHERE DID OUR GHG EMISSIONS COME FROM?



ENERGY CONSUMPTION BY BUILDING TYPE



BUILDINGS ENERGY USE BY FUEL TYPE



kWh = kilowatt hours
ekWh = equivalent kilowatt hours
tCO2e = tonnes of carbon dioxide equivalent

VAUGHAN

BASELINE vs. NOW OVERALL

10%

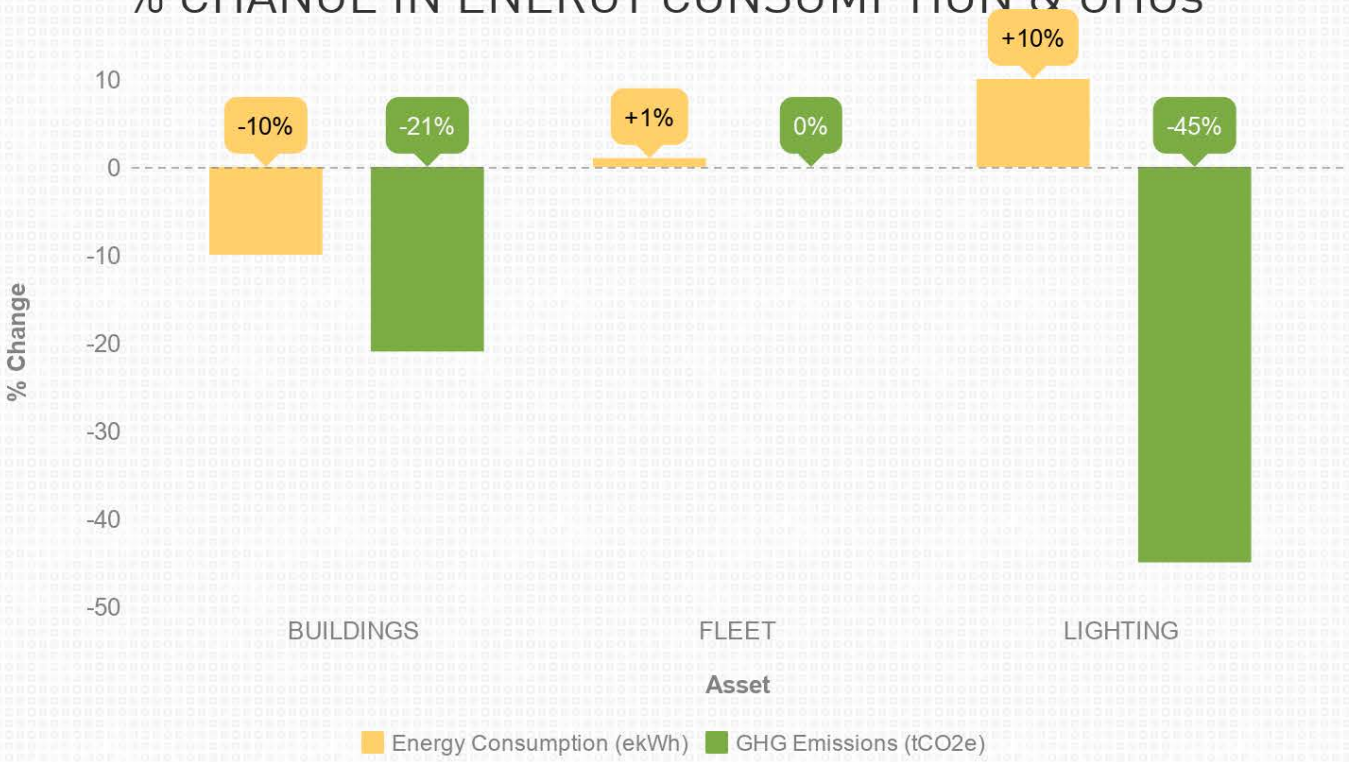
REDUCTION IN
ENERGY CONSUMPTION (ekWh)

20%

REDUCTION IN
GHG EMISSIONS (tCO2e)

2013-2017

% CHANGE IN ENERGY CONSUMPTION & GHGs



VAUGHAN

TARGETS

1. SHORT-TERM
   ENERGY CONSUMPTION & GHG REDUCTION TARGETS FOR FACILITIES TO 2024 & 2030
2. LONG-TERM 2050 TARGET

TARGET FACILITY EUI, BY TYPE:

- ADMIN **20 ekWh/sq.ft**
- FIRE STATION **28 ekWh/sq.ft**
- LIBRARY **19 ekWh/sq.ft**
- CC w POOL **42 ekWh/sq.ft**
- CC w ARENA **28 ekWh/sq.ft**
- CC w POOL & ARENA **35 ekWh/sq.ft**

EUI: Energy Use Intensity in equivalent kilowatt hours per square foot (ekWh/sq.ft.)

HOW?

2024

REDUCE ELECTRICITY CONSUMPTION
▼ 9%
BELOW 2017 LEVELS

REDUCE NATURAL GAS CONSUMPTION
▼ 10%
BELOW 2017 LEVELS

2030

REDUCE ELECTRICITY CONSUMPTION
▼ 14%
BELOW 2017 LEVELS

REDUCE NATURAL GAS CONSUMPTION
▼ 37%
BELOW 2017 LEVELS

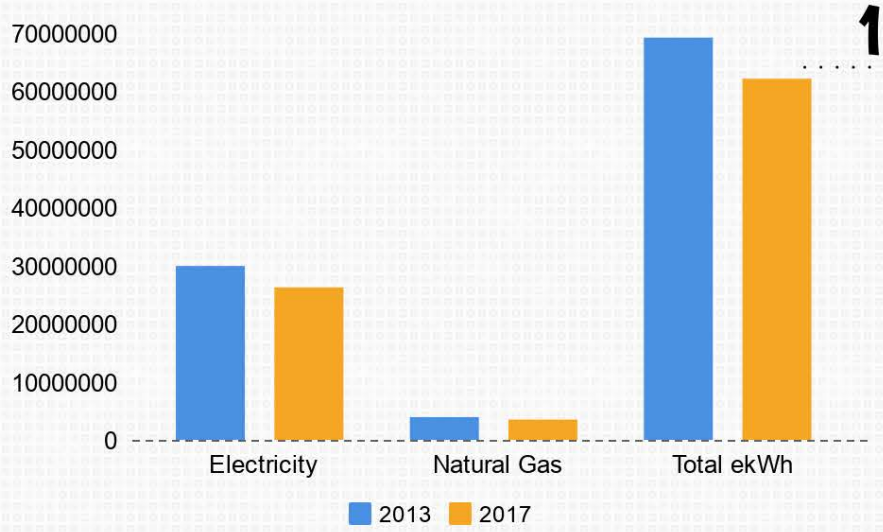
2050

ELIMINATE GHG EMISSIONS ASSOCIATED WITH BUILDING OPERATIONS FOR ALL FACILITIES

VAUGHAN

HOW ENERGY CONSUMPTION HAS CHANGED

BUILDINGS



10% REDUCTION IN TOTAL ekWh

GHG REDUCTION OF **21%**

IN OTHER WORDS...

2013-2017

9%
REDUCTION IN ELECTRICITY CONSUMPTION

$310,000
IN UTILITY COST SAVINGS FROM kWh REDUCTION

THIS INCLUDES 60+ PROJECTS REGISTERED WITH SAVE ON ENERGY POWER WHAT'S NEXT

$750,000
INVESTED IN 60+ RETROFITS

$250,000
IN ANNUAL SAVINGS

$138,000
RECEIVED IN INCENTIVES

LEADING TO

CREATION OF CORPORATE ENERGY FUND IN 2018

VAUGHAN

FLEET

1% INCREASE IN FUEL CONSUMPTION (ekWh) **DUE TO EXPANSION OF FLEET INVENTORY**

2013-2017

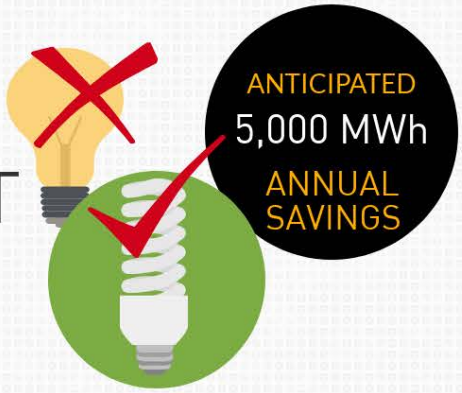
NO CHANGE IN GHG EMISSIONS

1st EV ACQUIRED IN 2018

LIGHTING

CITY-WIDE LED STREETLIGHT RETROFIT

PROJECT BEGINNING 2019



WHAT'S NEXT 2019+

ANNUAL PROGRESS UPDATE on EMP implementation, to be aligned with BPS Reporting

SEE PLAN FOR FULL LIST

6 POLICY Recommendations

5 RETROFIT-related Recommendations

3 ENGAGEMENT Recommendations

List of Recommendations

Corporate Energy Management Plan, 2019 Table A: 2019 EMP Recommendations		
Category	**Action**	**Timeline**
Policies	Join the Mayors' Megawatt Challenge and enter at least two facilities, including City Hall, and report regularly on progress	Immediate
	Ensure maintenance of the Corporate Energy Fund to continue its growth	Immediate
	Assist the Fleet Division with the Green Fleet Strategy update	Short term
	Recommend and implement an updated Energy Management approach to track utility bill data more efficiently	Short term
	Investigate transitioning the existing Corporate Energy Fund into a comprehensive energy account to essentially deposit cost savings and avoided cost from energy conservation measures	Short-medium term
	Explore options to revise and update the City's Corporate Green Building Policy to consider a higher-performance building standard in terms of energy efficiency	Short-medium term
Retrofits	Prepare a Request for Information (RFI) for solar photovoltaic (PV) and battery storage to better understand opportunities the City can pursue	Immediate
	Explore options to utilize the six solar-ready roofs on City Facilities	Short term
	Execute the LED streetlight retrofit project	Short term
	Implement energy conservation measures (ECMs) as identified through Facility Energy Audits	Short term and ongoing in Long term
	Develop individual plans for each Facility to meet their energy consumption and GHG reduction targets	Medium term
Engagement	Pursue LAS Facility Operations training workshops	Immediate
	Involve Facilities staff in all stages of the energy management process; strengthen communication to capitalize on incentive opportunities, make project invoice and savings tracking more efficient, and draw on their knowledge as facility experts to better understand both site-specific problems and solutions	Immediate-Short term
	Initiate a Community Centre Energy Savings Challenge	Short term

1.0 Introduction

1.1 Policy Direction

In 2009, the *Green Energy Act* and its regulation, Ontario Regulation (O. Reg.) 397/11, required broader public sector (BPS) organizations in Ontario, including municipalities, to publicly report on energy consumption and associated greenhouse gas (GHG) emissions annually. The regulation also requires publishing and implementing five-year energy conservation and demand management plans (energy management plans) related to the assets and operations of the organization.

Royal Assent on Bill 34, the *Green Energy Repeal Act* was received on December 6th, 2018. However, certain provisions of the *Green Energy Act*, including O. Reg. 397/11, were retained and reintroduced in the *Electricity Act, 1998* under what is now O. Reg. 507/18. As such, the City of Vaughan continues to report annually on its energy consumption and associated GHG emissions and continues to develop and implement an energy management plan every five years.

An Energy Management Plan (EMP) typically includes:

- Conservation goals and objectives
- Proposed conservation measures
- Cost and savings estimates
- A description of any renewable energy generation facilities, including the amount of energy generated annually

In July 2014, the City of Vaughan submitted and made publicly available its first EMP. The 2014 EMP provided a comprehensive overview of City operations relevant to energy management (e.g., municipal facilities, streetlighting, etc.) and discussed retrofits and conservation measures that could be implemented to reduce energy consumption. The 2014 EMP also described a target to reduce energy consumption by 10% on a per person served basis in equivalent kilowatt hours per square foot (ekWh/ft^2).

The Corporate Energy Management Plan 2019-2004 (the Plan) updates the 2014 EMP in accordance with O. Reg. 507/18. This Plan update provides:

- An update of the energy consumption target
- A GHG emissions reduction target
- An implementation plan to reach the new targets (i.e., identified energy conservation programs and measures)
- Financial implications (i.e., costs and savings associated with implementing measures)

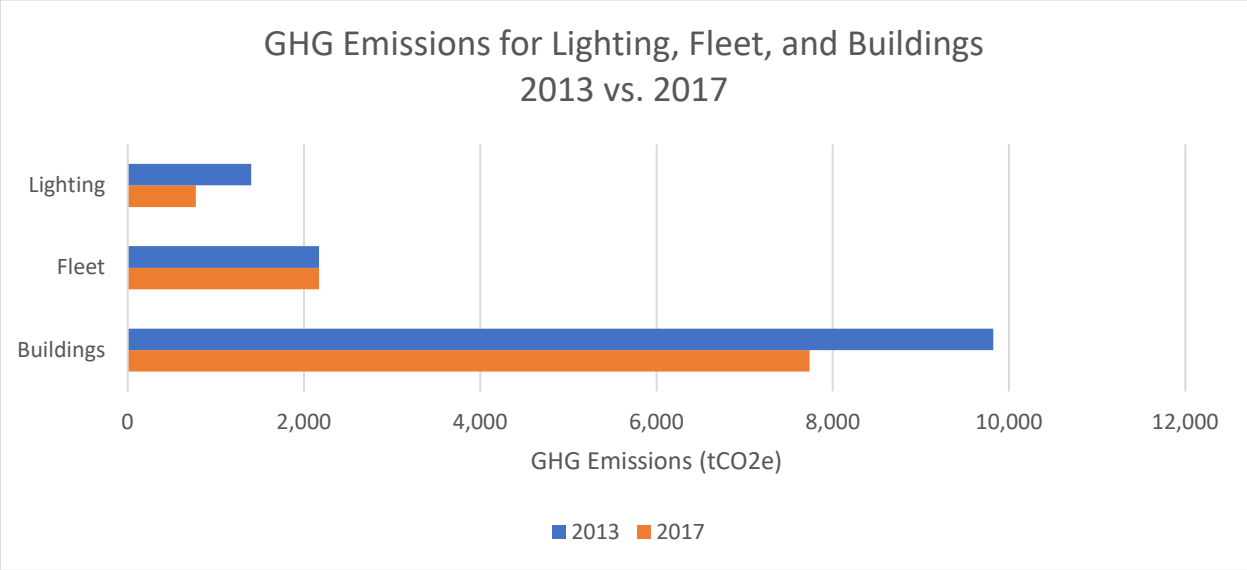
Energy reporting and conservation planning is beneficial because it will help:

- Better manage energy use and costs and demonstrate service excellence for citizens
- Identify best practices and energy-saving opportunities
- Find ways to reduce GHG emissions to contribute to a low-carbon economy
- Evaluate results by comparing similar facilities across the province
- Provide a benchmark to set goals
- Measure improvement over time

1.2 Progress to Date

Since 2012, the City has invested over $750,000 to implement over 60 electricity savings retrofit projects in several facilities and parks through the Save On Energy program. This capital investment of retrofit projects helps to avoid over $250,000 in annual electricity costs and has resulted in the receipt of over $138,000 in incentives from the Provincial Save On Energy program. Overall, electricity consumption has decreased by 2,685,116 kWh (2,685 MWh) from 2013 to 2017 representing an approximate 9% reduction. Figure 1-A below identifies GHG emissions for the three main asset groups considered in this EMP update: lighting, fleet, and buildings.

Figure 1-A: Corporate GHG Emissions by EMP Asset Type, 2013 vs. 2017



A summary of the change in overall energy consumption, in equivalent kilowatt hours (ekWh), for EMP assets from 2013 to 2017 is provided in Table 1 below. More detailed data and analysis on these figures can be found in Section 6.0 of this Plan.

Table 1: How Energy Consumption and GHG Emissions Have Changed 2013 vs. 2017

	Buildings	Fleet	Lighting	Total
Total Energy Consumption (ekWh)	-10.2%	+1%	+10.4%	-10%
GHG Emissions (tonnes CO2e)	-21.2%	0%	-44.8%	-20%

Notes: (-) = % decrease; (+) = % increase
The significant decrease in GHG emissions for Lighting, despite an increase in energy consumption, is due to the change in emission factor for electricity because of the Provincial phase out of coal-fired electricity generation.

In total (i.e. for City buildings, fleet, and lighting) this represents an overall GHG emissions reduction of 20% from 2013-2017.

2.0 Energy and Climate Drivers

UN Sustainable Development Goals

In 2015, the United Nations announced the 2030 Agenda for Sustainable Development, which introduced 17 Sustainable Development Goals (SDGs) and 169 targets. The SDGs build upon the previous Millennium Development Goals (MDGs) and aim to stimulate critical action over a period of 15 years in the three key pillars of sustainable development: economic, social, and environmental.

Governments and private sector corporations are demonstrating alignment with the SDGs. While EMP benchmarking and targets will also be driven by other related urgencies and issues, the EMP is part of the City's contribution towards meeting the following SDGs:

SDG 7 - Affordable and Clean Energy

- By 2030, increase substantially the share of renewable energy in the global energy mix.
- By 2030, double the global rate of improvement in energy efficiency.

SDG 9 – Industry, Innovation, and Infrastructure

- By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes.

SDG 11 – Sustainable Cities and Communities

- By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities.
- By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels.

SDG 12 – Responsible Consumption and Production

- By 2030, achieve the sustainable management and efficient use of natural resources.
- Encourage companies to adopt sustainable practices and to integrate sustainability information into their reporting cycle.

SDG 13 – Climate Action

- Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries.
- Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.

World Council on City Data

The City joined the World Council on City Data (WCCD) in 2011, becoming only the second Canadian city to join at that time. The WCCD provides a global platform for standardized City data and acts as a hub to help strengthen partnerships across cities, international organizations, corporate partners, and academia. Standardized indicators and membership with the WCCD enables the City to assess its performance, measure progress toward the UN SDGs, and draw comparative lessons from other cities both locally and globally.

Energy is a focus of one of the 18 WCCD themes that align with the UN SDGs. While most indicators under the energy theme relate to community energy rather than corporate energy consumption, indicators 7.3 and 7.4 are relevant to the EMP:

- 7.3 Energy consumption of public buildings per year (kWh/m^2)
- 7.4 Percentage of total energy derived from renewable sources, as a share of City's total energy consumption

ISO 50001 – Energy Management System

ISO 50001:2018 provides a framework of requirements for organizations to:

- Develop a policy for more efficient use of energy
- Fix targets and objectives to meet the policy
- Use data to better understand and make decisions about energy use
- Measure the results
- Review how well the policy works
- Continually improve energy management

Like all ISO management system standards, ISO 50001 has been designed for implementation by any organization in the public or private sector, whatever its size, activity or geographical location. ISO 50001 does not fix targets for improving energy performance, which is left up to the user organization or regulatory authorities. This means that any organization, regardless of its current level of energy performance, can implement ISO 50001 to establish a baseline and improve at its own rate.

International and Federal Targets

The 2018 report of the Intergovernmental Panel on Climate Change (IPCC) evaluates climate action needed to avoid a 1.5-degree Celsius increase in global atmospheric temperatures. The 2018 IPCC report calls for immediate and deep climate action: global net anthropogenic carbon dioxide (CO2) emissions must decline by about 45% from 2010 levels by 2030, reaching net-zero around 2050. This target can be interpreted for the purposes of municipal facilities, fleet, and other pertinent assets, described in more detail in Section 7.0 of this Plan.

The United Nations Environment Programme (UNEP) Emissions Gap Report 2018 provides a similar GHG emissions reduction target. It is noted that 2017 global emissions were 53.5 giga tonnes of CO2 equivalents (GtCO2e) and that "global GHG emissions in 2030 need to be approximately 25% and 55% lower than in 2017 to put the world on a least-cost pathway to limiting global warming to 2°C and 1.5°C respectively."

The Canadian federal commitment to the 2015 United Nations Climate Change Conference (COP21) Paris Agreement has a target of 523 MtCO2 by 2030 from projected Business-as-Usual

(BAU) 2030 emissions of 742 Mt. This represents a 30% change from BAU. By contrast, the "Deadline 2020" report of the C40 Cities identifies the need for almost 70% emissions reductions from BAU by 2030 to avoid a 1.5-degree Celsius increase in global temperatures. This is translated to an approximate 25% emissions savings from the 2015 baseline by 2030.

In 2019, Environment and Climate Change Canada (ECCC) released the Canada's Changing Climate Report, the first major report of the current National Assessment.[1] The report found that the average temperature in Canada is 1.7 degrees Celsius higher today than it was 70 years ago, while the average global temperature increased by 0.8 degrees Celsius. Both past and future warming in Canada is, on average, about double the magnitude of global warming. Shortly after the release of this Report, ECCC also released the updated National Inventory Report for 2017, which shows that in 2017, nationally, Canada reduced its GHG emissions by about 2% below 2005 levels.[2]

Provincial Targets

In November 2015, the Ontario Provincial government of the day released a Climate Change Strategy to set the long-term vision to meet GHG reduction targets. These targets were in line with actions taken by other provinces and states, and with global objectives. Ontario committed to reduce GHG emissions by 15% in 2020, 37% in 2030 and 80% in 2050, compared to 1990 levels.

In November 2018, the newly elected Provincial government released the Made-in-Ontario Environment Plan[3] which revised Ontario's GHG targets. Now, Ontario aims to reduce emissions by 30% below 2005 levels by 2030, consistent with the target adopted by the Federal government under the COP21 Paris Agreement.[4] This target is less ambitious than the goal set by the former Provincial government in 2015; setting ambitious GHG emission reduction targets for the 2030 and 2050 horizon provides support for municipalities, businesses, and residents to explore the potential innovation, partnerships and investments needed to build climate-resilient and low-carbon communities.

[1] Environment and Climate Change Canada, Canada's Changing Climate Report, 2019, https://changingclimate.ca/site/assets/uploads/sites/2/2019/03/CCCR_ExecSummary.pdf

[2] Environment and Climate Change Canada, 2019, National Inventory Report: GHG Sources and Sinks in Canada, 2017. https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/sources-sinks-executive-summary-2019.html#toc6

[3] https://prod-environmental-registry.s3.amazonaws.com/2018-11/EnvironmentPlan.pdf

[4] Canada's 2017 Nationally Determined Contribution Submission to the United Nations Framework Convention on Climate Change (UNFCC), 21st Session of the Conference of the Parties (COP21) in Paris, https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Canada%20First/Canada%20First%20NDC-Revised%20submission%202017-05-11.pdf

Partners for Climate Protection

Since 2011, the City has been a member of the Federation of Canadian Municipalities (FCM) Partners for Climate Protection (PCP) program. This is a network of over 180 Canadian municipalities, who have committed to a five-milestone program to reduce both corporate and community emissions. Vaughan's status is summarized in Table 2 below:

Table 2: City of Vaughan PCP Milestone Status

PCP Milestone		City Status (Corporate **&** Community)
1	Create a baseline emissions inventory and forecast	Completed
2	Set emissions reduction targets	Completed
3	Develop a local action Plan	Completed
4	Implement the local action Plan	In progress
5	Monitor progress and report results	Not yet achieved

This EMP will update targets for the City's corporate operations and help inform the next submission to PCP for Milestone 4 recognition, which is scheduled to be submitted in late 2019.

Zero Carbon Buildings

The World Green Building Council's (WorldGBC) Net-Zero Carbon Buildings Commitment calls on businesses, organizations, cities, states, and regions to reach net-zero carbon operating emissions within their portfolios by 2030, and to advocate for all buildings to be net-zero carbon in operation by 2050. The Commitment seeks to recognize and promote advanced climate leadership in decarbonizing the built environment, to inspire others to take similar action, and to remove barriers to implementation. It aims to maximise the chances of limiting global warming to below 2^{o} C and reduce operating emissions from buildings (currently 39% of energy-related global CO_2 emissions).

The Canada Green Building Council (CaGBC) has put forward a Zero-Carbon Building Standard. A zero-carbon building is defined as one that is highly energy-efficient and produces on-site, or procures, carbon-free renewable energy in an amount sufficient to offset the annual carbon emissions associated with operations. There are eight program requirements that apply to new construction and some apply to existing buildings. The Zero-Carbon Building Standard is not a commitment or pledge but reiterates the WorldGBC objective to eliminate GHG emissions associated with the operations of new buildings by 2030 and eliminate GHG emissions from all buildings by 2050.

The City of Toronto Zero Emissions Building Framework identifies a set of energy and GHG emission performance targets. Generally, for the building types assessed (e.g. office commercial, high-rise multi-use residential, low-rise multi-use residential), the annual energy use intensity targets proceed from the current Ontario Building Code interpretation of between 190 to 200 kWh/m^2 (17 to 18 kWh/ft^2) to between 60 to 70 kWh/m^2 (6 to 7 kWh/ft^2) for the described "Tier 4" performance target.

Project Drawdown Solutions

Project Drawdown, a nonprofit organization made up of academics, entrepreneurs, and advocates, is mapping and measuring the potential of solutions to reach 'drawdown.' Drawdown is the point in time when the concentration of atmospheric GHGs begins to decline on an annual basis. Project Drawdown identifies several ranked solutions for climate mitigation. The following select initiatives relate to municipal corporate energy management and are ordered by their rank according to the Drawdown report:

- Refrigerant management and the Kigali Accord (Rank #1)
- Rooftop solar (Rank #10)
- Electric vehicles (Rank #26)
- District heating (Rank #27)
- Alternative cement (Rank #36)
- Solar water (Rank #41)
- Heat pumps (Rank #42)
- LED lighting – commercial (Rank #44)
- Building automation (Rank #45)
- Cogeneration (Rank #50)

3.0 Co-Benefits

3.1 Alignment with City Plans, Policies, and Commitments

To successfully foster a culture of sustainability throughout the City, it is important to demonstrate leadership in sustainability within the Corporation. Effective energy management provides a broad range of co-benefits (see Figure 3-A), including environmental, economic, and broader strategic planning, such as contributing to the goals of the following existing City plans, policies, and commitments:

- Strategic Plan
- Official Plan
- Service Excellence Strategy
- Corporate Asset Management Policy
- Green Directions Vaughan
- Partners for Climate Protection Membership
- World Council on City Data Membership

Green Directions Vaughan (GDV), the City's community sustainability plan, outlines broader sustainability goals and assigns Department-specific actions that contribute to the achievement of these goals. One of the main goals of GDV is "to significantly reduce our use of natural resources and the amount of waste we generate." Under this goal, a main objective is to:

- Reduce GHG emissions and move towards carbon neutrality for the City of Vaughan's facilities and infrastructure.

Beneath this objective are department-specific actions, many of which align with the EMP, and will be identified throughout this document where applicable. The carbon neutrality target outlined above is also taken into consideration when setting targets for the EMP to ensure alignment across City goals.

3.2 Environmental

Reducing energy consumption, improving energy efficiency, and investing in alternative, renewable energy sources all have clear and positive impacts on the environment, which include:

- Mitigating the effects of climate change by reducing GHG emissions
- Conserving limited natural resources
- Improving air quality and protecting ecosystems

3.3 Economic

Reducing energy consumption and finding ways to use energy more efficiently makes financial sense. Investing in energy efficient equipment and retrofits saves more money in the long run. In some instances, the upfront capital cost of an energy efficient technology can be higher; despite this, the savings from the operation over time are far greater and result in much quicker payback. In addition, the life cycle of energy efficient equipment tends to be longer than standard equipment.

Figure 3-A: Co-Benefits of Sustainable Energy Management

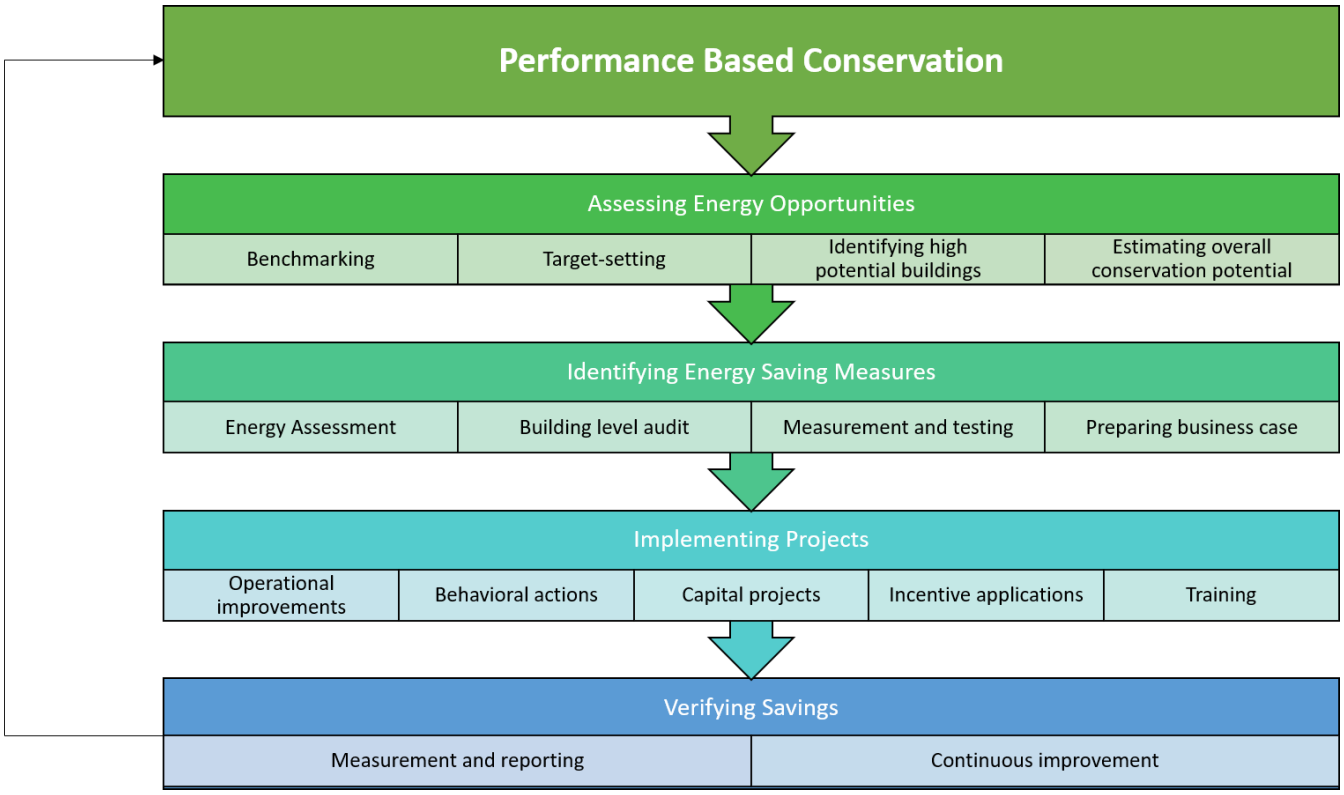
Energy management is a cross-cutting issue that impacts numerous departments and divisions within a corporation. Aside from simply being of concern to Environment/Sustainability teams (e.g., reduced GHG emissions resulting from improved energy efficiency), it is also important for Facilities (improved productivity in buildings), Finance (cost savings, implications for future budgets), Human Resources (improved air quality, health and safety) and Economic Development (fostering innovation and strengthening partnerships).

4.0 Energy Management Approach

This Plan revision emphasizes a performance-based approach to energy conservation and carbon emissions reduction for City infrastructure. This approach relies on categorizing assets (i.e. building types) based on similarity, and then benchmarking data from all the comparable assets to identify those that are most energy efficient (i.e. the top performers) in each category. This then helps form a target for the other assets of the same group to strive towards.

Figure 4-A below, taken from the City of Toronto's corporate energy plan, depicts the performance-based conservation approach. This is an adaptive management framework where lessons learned are incorporated into the work flow, including assessment, identification, implementation and verification of specific actions.

Figure 4-A: Performance Based Conservation [5]



[5] City of Toronto ECDM (2014-2019), Figure 2.

5.0 Plan Development

The first version of the City's EMP, approved in 2014, served as a starting point in the development of this Plan update. Additionally, this Plan is the result of the following research and consultation efforts:

- A jurisdictional scan to determine municipal best practices on key components, baseline and target development, and actions
- Provincial policy review
- Utility data collection and analysis
- Internal departmental consultations
- External consultations with community partners

5.1 Stakeholder Consultation

Multiple City departments and staff, in addition to key external stakeholders, were involved in developing this EMP. They will continue to be instrumental in initiating and implementing the associated energy management initiatives across the organization.

Corporate Energy Team

Effective energy management is a shared responsibility that impacts many divisions and departments within the City. As such, the core Corporate Energy Team is comprised of staff from the following departments and external stakeholders:

- Facility Services
- Financial Planning and Development Finance
- Infrastructure Delivery
- Infrastructure Planning and Corporate Asset Management
- Office of the Chief Information Officer (IT/Data Management)
- Policy Planning and Environmental Sustainability
- Alectra Utilities

Staff from the above departments meet regularly (approximately monthly) to collaboratively discuss and provide updates on ongoing energy retrofit projects, energy management issues such as data tracking, and to identify opportunities and barriers to better formalize and integrate energy management throughout City operations.

The Corporate Energy Team acts as the governing body of the EMP, helping support both the development and implementation of the Plan's goals and actions.

In addition to the Corporate Energy Team, the following internal stakeholders are important to fulfill the goals of the EMP:

Vaughan City Council

City Council, comprised of the Mayor and Councillors, have a crucial role to play in setting the direction for corporate energy and environmental sustainability planning. Demonstrating the City's commitment to environmental sustainability and sustainable development, Council first approved GDV (also undergoing a 2019 update) in 2009 and the first EMP in 2014.

Senior Management Team

The Senior Management Team is responsible for creating the administrative framework and for providing leadership to City staff in the ongoing effort to fulfill the broader goals of the EMP and to support the development and implementation of energy initiatives resulting from the EMP.

IESO, Alectra Utilities, and Enbridge Gas

The Independent Electricity System Operator (IESO) Save on Energy Retrofit Program, served through Alectra Utilities for the City of Vaughan, provides incentives for projects that show sustainable, measurable and verifiable reductions in peak electricity demand and electricity consumption. Project examples include:

- Lighting retrofits
- Chiller replacements
- HVAC upgrades
- Variable-speed drives
- Implementation of new operating procedures required either to obtain or increase the effectiveness of an energy management system or building automation system, including the installation of equipment such as:
    - an energy management system
    - building automation systems
    - sensors
    - control equipment
    - metering equipment
    - related communication systems

Since 2012, the City has registered over 65 energy projects through the Save on Energy program. Alectra Utilities is a key partner and resource when it comes to EMP implementation; not just in terms of incentive programs, but for technical knowledge, support, and ideas sharing.

Similarly, Enbridge Gas also provides opportunities to receive incentives for natural gas saving retrofits. Natural gas saving measures are especially important due to the higher GHG savings potential. Enbridge and Alectra are also key partners in terms of data tracking and ensuring we have accurate and up to date utility bill data.

Municipal Energy Managers Network

Through the Clean Air Partnership (CAP), the City regularly participates and engages in a Municipal Energy Managers Network comprised of Energy Managers from several Greater Toronto and Hamilton Area (GTHA) municipalities. The Municipal Energy Managers group held regular meetings during the Plan's development and was consulted often. The group is a valuable resource to share ideas and advice on all aspects of the Plan, including baselines and targets, key actions, best practices, and lessons learned from previous EMP development.

ClimateWise Business Network

Inspired by the Sustainable Waterloo Region program, the Windfall Ecology Centre established the ClimateWise Business Network in partnership with Green Economy Canada in 2016. ClimateWise is a network of leading businesses and organizations operating in and around York Region who are setting and achieving sustainability goals. This Network allows the City to engage with local businesses and find opportunities to collaborate.

The City of Vaughan, along with Alectra Utilities, Lake Simcoe Region Conservation Authority, and York Region, is a founding member of ClimateWise and participates in their framework for emissions reduction, which is based on the global GHG Protocol standard. The City has aligned the baseline and targets developed for this EMP with its ClimateWise reporting.

5.2 Energy Audits

To help inform the 2014 EMP, the City completed energy audits for 15 facilities in 2013. In preparation for this EMP update, energy audits were also updated, starting in January 2019. The 2019 Level II ASHRAE audits for 30 facilities, including administration buildings, community centers, fire stations, and libraries, identify specific retrofit opportunities and overall strategies to reduce energy consumption and improve energy efficiency in City buildings. These retrofit projects will contribute to the reduction targets outlined in this Plan.

The recommendations of the facility energy audits will be integrated into the EMP. The energy conservation measures detailed in the audits will inform the City's annual budgeting process for capital projects.

6.0 Baseline and Now

6.1 City of Vaughan Energy Profile

An overview and breakdown of City assets that fall within the scope of this EMP is provided in Table 3. City facilities were categorized based on their primary use (e.g. administration, community centre, fire station, library). Community centres (CC) were further broken down by their key energy-using features (e.g. swimming pool, arena, etc.).

Table 3: City of Vaughan – EMP Assets Breakdown

Buildings	**Administration**	City Hall
		Joint Operations Centre
	Community Centres with Pool	Chancellor Community Centre + Library
		Dufferin Clark Community Centre + Library
		North Thornhill Community Centre + Library
		Vellore Village Community Centre + Library
	Community Centres with Arena	Rosemount Community Centre
	Community Centres with Pool and Arena	Al Palladini Community Centre
		Father Ermanno Bulfon Community Centre
		Garnet A. Williams Community Centre
		Maple Community Centre + Library
		Woodbridge Memorial Pool and Arena
	Outdoor Pools	Thornhill Outdoor Pool
	Fire Stations	7-1
		7-2
		7-3
		7-5
		7-6
		7-7
		7-8
		7-9
		7-10
	Libraries (standalone)	Bathurst Clark Library
		Civic Centre Resource Library
		Kleinburg Library
		Pierre Berton Resource Library
		Woodbridge Library
	Miscellaneous	Heritage Buildings
		Sport Buildings
		Senior Clubs
	Work Yards	East District Parks Yard
		Woodbridge Yard
Fleet		
Outdoor Lighting	**Streetlights**	
	Parks	

Utility Costs – Buildings

In 2017, utility costs for buildings were approximately $4,675,744 for electricity, and $1,090,070 for natural gas. Although electricity costs have fluctuated over time (Figure 6-A), overall spending on electricity has increased when comparing 2013 to 2017, despite a reduction in consumption (the red line in Figure 6-B below demonstrates the rising costs of electricity). It should be noted, the data examined only considers the City's major facilities (i.e. administration buildings, community centres, fire stations, and libraries) and that there are some gaps in utility billing data for some community centres (most notably, Rosemount Community Centre).

As shown in Table 6 on page 27, for City buildings as an asset group, electricity use has been reduced by approximately 9%, or 2.7 million kWh, and natural gas use has been reduced by about 11% from 2013-2017. This reduction in electricity use has allowed the City to avoid over $310,000 in annual utility costs.[6]

Figure 6-A: Annual Electricity Costs, 2013-2017

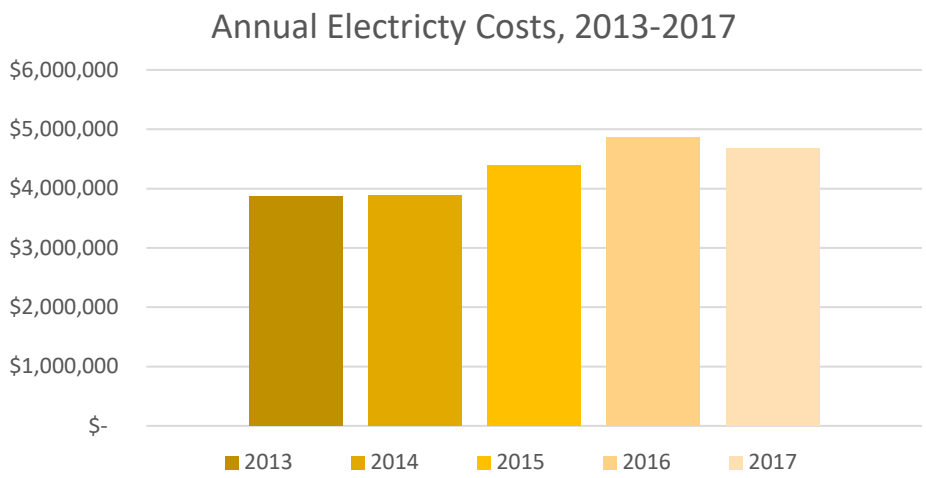
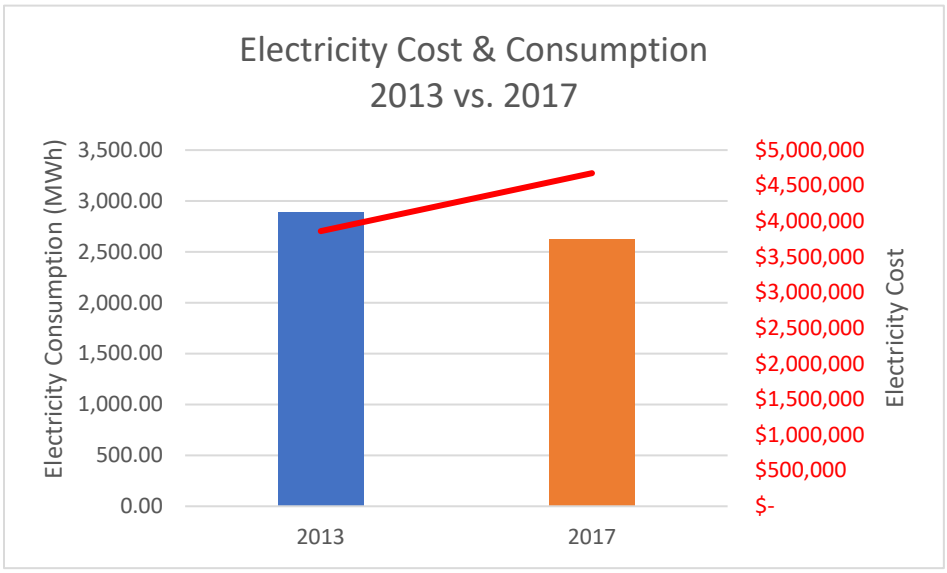


Figure 6-B: Electricity Consumption & Cost, 2013 vs. 2017



[6] Based on the 2017 average IESO Hourly Ontario Energy Price, at $0.1155/kWh

Figure 6-C: Energy Consumption by Asset Type, 2013 vs. 2017

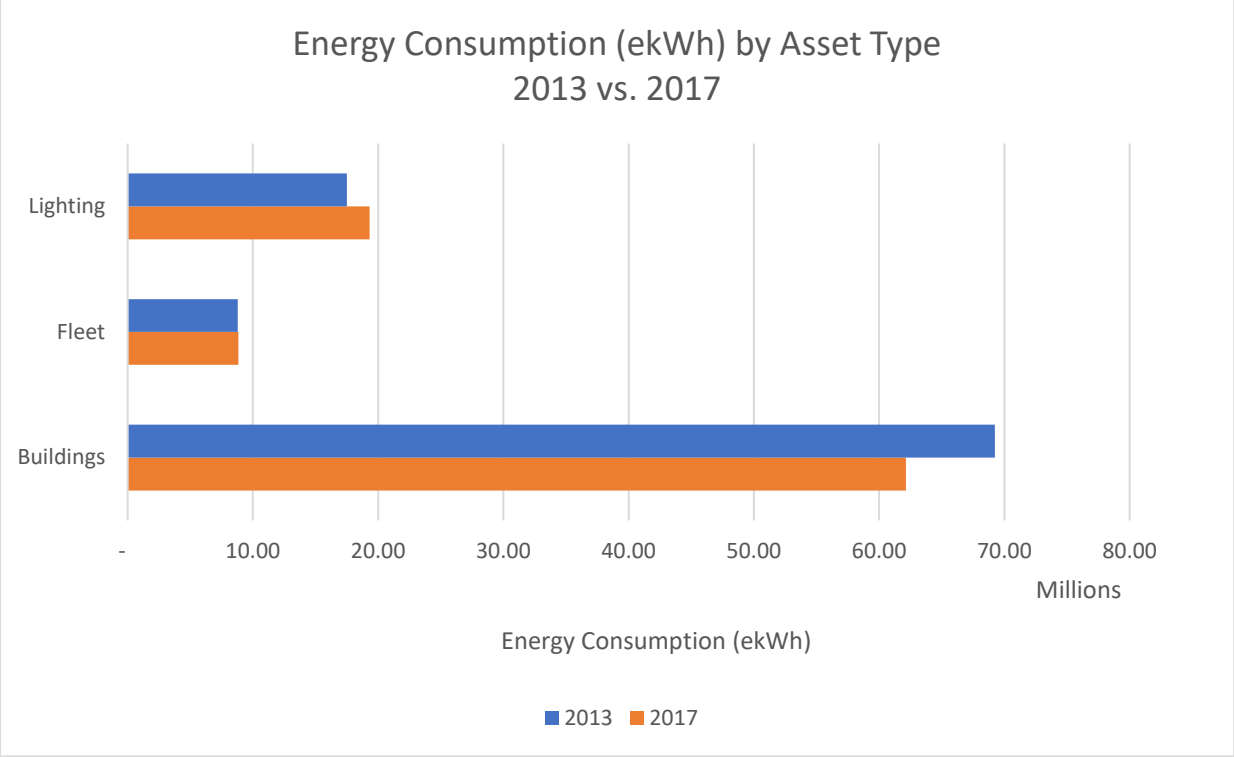
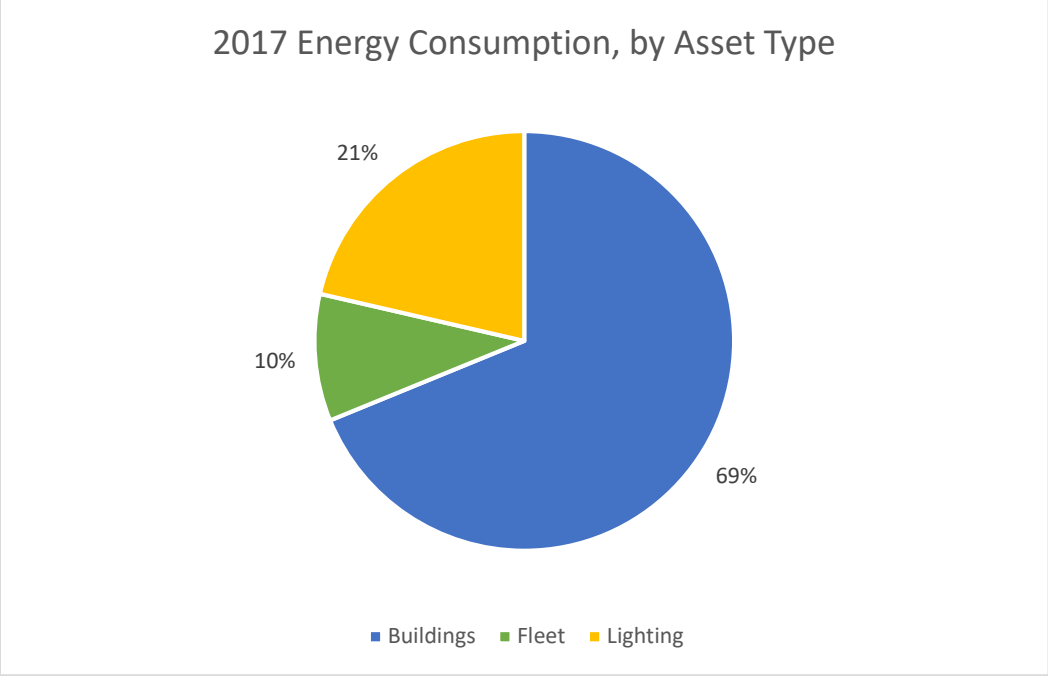


Figure 6-D: 2017 Energy Consumption, by Asset Type



6.1.2 Buildings

For the purposes of this EMP, 77 buildings are considered in the City portfolio, including two administrative buildings, two work yards, 11 community centres/recreation facilities, nine fire stations, five standalone libraries, 19 heritage buildings, six sport buildings, eight seniors' clubs, and 15 miscellaneous buildings. The City also has 15 water/wastewater pumping stations, which are not analyzed in this Plan due to a lack of data.

Baseline: 2013 Buildings Energy Profile

2013 was used as a baseline year for this Plan update, and as shown in Table 4, baseline data was further broken down based on asset class:

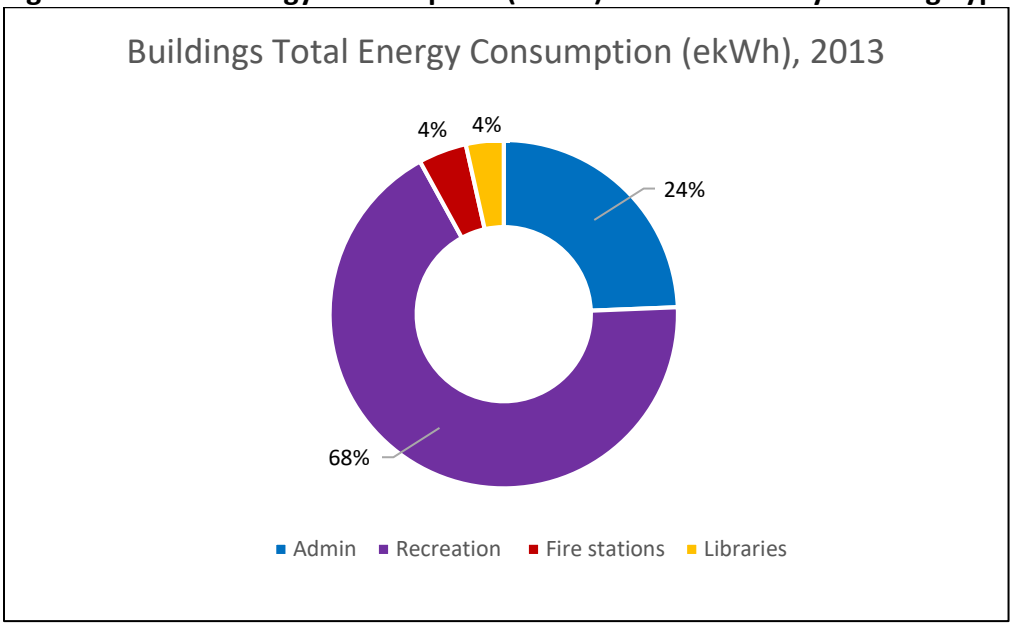
Table 4: 2013 Buildings Energy Profile

Building Type	Total Electricity Consumption (kWh)	Total Natural Gas Consumption (m^3)	Total Energy Consumption (ekWh)	Total GHG Emissions (tCO2e)
Administration	8,573,809.00	806,767.56	16,865,586.70	2230.75
Community Centres with Pool	7,643,818.14	1,522,814.11	23,294,963.16	3,527.47
Community Centres with Pool and Arena	10,345,673.37	1,252,613.37	23,219,755.23	3,226.22
Outdoor Pool	134,210.64	18,335.00	322,653.70	45.85
Fire Stations	852,905.67	218,791.26	3,101,593.62	487.19
Libraries	1,378,576.00	101,977.44	2,426,677.47	305.56
Total	**28,928,992.82**	**3,921,298.74**	**69,231,229.88**	**9,823.04**

* Note: Although listed under assets in Table 3, due to incomplete consumption data, Rosemount CC and the Work Yards are not included in analysis under Tables 4 and 5.

Full baseline data for each individual building, including Energy Use Intensity (EUI) for each building, can be found in Appendix B and is summarized in Figure 6-E.

Figure 6-E: 2013 Energy Consumption (ekWh) – Breakdown by Building Type



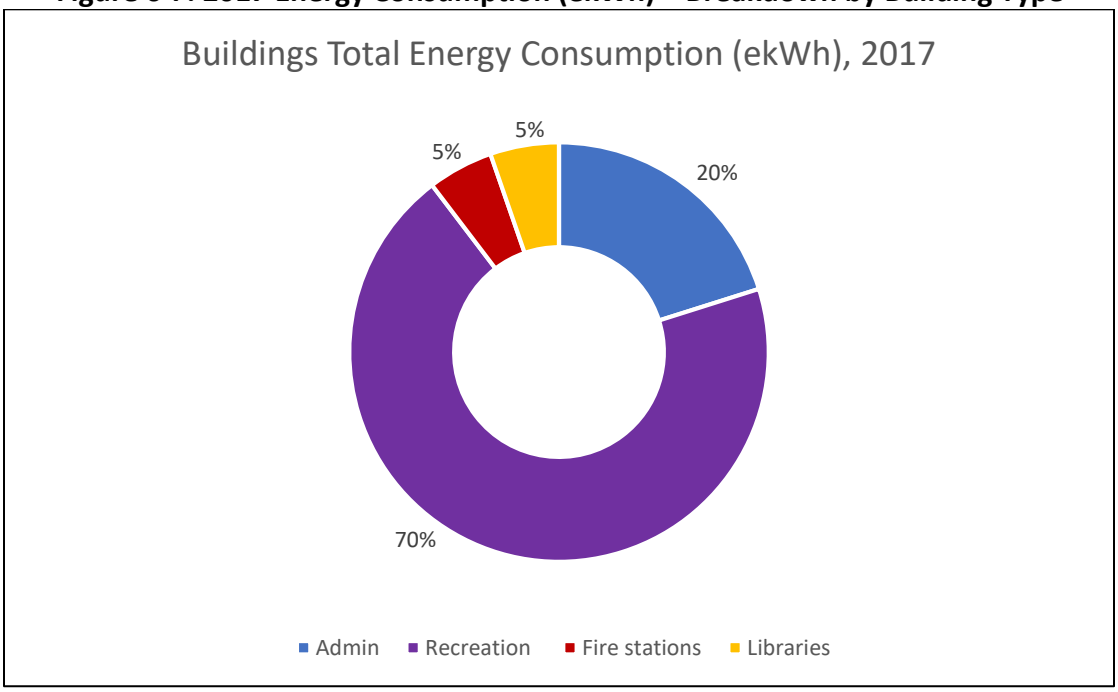
2017 Buildings Energy Profile

The year 2017 consists of the most recent and complete utility data set. For this reason, 2017 data (shown in Table 5) represents the most recent reference year ("now") in comparison to the 2013 baseline. Figure 6-F provides the breakdown of energy consumption by facility type for 2017.

Table 5: 2017 Buildings Energy Profile

Building Type	Total Electricity Consumption (kWh)	Total Natural Gas Consumption (m3)	Total Energy Consumption (ekWh)	Total GHG Emissions (tCO2e)
Administration	6,811,786.00	574,915.87	12,720,643.55	1,373.35
Community Centres with Pool	7,652,077.47	1,336,763.53	21,982,244.58	2,865.79
Community Centres with Pool and Arena	9,138,731.00	1,187,228.34	21,340,800.05	2,638.92
Outdoor Pool	122,127.00	20,887.12	336,800.18	44.88
Fire Stations	808,940.00	231,535.08	3,188,606.10	475.71
Libraries	1,710,215.34	141,682.85	3,166,400.19	339.71
Total	**26,243,876.81**	**3,493,012.79**	**62,144,286.04**	**7,738.36**

Figure 6-F: 2017 Energy Consumption (ekWh) – Breakdown by Building Type



Comparing Figures 6-E and 6-F, energy use amongst buildings has not changed significantly based on building type – recreation facilities continue to use the majority (70%) of energy compared to other building types. Administration buildings are next, accounting for approximately 20%, and fire stations and libraries account for 5% each.

Changes can be noted, however, comparing 2013 to 2017 total energy consumption and GHG emissions based on building type. Since 2013, total energy use of City buildings (including both

electricity and natural gas, in ekWh) has decreased by approximately 10% (see Figure 6-G and Table 6 below). Community centres and administration buildings also demonstrate reduced GHG emissions, whereas libraries, fire stations, and the City's outdoor pool facility show an increase in GHG emissions during the same period (see Figure 6-H below). In the 2013 to 2017 period, the City added one library (Civic Centre Resource Library) and one fire station to the portfolio of buildings, in addition to several expansions at existing community centres. GHG emissions from buildings overall have decreased by 21% from 2013-2017.

Some of the energy savings is attributed to a decrease in heating degree days (HDD) from 3,881 in 2013 to 3,528 in 2017.[7] This accounts for some of the 11% decrease in natural gas use in City buildings. However, most of the energy savings is attributed to building improvements such as Building Automation Systems (BAS) upgrades, LED lighting retrofits, HVAC replacements and other retrofits targeting electricity conservation. The upgrades have helped achieve electricity savings of about 2,685,000 kWh (2,685 MWh), or a 9% savings between 2013 and 2017.

Figure 6-G: Buildings Energy Consumption, 2013 vs. 2017

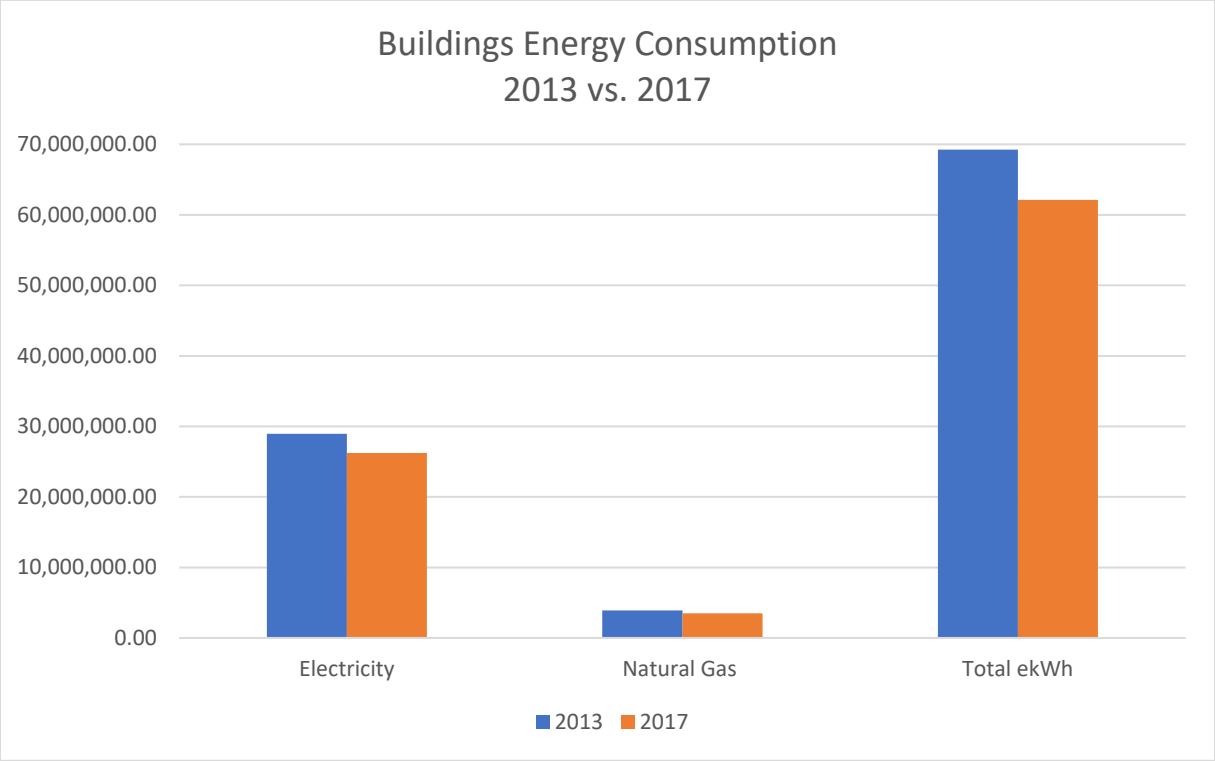
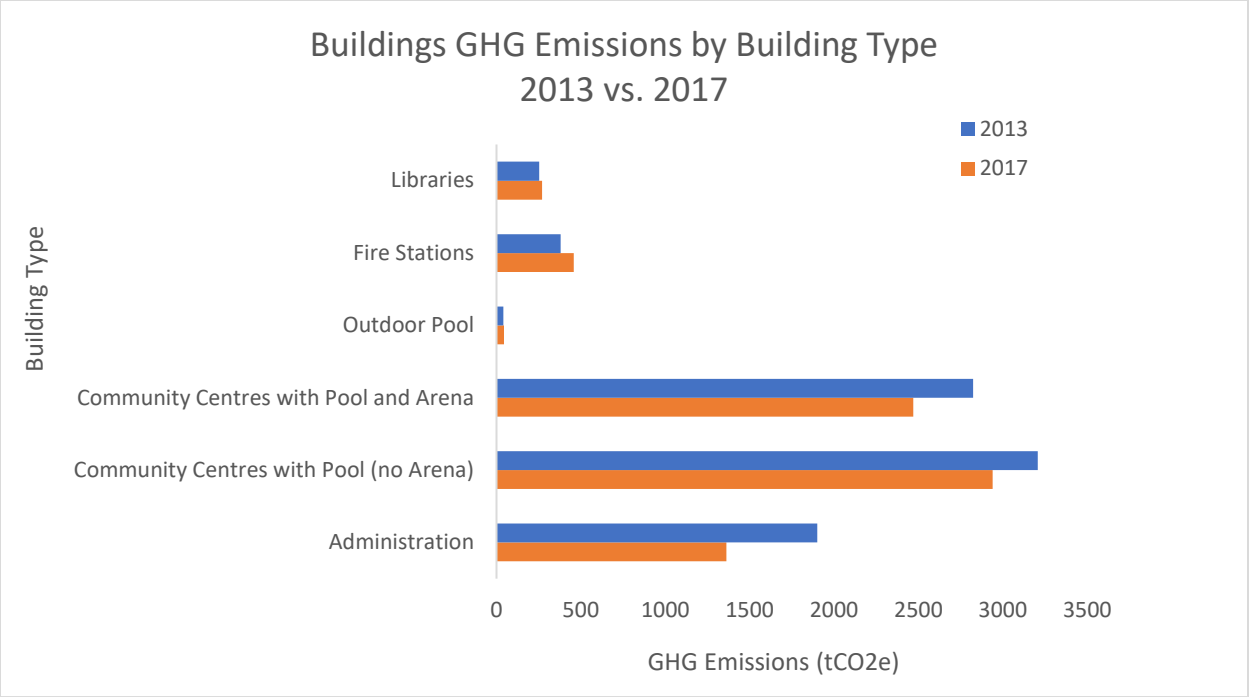


Table 6: Buildings Energy Consumption, 2013 vs. 2017			
	2013	**2017**	**% Change**
Electricity (kWh)	28,928,992.82	26,243,876.81	-9.3
Natural Gas (m^3)	3,921,298.74	3,493,012.79	-10.9
Total ekWh	69,231,229.87	62,144,286.04	-10.2

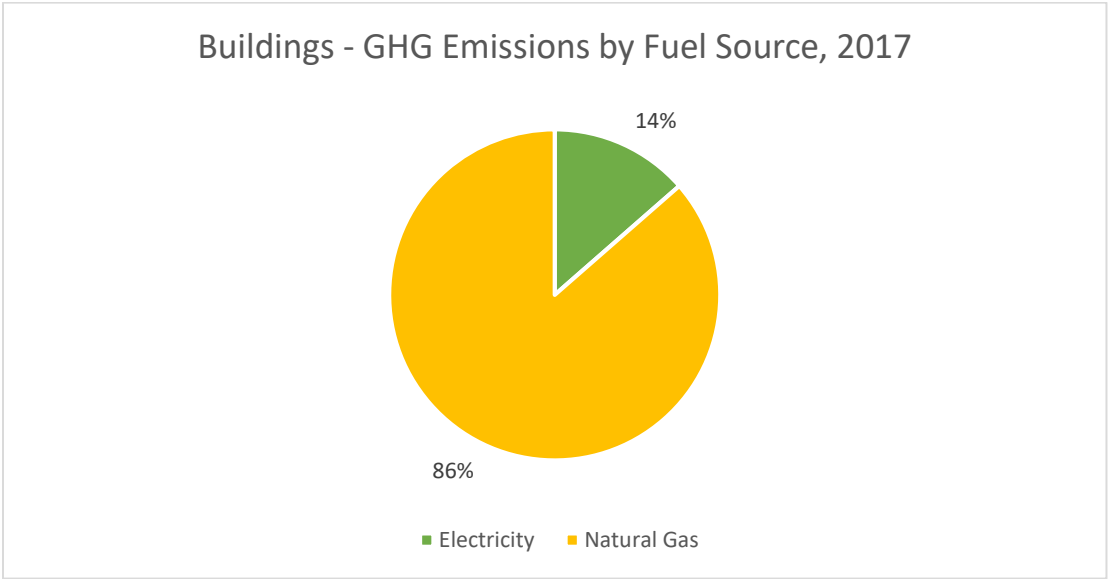
Figure 6-H: Buildings GHG Emissions, Breakdown by Building Type, 2013 vs. 2017

[7] Source: https://www.weatherdatadepot.com/



As seen in Table 6, in 2017, buildings used 26,243,877 kWh of electricity in comparison to 3,493,013 m^3, or 35,900,409 ekWh, of natural gas. Due to the increased impact on GHG emissions from natural gas (see Figure 6-I), as well as the fact that when compared in ekWh, natural gas consumption is over 4,000,000 ekWh higher than electricity consumption, it is critical to achieve savings in natural gas use to achieve the short and long-term savings targets outlined in this EMP.

Figure 6-I: Buildings GHG Emissions by Fuel Source, 2017



6.1.3 Fleet

The City's Corporate Fleet consists of a total of 373 vehicles as of 2018. This includes vehicles used by the Fire and Rescue Service that are not actively managed by the Fleet Management Services department. A breakdown of vehicle types and quantities is provided in Table 7:

Table 7: City of Vaughan Corporate Fleet Inventory, 2018

Vehicle Type	Cars	Electric Vehicles	SUVs	Vans	Dump Trucks	Pick-up Trucks	Utility Trucks	Fire Vehicles	Other
Quantity in Fleet	2	1	39	48	31	163	6	66	17

In 2018, the City added its first electric vehicle (EV), a Nissan Leaf, into its corporate Fleet and at this time has five EV charging stations. These stations include one (dual wand) at City Hall, two (single wand) at the Civic Centre Resource Library, and two (dual wand) at the Joint Operations Centre. Table 8 below shows how the City's Fleet inventory has changed from 2013 to 2017.

Table 8: Fleet Inventory by Fuel Type, 2013 vs. 2017

Year	Number of Vehicles		
	Diesel	Gas	Electric
2013	184	507	0
2017	177	516	0

It should be noted that this EMP supports the sustainability action in Green Directions Vaughan to "update and implement the 'Green Fleet Strategy' to optimize fleet use and vehicle type, identify fuel switching for low carbon mobility and minimize environmental impacts." There is a need to revise the City's Green Fleet Strategy and to further explore and implement low-carbon options for Corporate Fleet. This can include procuring more EVs and alternative-fuel vehicles, expanding upon and improving EV charging infrastructure both for City staff and the wider community, and exploring the development of GHG emissions reduction targets specifically for Fleet.

Table 9 below shows the 2013 (baseline) and 2017 fuel consumption data for the Corporate Fleet; between this time, Fleet increased its fuel consumption by approximately 1%, and saw no reduction in GHG emissions. Figure 6-J below shows that Fleet vehicles accounted for approximately 20% of the City's GHG emissions in 2017. Opportunities for significant GHG reductions will be targeted through the revision of the Green Fleet Strategy, to be led by Fleet Management Services.

Table 9: Fleet Fuel Consumption & GHG Emissions, 2013 vs. 2017

Year	Diesel Consumption (L)	Gasoline Consumption (L)	Total Fuel Consumption (ekWh)	GHG Emissions (tCO2e)
2013	351,457.00	519,877.00	**8,781,063.69**	**2,172.32**
2017	305,598.00	577,374.00	**8,842,234.14**	**2,172.45**

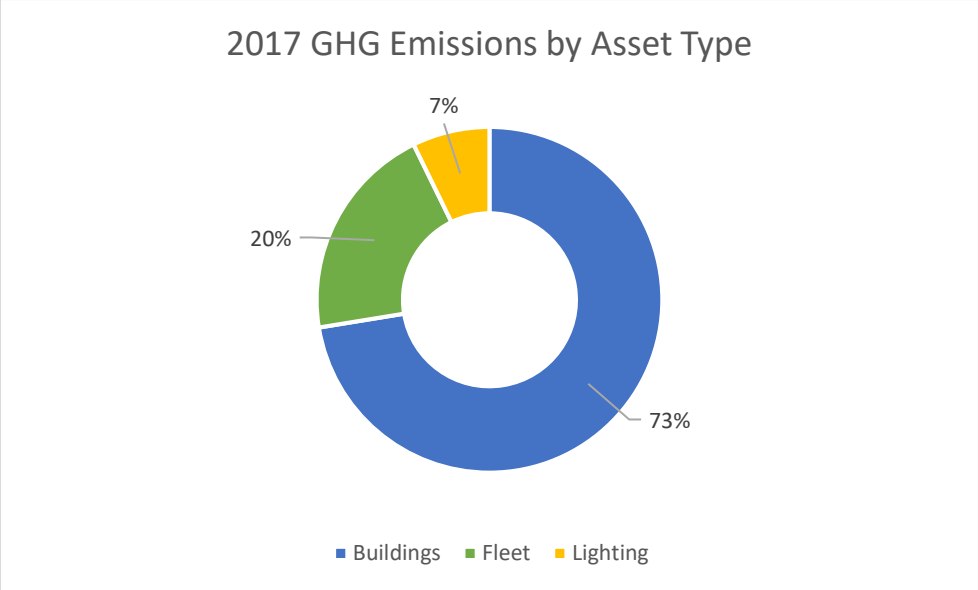
6.1.4 Lighting

Table 10: Lighting Electricity Consumption & GHG Emissions, 2013 vs. 2017				
Year	**Parks Lighting (kWh)**	**Streetlights (kWh)**	**Total Electricity (kWh)**	**Total GHG Emissions (tCO2e)**
2013	77,975	17,420,613	17,498,588.00	1,399.89
2017	643,469	18,675,555	19,319,024.00	772.76

In 2013, outdoor lighting (including parks lighting and streetlights) consumed a total of 17,498,587 kWh, compared to 19,319,024 kWh in 2017, representing an increase in consumption of about 10%. Lighting accounted for approximately 7% of the City's GHG emissions in 2017, as shown in Figure 6-J below. It should be noted that due to challenges with data tracking, there are gaps in the outdoor lighting consumption data. The 2013 data considers a smaller inventory of lighting (i.e., 2013 energy consumption includes lighting in only five parks) whereas 2017 energy consumption data for lighting includes 11 parks. The 2017 data is not a full and accurate dataset.

As identified in Table 10 above, the significant decrease in GHG emissions for outdoor lighting, despite an increase in energy consumption, is due to the change in emission factor for electricity. The Provincial phase out of coal-fired electricity generation was completed in 2014, and electricity consumption and generation from 2014 onwards is less carbon-intensive than pre-2014.

Figure 6-J: 2017 GHG Emissions (tCO2e), as a Percentage, by Asset Type



Streetlight Retrofit

A city-wide LED Streetlight Retrofit project, commencing in 2019, will retrofit approximately 20,000 existing high-pressure sodium (HPS) streetlights to LED. Upon completion, this will result in annual energy savings of approximately 5,000 MWh, equivalent to the average annual electricity use of approximately 550 Ontario homes.

7.0 Targets

7.1 Long-Term Targets

Long-term energy and GHG emissions targets are based on the CaGBC Zero-Carbon Building Standard to eliminate GHG emissions associated with the operations of new buildings by 2030 and eliminate GHG emissions from all buildings by 2050. For the purposes of this report, the long-term GHG reduction target is interpreted as follows:

- **Eliminate GHG emissions associated with the operations of buildings by 2050 for all City facilities.**

This target aligns with the GDV target to reduce GHG emissions and move towards carbon neutrality for the City of Vaughan's facilities and infrastructure. Specific actions to achieve the long-term target are not described in detail in this Plan. Technology and costs will change over this time horizon. However, the types of GHG emissions reduction actions to explore will include high-performance building envelopes, fuel switching from natural gas to electricity use, on-site renewable energy generation, thermal energy networks, geothermal heating and cooling, and forms of energy storage and microgrids.

7.2 Short-term Targets

The Mayors' Megawatt Challenge provides an approach to set short-term energy and GHG emissions reduction targets to 2024 and 2030 based on best practices review and benchmarking (TRCA and Enerlife Consulting 2016). Public reporting of building energy use in Ontario to the Broader Public Sector (BPS) registry offers a database for benchmarking by comparing the City's portfolio of buildings to the most efficient buildings of similar typology.

7.2.1 Energy Intensity Targets - Benchmarking to the Top Quartile of Public Buildings

A sample of energy consumption reporting of BPS facilities in southern Ontario was used to inform the energy intensity targets for City facilities. Weather normalization is not required as the facilities are in the same general climatic conditions. The energy targets derived from the top quartile of sampled buildings using this approach are described in more detail in Appendix C and listed below as follows:

- 20.0 ekWh/ft^2 for Administration buildings[8]
- 21.8 ekWh/ft^2 for Community Centres (without a pool or arena)[9]
- 42.0 ekWh/ft^2 for Community Centres with a pool[10]
- 27.9 ekWh/ft^2 for Community Centres with an arena, or a stand-alone arena[11]
- 35.0 ekWh/ft^2 for Community Centres with a pool and arena[12]
- 27.5 ekWh/ft^2 for Fire Stations[13]
- 19.4 ekWh/ft^2 for Libraries[14]

[8] based on the TRCA and Enerlife 2015 report for the Mayors' Megawatt Challenge

[9] based on the 2016 TRCA and Enerlife report for Mayors' Megawatt Challenge

[10] based on a sample of 15 facilities

[11] based on a sample of 28 facilities

[12] based on a sample of 18 facilities

[13] based on a sample of 60 facilities

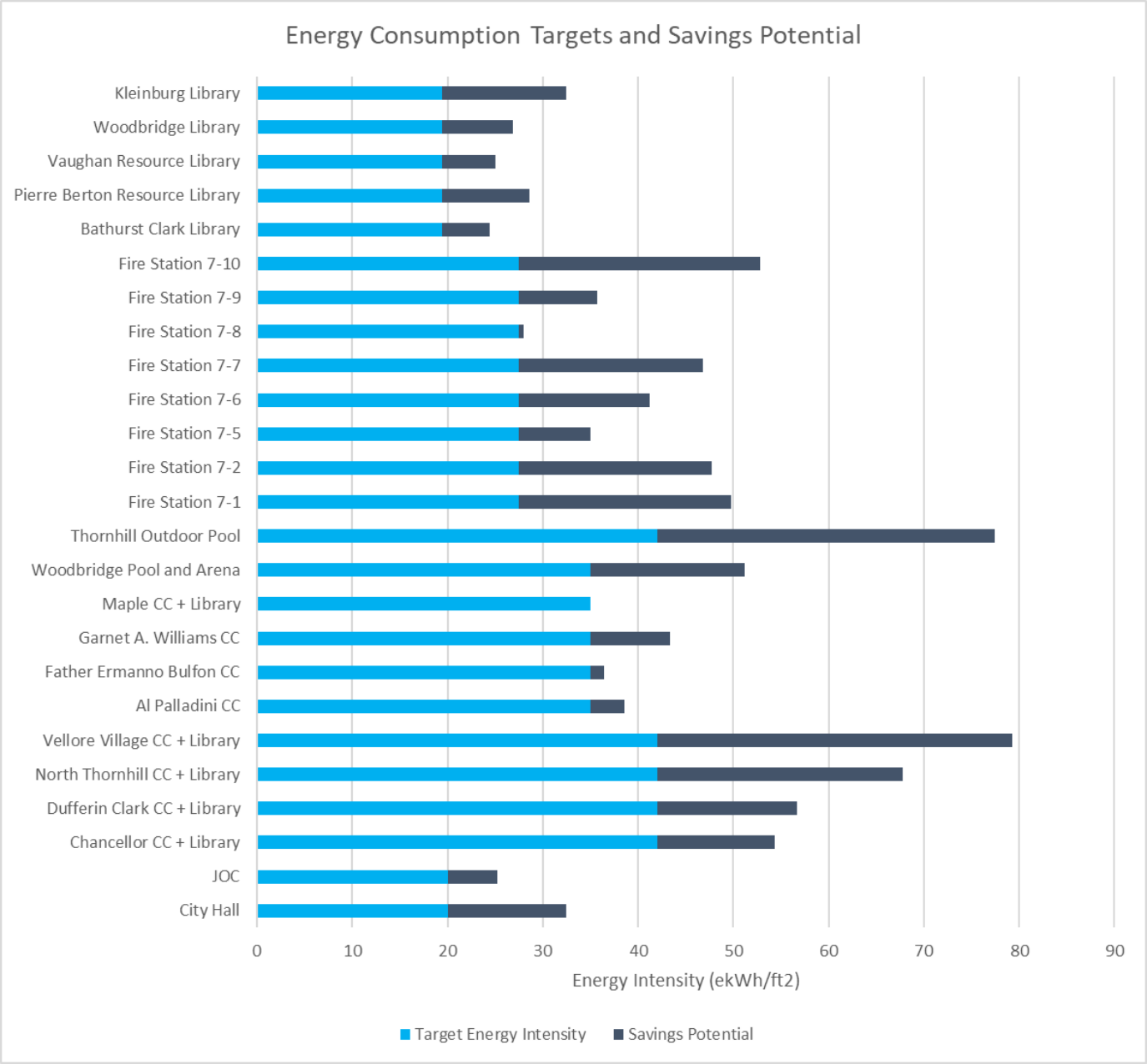
[14] based on a sample of 40 facilities

7.2.2 Savings Potential to Short-term Energy Intensity Targets

The savings potential can be determined by calculating the actual energy intensity of City facilities less the target energy intensity derived from the best practices approach. The facility energy audits will inform the specific actions that can be taken to achieve the energy efficiency targets.

Considering the actual energy consumption for 2017, some facilities are already operating at or below the target energy intensity (Figure 7-A). In these cases, energy savings will be pursued through ongoing improvement to operations as well as optimizing energy and water savings opportunities through regular life cycle equipment replacement.

Figure 7-A: Energy Consumption Targets and Savings Potential of City Facilities



7.2.3 2024 Savings Targets and Potential GHG Reductions for Facilities

The City's facilities account for 73% of corporate GHG emissions and about 7,700 tonnes CO2e per year as of 2017. Since some facilities are already operating at the benchmark for electricity consumption, limiting the natural gas savings to 10% of the 2017 consumption by 2024 results in an overall GHG emissions potential that is less than 10% of GHG emissions from facilities in 2017. The opportunity to exceed this savings potential will need to be explored through the findings of the 2019 facility energy audits. Table 11 below shows the 2024 targets by facility.

Table 11: 2024 Savings Targets for Natural Gas and Electricity and GHG Reductions

	Natural Gas Savings Targets in Comparison to 2017 Consumption			Electricity Savings Targets in Comparison to 2017 Consumption		
Facility	Savings (m^3)	% of 2017 Consumption	GHG Reduction (tCO2e)	Savings (kWh)	% of 2017 Consumption	GHG Reduction (tCO2e)
City Hall	44,768.52	10%	85.73	516,128.65	9%	20.65
JOC	12,723.07	10%	24.36			
Chancellor CC + Library	20,476.11	10%	39.21	23,182.90	2%	0.93
Dufferin Clark CC + Library	31,327.33	10%	59.99			
North Thornhill CC + Library	42,671.72	12%	81.72	528,497.58	20%	21.14
Vellore Village CC + Library	44,953.50	10%	86.09	465,901.32	20%	18.64
Al Palladini CC	23,367.30	9%	44.75	248,190.19	9%	10.67
Fr Ermanno Bulfon CC	21,111.48	13%	40.43	77,494.20	9%	3.33
Garnet A. Williams CC	31,220.44	10%	59.79			
Maple CC + Library	24,112.29	9%	46.18	204,389.00	9%	8.79
Woodbridge Pool and Arena	15,007.69	8%	28.74			
Thornhill Outdoor Pool	2,092.09	10%	4.01	11,311.60	9%	0.45
Fire Hall 7-1	2,915.30	8%	5.58	3,992.60	4%	0.16
Fire Hall 7-2	3,135.60	10%	6.00	12,677.00	9%	0.51
Fire Hall 7-5	1,809.30	10%	3.46			
Fire Hall 7-6	1,688.50	9%	3.23			
Fire Hall 7-7	1,710.70	7%	3.28	3,912.20	5%	0.16
Fire Hall 7-8	74.54	0.3%	0.14			
Fire Hall 7-9	2,853.10	8%	5.46			
Fire Hall 7-10	2,079.80	7%	3.98			
Bathurst Clark Library	3,723.70	11%	7.13	51,529.02	10%	2.06
Pierre Berton Library	4,315.21	10%	8.26	50,157.62	10%	2.01
Vaughan Resource Library	5,187.65	10%	9.93			
Woodbridge Library				26,532.11	10%	1.06
Kleinburg Library	1,307.40	12%	2.5	5,831.90	8%	0.23
TOTALS	344,632		660	2,229,728		91

7.2.4 2030 Savings Targets and Potential GHG Reductions for Facilities

Limiting the natural gas savings to 10% of the 2017 consumption by 2024 shifts most of the effort for GHG emissions reduction to the time period between 2024 and 2030. The estimated GHG reduction for 2030 is about 1,800 tonnes CO2e, compared to 650 tonnes CO2e by 2024. For some facilities, the required natural gas savings in the 2024 to 2030 time period represents over 40% of the 2017 annual consumption and is on average about 24% of the 2017 consumption for all facilities. Table 12 below shows the 2030 targets by facility.

The short-term energy savings and GHG reduction targets to 2024 and 2030 will be revised based on the findings of the facility energy audits to shift more of the energy savings, and cost savings, to the 2024 time period where feasible.

Table 12: 2030 Savings Targets for Natural Gas and Electricity and GHG Reductions

	Natural Gas Savings Targets in Comparison to 2017 Actual Consumption			Electricity Savings Targets in Comparison to 2017 Actual Consumption		
Facility	Savings (m^3)	% of 2017 Consumption	GHG Reduction (tCO2e)	Savings (kWh)	% of 2017 Consumption	GHG Reduction (tCO2e)
City Hall	188,824.99	42%	361.6	558,724.85	10%	22.35
JOC	46,306.17	36%	88.68			
Chancellor CC + Library	49,167.93	24%	94.16			
Dufferin Clark CC + Library	94,044.82	30%	180.1			
North Thornhill CC + Library	170,447.89	46%	326.41	317,828.84	12%	12.71
Vellore Village CC + Library	207,579.95	46%	397.52	207,001.38	9%	8.28
Al Palladini CC						
Fr Ermanno Bulfon CC	1,961.32	1%	17.23			
Garnet A. Williams CC	64,938.19	21%	124.36			
Maple CC + Library						
Woodbridge Pool and Arena	38,791.62	21%	74.29			
Thornhill Outdoor Pool	9,054.12	43%	17.34	19,608.30	16%	0.78
Fire Hall 7-1	10,094.61	29%	19.33			
Fire Hall 7-2	10,903.46	34%	20.88	18,640.20	13%	35.04
Fire Hall 7-5	3,009.06	16%	5.76			
Fire Hall 7-6	4,360.13	23%	8.35			
Fire Hall 7-7	3,791.88	16%	7.26			
Fire Hall 7-8						
Fire Hall 7-9	2,019.71	6%	3.87			
Fire Hall 7-10	6,121.05	20%	11.72			
Bathurst Clark Library	3,139.67	9%	6.01	79,823.81	15%	150.07
Pierre Berton Library	10,901.14	25%	20.88	98,297.19	20%	184.8
Vaughan Resource Library	16,565.74	32%	31.72			
Woodbridge Library				129,670.38	49%	243.78
Kleinburg Library	7,032.20	65%	13.47			
TOTALS	949,056		1,831	1,429,595		658

7.3 General Recommendations for Conservation Action

A consideration of energy consumption by end use provides general guidance to prioritize energy conservation actions. The energy breakdown shown in Figure 7-B and Figure 7-C are provided in the Ontario Municipal Energy Profile Report (ICF Canada, 2018) prepared for the IESO. The detailed facility energy audits characterize process energy loads and will differ from the general end use breakdown provided by the IESO.

Figure 7-B: Municipal Electricity End Use Breakdown, 2014[15]

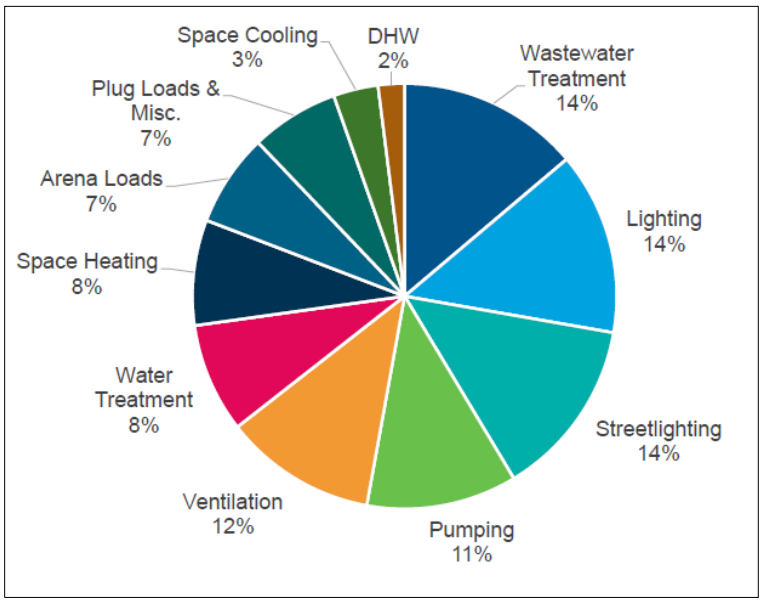
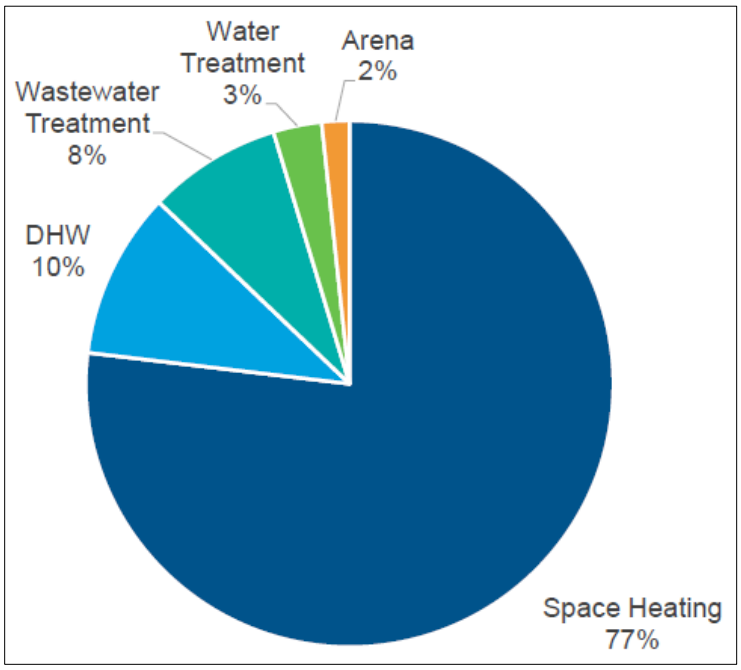


Figure 7-C: Municipal Natural Gas End Use Breakdown, 2014[16]



[15] ICF Canada, 2018. Ontario Municipal Energy Profile Report. http://www.ieso.ca/en/sector-participants/conservation-delivery-and-tools/conservation-e-blasts/2018/05/municipal-energy-profile-report

[16] ICF Canada, 2018.

The following general recommendations follow from the assessment of energy end use, and will be finalized upon completion of the facility energy audits in 2019:

i. Completing the LED streetlight retrofit program and continuing facility LED retrofits; both are supported by the end use breakdown (28% of electricity consumption).

ii. Addressing energy loads for ventilation (12% of electricity consumption) should be considered as a higher priority. Conservation measures addressing ventilation energy use could include verifying that operating periods of ventilation systems are optimized in the BAS, testing and tuning mechanical units, improving make-up air units and possible use of energy-efficient ceiling fans.

iii. Reducing energy loads for space heating is complicated by the need to consider fuel-switching to air source heat pumps, where feasible, to reduce GHG emissions. Significant improvements are required to building envelopes to achieve long-term energy and GHG emission targets, and reduce energy loads sufficiently to switch to air source heat pumps and other electricity-driven mechanical equipment. In the short-term, in addition to ongoing upgrades to high efficiency equipment for heating systems, improving sealing for window and wall assemblies, heat recovery units, and solar heating installations can address space heating savings.

8.0 Implementation Plan

8.1 Financial Framework

8.1.1 Corporate Energy Fund

In 2018, the City recognized and acted on the need for a Corporate Energy Fund to financially support and implement energy retrofit projects. Initial steps undertaken to establish the Fund included conducting a municipal scan to research the approach of other municipalities, and partnering with relevant internal stakeholders, including the Finance and Facility Services teams.

At this time, the City's Corporate Energy Fund is financed primarily through utility incentives from the IESO's Save on Energy program, and any incentives received from other sources like Enbridge Gas can be directed into the Fund as well.

The City will investigate transitioning the existing Corporate Energy Fund into a comprehensive energy account to essentially deposit cost savings and avoided cost from energy conservation measures. The benefits contributing to the business case for an energy account include:

- Supporting conservation measures that have a longer return on investment
- Promoting accountability and transparency (measurement and verification of energy and cost savings from conservation actions are critical documentation for the energy account)
- Improving financial reporting by demonstrating results from investments
- Improving likelihood of securing external funding by demonstrating leadership and results

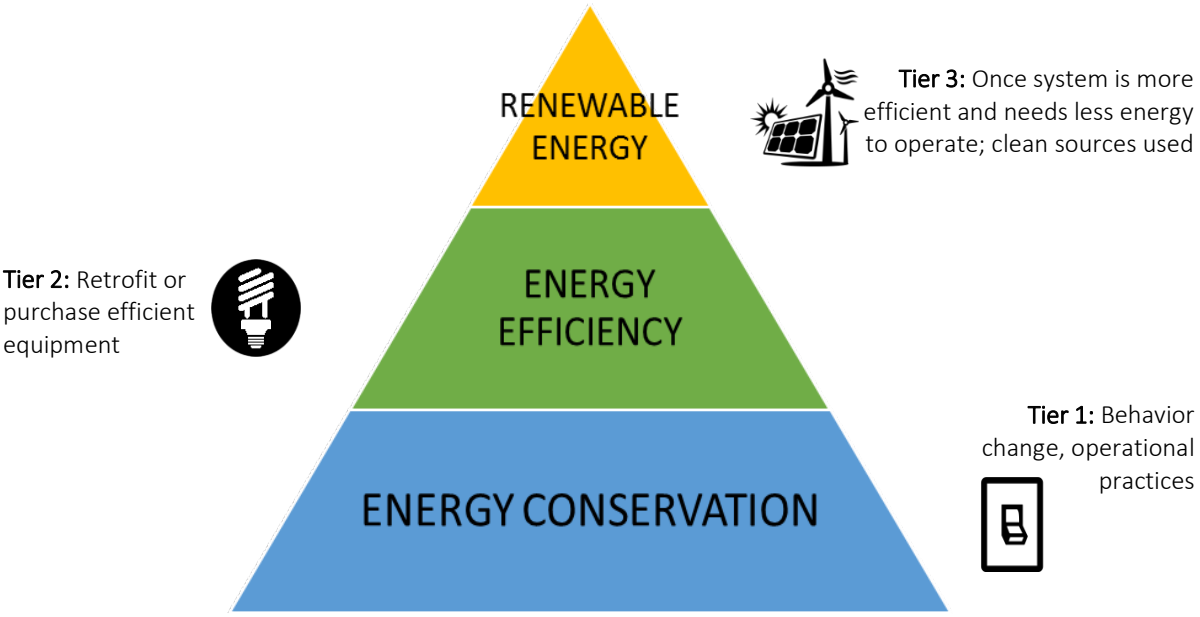
Another action to explore further is the procurement of an energy management software or third-party service to more efficiently track utility bill data. A software or service will also improve the monitoring and verification of results of energy efficiency retrofit projects. This action will require discussions with staff from Financial Services and the Office of the Chief Information Officer.

8.2 Organizational Strategies

Energy management strategies generally involve at least one of three components: conservation, efficiency, and renewable technology (see Figure 8-A below). Conservation comes first; it is the easiest starting point because it involves examining existing systems, behaviors, and practices, and finding ways to reduce the amount of energy used day-to-day. During discussions with Facility Services staff, which were held to gather input on short-term target setting, the importance of actions to target and encourage behavior change was emphasized and confirmed that a significant percentage of the reduction target could be achieved through simple measures like regulating thermostat temperatures and other operations efficiencies.

Measures to increase energy efficiency come next; this involves finding products and services to reduce the amount of energy required to do something. Once conservation and efficiency measures have been implemented and the amount of energy needed has been reduced, renewable energy sources can be used to generate clean energy.

Figure 8-A: Energy Management Pyramid



8.2.1 Energy Conservation Measures by Asset Class

Specific energy conservation measures (ECMs) will be made available as the 2019 facility energy audits are completed.

8.2.2 New Construction Standards

Considering expected population growth, from about 324,100 now to 424,500 by 2031[17], the City continues to invest in its parks, recreation, and library infrastructure to meet increasing needs and pressures on existing and proposed recreation and library facilities.

While the City currently has a Corporate Green Building Policy that requires all new City buildings to be built to LEED Gold at minimum, there is a need to update it to identify specific energy, water, and resiliency performance standards. This not only demonstrates that the City is leading by example, but also future-proofs the City against rising energy costs either from potential electricity or natural gas price increases and strengthens the City's energy security.

The City's Active Transportation Master Plan (ATMP) identifies, for both the short-to-medium and long terms, the need for the following new recreation related buildings to accommodate upcoming growth and community development, between 2019-2031:

- Six branch libraries and one storefront library
- Four community centres
    - Three indoor pools
    - Two ice pad arenas
    - Four-five outdoor rinks or skating trails
- 15 waterplay facilities

[17] City of Vaughan, 2018 ATMP Review & Update; population growth estimate includes institutional adjustment and undercount, based on 45% scenario prepared by the Region in November 2015, adjusted to remove growth in Vaughan's Whitebelt

Considering the future additions to the City's buildings and infrastructure portfolio, newer and better construction standards are needed and should include considerations of the standards listed below (Figure 8-B explains the differences between common types of green buildings).

Passive House

The Passive House high-performance building standard is an internationally recognized and science-based energy standard in construction, to build for comfort, affordability, and energy efficiency of residential, institutional, and commercial buildings through all stages of design, construction, and livability. The primary goal of a Passive House building is to achieve a well-insulated building envelope, and then introduce fresh air through a high-efficiency heat recovery ventilation system. Renewable energy technologies can be, and are often, installed on Passive House buildings as well.

Zero Carbon Building Approach

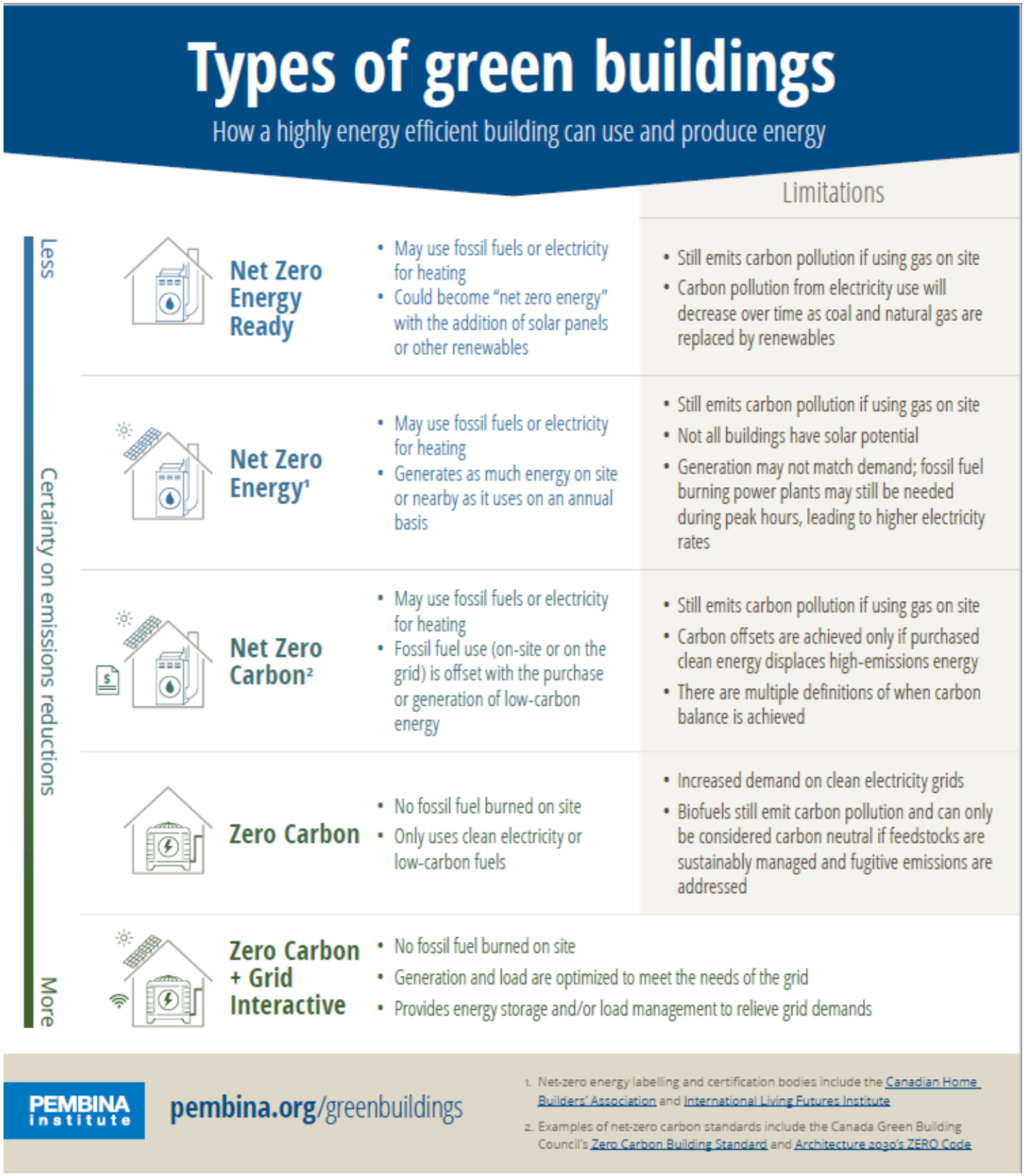
A Zero-Carbon Building (ZCB) is characterized mainly by demonstrating a zero-carbon balance in its operations; i.e., it produces zero emissions over the course of a year. This can be achieved primarily through on-site carbon reduction actions but may require offsetting emissions (e.g. through purchasing renewable energy). A "net-zero" building is simply one which produces as much energy as it uses.

The CaGBC report on the business case for ZCBs found that ZCBs are both technologically feasible and financially viable.[18] More specifically, when evaluated over a 25-year life-cycle, the ZCB archetypes studied can provide a positive financial return of 1% and require a modest 8% capital cost premium, along with 24% annual operating savings. Although energy intensive recreation buildings were not included as one of the studied archetypes, the CaGBC study found that "mid-rise offices, and likely for other larger buildings or buildings with higher energy costs, life-cycle costs are much more sensitive, overall, to energy costs than to either capital costs or the cost of carbon." That is, for the most energy-intensive buildings in the City's portfolio, a ZCB approach is likely to demonstrate overall life-cycle savings from energy and maintenance savings that outweigh up front capital costs.

A key recommendation of this Plan is to, firstly, further explore and research standards such as Passive House, ZCB and Net-Zero, among others, to determine what is best to incorporate into a renewed Corporate Green Building Policy for the City; and, secondly, to establish an updated, higher-performance building standard for the City's Corporate Green Building Policy based on the research findings. The establishment of a revised standard will require collaboration amongst various departments, including Facility Services, Infrastructure Delivery, Infrastructure Planning and Corporate Asset Management, Financial Planning and Development Finance, and Policy Planning and Environmental Sustainability. Higher performance building standards may need to be phased over time and will be a consideration in the revision of the Corporate Green Building Policy.

[18] Making the Case for Building to Zero Carbon, https://www.cagbc.org/makingthecase

Figure 8-B: Types of Green Buildings



8.2.3 Renewable Energy and Future Technologies

Drawdown Solutions for Buildings

The Drawdown Project identifies several solutions for reducing carbon emissions from buildings. A description of each solution can be found on the Drawdown website. Of the ten Drawdown solutions for buildings, seven are noted below that are pertinent to City facilities.

- **BAS:** Automation systems, through controls and sensors, can program different set points depending on time and utilization.
- **Green Roofs and Cool Roofs:** Green and cool roofs reduce energy loads of the associated building for both heating and cooling. Green roofs, in addition, reduce neighborhood cooling loads through evapotranspirative cooling effects.
- **Heat Pumps:** When paired with renewable energy sources and building structures designed for efficiency, heat pumps could eliminate almost all emissions from heating and cooling for buildings.
- **Insulation:** Improved building envelopes are a first strategy to reduce energy demand. The Vancouver Zero Emissions Building Plan[19] requires all new city owned buildings to meet Passive House Certification, as well as the requirement to use only low carbon fuel sources unless both or either is deemed unviable. Passive House certification strives for very efficient building envelopes.
- **LED Lighting:** Upgrading to LED lights has been a common energy retrofit in City facilities given the proven savings.
- **Smart Glass:** Various measures can improve a window's efficiency: layered panes, reflective low-emissivity coatings, insulating gas between panes and tightly sealed frames. More adaptive technologies, dubbed 'smart glass,' make windows responsive in real time to sunlight and weather, reducing a building's energy load for lighting and improving heating and cooling efficiency.
- **Solar Hot Water:** In commercial buildings, water heating can be roughly 12% of energy loads. Solar water heating—exposing water to the sun to warm it—can reduce that fuel consumption by 50 to 70%.

Distributed Energy Resources (DERs)

The City is aware of technologies and integrated design approaches that can be grouped under the heading of distributed energy resources (DERs). The City will evaluate these approaches for both major renovations and new construction. Some of these technologies are described below.

Solar Photovoltaic (PV)

There are two main types of solar energy: solar PV cells (solar panels), and solar-thermal. Solar PVs produce electricity directly from sunlight, and solar thermal technologies use sunlight to first generate heat, and then generate electricity.

In 2017, the City completed roof upgrades (originally required due to roof assessments conducted in 2016) for the installation of solar panels at six community centres: Chancellor CC, Dufferin Clark CC, Father Ermanno Bulfon CC, Garnet A. Williams CC, Maple CC, and North

[19] https://vancouver.ca/files/cov/zero-emissions-building-plan.pdf

Thornhill CC. A recommendation of this Plan is to explore how to best utilize this opportunity, as the six roofs can be equipped with solar PV technology.

Geothermal Energy

Geothermal energy is another type of renewable energy that is generated through the Earth's internal heat. Thermal energy that is contained below the Earth's crust (in underground reservoirs of steam and hot water) can be tapped into to generate electricity or to directly heat and cool buildings.

Why Geothermal?

It is renewable – With proper management, the rate of energy extraction can be balanced with a reservoir's natural heat recharge rate.

It is reliable – Geothermal power plants produce electricity consistently, running 24 hours per day / 7 days per week, regardless of weather conditions. It also has the ability to produce more electricity over the same time period than coal, natural gas, nuclear or large hydro stations.

It has a small footprint–Geothermal power plants are compact; using less land per GWh (404 m2) than coal (3642 m2) wind (1335 m2) or solar PV with center station (3237 m2).*

It is clean – Modern closed-loop geothermal power plants emit no greenhouse gasses. Geothermal power plants consume less water on average over the lifetime energy output than the most conventional generation technologies.

It is versatile - Geothermal power facilities produce useful by-product heat that can be integrated with greenhouses, fish farms, and food processing; you can also directly drill for heat.

Source: Enbridge Gas

McMaster Innovation Park (MIP) in Hamilton, Ontario undertook an innovative application of such technologies that the City can also consider exploring. The MIP district heating system combines geo-exchange (geothermal heat pump technology), solar thermal, and boilers in a cascaded loop to supply space heating and domestic hot water to all the buildings at the park.[20]

Microgrids

The illustration (Figure 8-C)[21] shows how a customized energy-management software program, developed for Alectra Utilities by GE Digital Energy, will route electricity from the company's existing generation to power the building's various electrical loads during phase one of the trial.

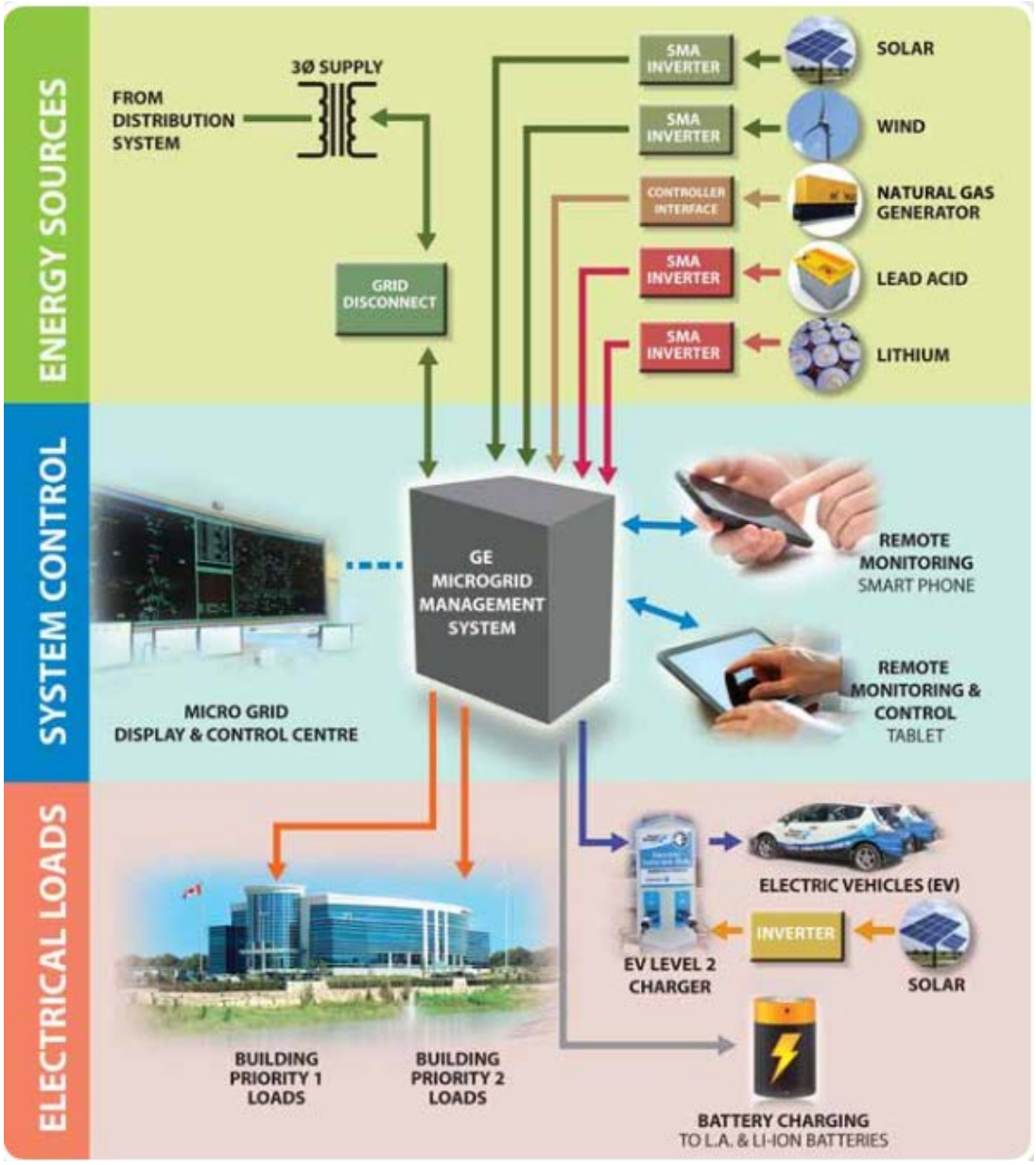
Alectra Utilities' Microgrid Project

The Alectra Utilities Microgrid project will supply electricity for the company's lighting, air conditioning and refrigeration ('loads') at its office in Vaughan.

[20] http://www.districtenergy-digital.org/districtenergy/2017q1?pg=9#pg9

[21] https://www.powerstream.ca/innovation/smart-grid/micro-grid-case-study.html

Figure 8-C: Alectra Utilities Microgrid Project



Combined Heat and Power (CHP)

Combined heat and power systems generate electricity and thermal energy simultaneously from a single fuel source. Waste heat from the generation of electricity can be used directly as hot air for heating buildings, for drying purposes, or to produce steam, hot water or chilled water for heating, cooling or industrial processes.

In February 1995 a 1,030 kWe reciprocating engine CHP scheme was commissioned at York University.[22] This provides 60% of the campus electrical demands and 20% of the annual heat requirement, including all heating and hot water needs from June to October. Heat is provided at up to 127˚C from the reciprocating engine. Installation was straightforward and initial operating experience showed over 97% availability at an average load factor of 85%. The initial

[22] http://www.cwp-ltd.com/wp-content/uploads/2012/03/UKGoodPracticeGuide.pdf)

capital cost was paid back in around 3.5 years with subsequent years' savings going directly towards running the university. The CHP unit saves around 14% of the overall annual energy bill.

Low-Carbon Thermal Energy Networks

Sewer heat recovery, lake water cooling and geo-exchange are examples of heat transfer in a thermal energy network. The Enwave deep lake water cooling infrastructure in Toronto is an example of a thermal energy network. The City of Hamilton is studying the expansion of the McMaster Innovation Park with new geothermal fields, solar thermal absorption and solar PV electric-driven chillers, upgraded distribution infrastructure and additional conventional backup.[23]

8.2.4 Training and Capacity Building

As shown in Figure 8-A earlier, behavior change and shifting operational practices are arguably the most important strategies to begin any energy management program. This includes training and educating staff about the importance of sustainable energy management and of things they can do as individuals to contribute to the City's corporate goals. Because energy conservation relies heavily on individual behavior, it is important for staff to be a part of the process from the start.

Staff Training and Ongoing Engagement

A critical contributor to the goals outlined in this EMP are Facilities staff working in and responsible for individual buildings; an important recommendation is therefore to continue to seek and involve Facilities staff in all stages of the energy management process. This includes providing training opportunities, as well as drawing on their knowledge as experts of their facilities to understand both site-specific problems and solutions, not just for their own facilities, but also as lessons learned that can be applied to and shared with other sites.

Local Authority Services (LAS), created by the Association of Municipalities of Ontario (AMO), is a non-profit organization that works with Ontario municipalities and the BPS. Some of their offerings include energy training opportunities, which should be further pursued, such as:

Energy Efficient Building Operations 101

Customizable sessions for facilities and operators, designed to provide flexible, on-site technical training specific to a broad range of municipal facilities that will be both cost effective and time efficient. Operations 101 workshops are eligible for incentives through the IESO.

Employee Engagement Workshop

Employee engagement alone can achieve 3-5% energy savings and is crucial to maintaining the savings related to most equipment and technology upgrades. This workshop provides a Facility Scan, Staff Awareness Survey, workshop time covering Energy 101, Understanding Your Bill, Ways to Save at Work & Home, and a Follow-Up Survey.

Peer-to-peer Learning

Continuous engagement with and participation in groups such as the Mayor's Megawatt Challenge (MMC) network, the CAP Energy Manager's group, and other similar networks is important for continuous improvement. A specific recommendation of this Plan is for the City to join the MMC and submit data for at least two facilities, including City Hall.

[23] https://data.fcm.ca/home/programs/green-municipal-fund/funded-initiatives.htm

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Appendix B – Energy Consumption Data

City of Vaughan Corporate Energy Management Plan, 2019

GHG Emissions Quantification Methodology

City of Vaughan, Energy Management Plan (2019-2024)

CO2e Emission Factors

2015 Reporting Year	**Electricity**	0.080	kg CO2e/kWh	**Note:** The 2015 Report is used as this report provides the correct emission factors for the 2013 data year
	Natural gas	1.915	kg CO2e/m3	
	Gasoline	2.326	kgCO2e/L	
	Diesel	2.740	kgCO2e/L	

Source: Government of Canada, 2015. National Inventory Report 1990–2013: Greenhouse Gas Sources and Sinks in Canada. (Electricity: Table A13-7; Natural Gas: Table A6-1; Gasoline & Diesel: Table A6-11)

2018 Reporting Year	**Electricity**	0.040	kg CO2e/kWh	**Note:** The 2018 Report is used as this report provides the correct emission factors for the 2016 data year (the 2019 report, which would provide up-to-date factors for the 2017 data year has not yet been released, and so the 2018 Report presents the most recent information)
	Natural gas	1.915	kg CO2e/m3	
	Gasoline	2.317	kg CO2e/L	
	Diesel	2.731	kg CO2e/L	

Source: Government of Canada, 2018. National Inventory Report 1990–2016: Greenhouse Gas Sources and Sinks in Canada. (Electricity: Table A13-7; Natural Gas: Table A6-1; Gasoline & Diesel: Table A6-12)

Methodology to calculate CO2e

Note: values below are shown for the 2018 Reporting year, and both sets of emission factors above include these calculations for their respective years

The use of natural gas, gasoline, and diesel also releases nitrous oxide (N2O) and methane (CH4) in addition to CO2. As such, the emission factors above include the following considerations:

Each gas has a unique global warming potential (GWP) relative to CO2; GWP is a measure of how much heat a greenhouse gas traps in the atmosphere for a given time period, relative to carbon dioxide, where the GWP of CO2 is 1. The GWP for the 3 major gases are:

CO2	1
CH4	25
N2O	298

Source: Government of Canada, 2018. National Inventory Report 1990–2016: Greenhouse Gas Sources and Sinks in Canada. Table 1-1. (References IPCC Fourth Assessment Report)

CO2e = [(mass CO2 x 1) + (mass CH4 x 25) + (mass N2O x 298)]

Natural Gas	1.888 kg CO2/m3
+	0.00049 kg CH4/m3
+	0.000049 kg N2O/m3
=	[(1.888)+(0.00049 x 25)+(0.000049 x 298)]
=	**1.915**

Gasoline	2.307 kg CO2/L
+	0.00014 kg CH4/L
+	0.000022 kg N2O/L
=	[(2.307)+(0.00014 x 25)+(0.000022 x 298)]
=	**2.317**

Note: Using CH4 and N2O emission factors for Tier 2 Light-Duty Gasoline Vehicles

Diesel	2.681 kg CO2/L
+	0.00010 kg CH4/L
+	0.00016 kg N2O/L
=	[(2.681)+(0.00010 x 25)+(0.00016 x 298)]
=	**2.731**

Note: Using CH4 and N2O emission factors for Light Duty Diesel Vehicles - Uncontrolled

Appendix B – Energy Consumption Data

City of Vaughan Corporate Energy Management Plan, 2019

Corporate Energy Consumption Summary	2013		2017	
	Total ekWh	GHGs (tCO2e)	Total ekWh	GHGs (tCO2e)
Buildings	69,231,229.87	9,823.03	62,144,286.04	7,738.36
Fleet	8,781,063.69	2,172.32	8,842,234.14	2,172.45
Lighting	17,498,588.00	1,399.89	19,319,024.00	772.76
Total:		**13,395.23**		**10,683.57**
Buildings Breakdown by Type	**Total ekWh**	**GHGs (tCO2e)**	**Total ekWh**	**GHGs (tCO2e)**
Admin	16,865,586.70	2230.75	12,174,746.46	1,351.51
Service Yards	Incomplete data			
Community Centres with Pool (no Arena)	23,294,963.16	3,527.47	21,982,244.58	2,975.94
Community Centres with Arena (no Pool)	Incomplete data			
Community Centres with Pool and Arena	23,219,755.23	3,226.22	19,735,340.13	2,461.83
Outdoor Pool	322,653.70	45.85	328,136.16	44.59
Fire Stations	3,101,593.62	487.19	3,050,452.33	459.40
Libraries	2,426,677.47	305.56	$3,208,481.55	348.16

***** Due to incomplete utility data for the two Service Yards and Rosemount CC, these three buildings are excluded from data analysis

2013 vs. 2017, % Change				
	Buildings	**Fleet**	**Lighting**	**Total**
Total Energy Consumption (ekWh)	- 10.2%	+ 0.7%	+ 10.4%	**- 10%**
GHG Emissions (tCO2e)	- 21.2%	0%	- 44.8% *	**- 20%**
(-) = % decrease (+) = % increase				
*Lighting emissions reduction is so significant due to the change in emission factor (Provincial phase out of coal, completed in 2014)				

Buildings – Energy Consumption Breakdown, 2013-2017						
	Total Energy Consumption (ekWh)	**% Change in Total Energy Consumption**	**Electricity Consumption (kWh)**	**% Change in Electricity Consumption**	**Natural Gas Consumption (m^3)**	**% Change in Natural Gas Consumption**
2013	69,231,229.87	-10.24 %	28,928,992.82	-9.28 %	3,921,298.74	-10.92 %
2017	62,144,286.04		26,243,876.81		3,493,012.79	

How our building profile has changed	2013	2017	
Admin	3	2	* From 2013-2017, the City has expanded several community centres, decommissioned 1 fire station, and constructed 1 new fire station and 1 library
Service Yards	2	2	
Community Centres	10	10	
Outdoor Pools	1	1	
Fire Stations	8	9	
Libraries	4	5	
Total number of buildings:	**28**	**29**	

Appendix B – Energy Consumption Data

City of Vaughan Corporate Energy Management Plan, 2019

kWh = Electricity Consumption (in kilowatt hours) | **m^3 = Natural Gas Consumption (in cubic metres)**
ekWh = Total Energy Consumption (in equivalent kWh)
EUI = Energy Intensity (in ekWh per square foot) | **tCO2e = GHG Emissions (in tonnes of carbon dioxide equivalent)**

Baseline: 2013 Energy Consumption by Asset Type

Admin Buildings	kWh	m^3	Total ekWh	EUI (ekWh/ft^2)	GHG Emissions (tCO2e)
City Hall (New)	5,853,103.00	577,534.78	11,788,877.13	**42.10**	**1,574.14**
Civic Centre (Old City Hall)	1,319,760.00	83,645.00	2,179,444.72	**26.60**	**265.75**
JOC	1,400,946.00	145,587.78	2,897,264.85	**28.93**	**390.85**
Group Total	**8,573,809.00**	**806,767.56**	**16,865,586.70**		**2,230.75**

Service Yards	kWh	m^3	Total ekWh	EUI (ekWh/ft^2)	GHG Emissions (tCO2e)
East District Parks Yard	12,779.25		12,779.25		
Woodbridge Yard	229,894.73	55,662.73	801,983.90	**69.04**	**124.98**
Group Total	**242,673.98**	**55,662.73**	**814,763.15**		

Community Centres with Pool (no Arena)	kWh	m^3	Total ekWh	EUI (ekWh/ft^2)	GHG Emissions (tCO2e)
Chancellor CC + Library	1,151,051.03	277,196.00	4,000,009.92	**66.54**	**622.87**
Dufferin Clark CC + Library	1,596,056.18	248,823.00	4,153,403.68	**49.68**	**604.14**
North Thornhill CC + Library	2,672,015.93	564,747.73	8,476,367.60	**89.19**	**1,295.17**
Vellore Village CC + Library	2,224,695.00	432,047.38	6,665,181.96	**76.04**	**1,005.28**
Group Total	**7,643,818.14**	**1,522,814.11**	**23,294,963.16**		**3,527.47**

Community Centres with Arena	kWh	m^3	Total ekWh	EUI (ekWh/ft^2)	GHG Emissions (tCO2e)
Rosemount CC	2,218,800.00	229,095.00	4,573,387.50	**101.59**	**616.19**

Community Centres with Pool and Arena	kWh	m^3	Total ekWh	EUI (ekWh/ft^2)	GHG Emissions (tCO2e)
Al Palladini CC	3,401,221.71	269,834.55	6,174,521.25	**42.97**	**788.79**
Father Ermanno Bulfon CC	915,013.00	126,313.62	2,213,236.32	**32.03**	**315.07**
Garnet A. Williams CC	2,339,140.63	277,196.00	5,188,099.52	**40.89**	**717.92**
Maple CC + Library	2,556,135.45	391,581.68	6,580,724.94	**44.53**	**954.31**
Woodbridge Pool and Arena	1,134,162.58	187,687.52	3,063,173.20	**54.17**	**450.13**
Group Total	**10,345,673.37**	**1,252,613.37**	**23,219,755.23**		**3,226.22**

Outdoor Pools	kWh	m^3	Total ekWh	EUI (ekWh/ft^2)	GHG Emissions (tCO2e)
Thornhill Outdoor Pool	134,210.64	18,335.00	322,653.70	**74.19**	**45.85**

Appendix B – Energy Consumption Data

City of Vaughan Corporate Energy Management Plan, 2019

Fire Stations	kWh	m^3	Total ekWh	EUI ($ekWh/ft^2$)	GHG Emissions (tCO_2e)
7-1	100,460.34	28,563.81	394,032.83	**42.51**	**62.73**
7-2	143,538.67	25,285.39	403,416.29	**40.57**	**59.90**
7-3 7-4	**Not included in Baseline as they no longer exist in Building Portfolio**				
7-5	66,360.18	15,645.72	227,163.41	**29.80**	**35.27**
7-6	103,821.82	22,026.56	330,205.91	**53.07**	**50.48**
7-7	83,280.00	21,065.21	299,783.55	**44.99**	**47.00**
7-8	148,895.14	33,857.62	496,876.23	**35.65**	**76.74**
7-9	126,434.52	36,080.36	497,260.44	**36.61**	**79.20**
7-10	80,115.00	36,266.59	452,854.95	**62.61**	**75.85**
Group Total	**852,905.67**	**218,791.26**	**3,101,593.62**		**487.19**

Libraries (standalone)	kWh	m^3	Total ekWh	EUI ($ekWh/ft^2$)	GHG Emissions (tCO_2e)
Bathurst Clark Library	590,481.00	44,034.06	1,043,053.28	**29.07**	**131.56**
Pierre Berton Resource Library	567,054.00	47,938.60	1,059,756.28	**32.11**	**137.16**
Vaughan Resource Library	**N/A – constructed in 2016**				
Woodbridge Library	155,929.00	2,577.00	182,414.83	**17.89**	**17.41**
Kleinburg Library	65,112.00	7,427.78	141,453.07	**25.29**	**19.43**
Group Total	**1,378,576.00**	**101,977.44**	**2,426,677.47**		**305.56**

Fleet	L	Total ekWh	GHG Emissions (tCO_2e)
Diesel	351,457.00	3,774,648.18	**963.06**
Gasoline	519,877.00	5,006,415.51	**1,209.26**
Group Total		**8,781,063.69**	**2,172.32**

Lighting	kWh	Total ekWh	GHG Emissions (tCO_2e)
Parks (data is only from 5 parks)	77,975	77,975.00	6.24
Streetlighting	17,420,613	17,420,613.00	1,393.65
Group Total	**17,498,588.00**	**17,498,588.00**	**1,399.89**

Assumptions/Calculation Methodology

- Data is primarily from Internal Energy Dashboard system, which uses utility billing data.
- For Rosemount CC and Thornhill Outdoor Pool, data is taken from BPS Reporting due to gaps in Dashboard
- Fleet data is received directly from the Fleet Services division

Calculation to convert m^3 to ekWh: 1 m^3 = 37 MJ and 1 kWh = 3.6 MJ 1 m^3 * 37 MJ / 3.6 MJ = 10.27777 ekWh	
To convert Fleet data to ekWh: Diesel (L) * 10.74 = ekWh Gasoline (L) * 9.63 = ekWh	Source: Natural Resources Canada, Energy Efficiency in Buildings, Table 1 https://www.nrcan.gc.ca/energy/publications/efficiency/buildings/5985

Appendix B – Energy Consumption Data

City of Vaughan Corporate Energy Management Plan, 2019

2013 Consumption

Corporate Energy Consumption - 2013	(ekWh)
Total Electricity	46,427,581
Total Natural Gas	43,228,914
Total Diesel	3,774,648.18
Total Gasoline	5,006,415.51

Corporate GHG Emissions (tCO2e), 2013		
Total GHGs	13,395.23	Not including Service Yards or Rosemount CC
Buildings	9,823.03	
Fleet	2,172.32	
Lighting	1,399.89	

Buildings Energy Consumption Breakdown - 2013		
Total Electricity Consumption (kWh)	**28,928,992.82**	Not including Service Yards or Rosemount CC
Total Natural Gas Consumption (m^3)	3,921,298.74	
Total Natural Gas in ekWh	**40,302,237.05**	
Total Energy Consumption (ekWh)	**69,231,229.87**	

Appendix B – Energy Consumption Data

City of Vaughan Corporate Energy Management Plan, 2019

2017 Energy Consumption by Asset Type

Admin Buildings	kWh	m^3	Total ekWh	EUI ($ekWh/ft^2$)	GHG Emissions (tCO_2e)
City Hall	5,594,194.00	447,685.22	10,195,403.21	**32.43**	**1,081.02**
JOC	1,217,592.00	127,230.65	2,525,240.35	**25.22**	**292.33**
Group Total	**6,811,786.00**	**574,915.87**	**12,720,643.55**		**1,373.35**

Service Yards	kWh	m^3	Total ekWh	EUI ($ekWh/ft^2$)	GHG Emissions (tCO_2e)
EDPY					
Woodbridge Yard	205,919.00		205,919.00		
Group Total					

Community Centres with Pool (no Arena)	kWh	m^3	Total ekWh	EUI ($ekWh/ft^2$)	GHG Emissions (tCO_2e)
Chancellor CC + Library*	1,159,394.20	204,761.06	3,263,882.87	**54.29**	**438.46**
Dufferin Clark CC + Library	1,520,688.75	313,273.29	4,740,442.01	**56.70**	**660.70**
North Thornhill CC + Library	2,642,487.92	369,194.19	6,436,983.76	**67.73**	**812.65**
Vellore Village CC + Library	2,329,506.60	449,534.99	6,949,727.33	**79.29**	**953.97**
Group Total	**7,652,077.47**	**1,336,763.53**	**21,391,035.97**		**2,865.79**

*Natural gas figure does not include Library consumption for Chancellor CC

Community Centres with Arena	kWh	m^3	Total ekWh	EUI ($ekWh/ft^2$)	GHG Emissions (tCO_2e)
Rosemount CC		84,906.40	**872,649.11**		**162.58**

Community Centres with Pool and Arena	kWh	m^3	Total ekWh	EUI ($ekWh/ft^2$)	GHG Emissions (tCO_2e)
Al Palladini CC	2,733,253.00	273,496.26	5,544,186.78	**38.59**	**633.03**
Father Ermanno Bulfon CC*	907,223.00	156,827.67	2,519,062.94	**36.45**	**336.59**
Garnet A. Williams CC	2,291,685.00	312,204.35	5,500,451.93	**43.35**	**689.49**
Maple CC + Library	2,213,130.00	259,543.49	4,880,660.31	**33.02**	**585.51**
Woodbridge Pool and Arena	993,440.00	185,156.57	2,896,438.08	**51.22**	**394.29**
Group Total	**9,138,731.00**	**1,187,228.34**	**21,340,800.05**		**2,638.92**

* Natural gas figure does not include rink consumption for Father Ermanno CC

Outdoor Pools	kWh	m^3	Total ekWh	EUI ($ekWh/ft^2$)	GHG Emissions (tCO_2e)
Thornhill Outdoor Pool	122,127.00	20,887.12	336,800.18	**77.44**	**44.88**

Appendix B – Energy Consumption Data

City of Vaughan Corporate Energy Management Plan, 2019

Fire Stations	kWh	m^3	Total ekWh	EUI ($ekWh/ft^2$)	GHG Emissions (tCO_2e)
7-1	101,391.00	35,013.88	461,255.88	**49.76**	**71.10**
7-2	140,410.00	32,515.98	474,602.02	**47.73**	**67.88**
7-3 Old Site (Jan-May)	30,103.00	12,765.97	161,308.80	**11.65**	**25.65**
7-3 New Site (May-Dec)					
7-5	79,156.00	18,260.86	266,837.06	**35.01**	**38.13**
7-6	59,326.00	19,149.46	256,139.89	**41.17**	**39.04**
7-7	73,517.00	23,158.55	311,535.43	**46.76**	**47.29**
7-8	144,376.00	23,853.73	389,539.34	**27.95**	**51.45**
7-9	107,970.00	36,698.94	485,153.55	**35.72**	**74.59**
7-10	72,691.00	30,117.71	382,234.13	**52.85**	**60.58**
Group Total	**808,940.00**	**231,535.08**	**3,188,606.10**		**475.71**

Libraries (standalone)	kWh	m^3	Total ekWh	EUI ($ekWh/ft^2$)	GHG Emissions (tCO_2e)
Bathurst Clark Library	515,290.23	34,946.41	874,461.67	**24.37**	**87.53**
Pierre Berton Resource Library	501,576.21	43,152.10	945,083.90	**28.64**	**102.69**
Vaughan Resource Library	358,205.81	51,876.45	891,380.44	**25.05**	**113.66**
Woodbridge Library	265,321.09	829.26	273,844.04	**26.85**	**12.20**
Kleinburg Library	69,822.00	10,878.63	181,630.14	**32.47**	**23.62**
Group Total	**1,710,215.34**	**141,682.85**	**3,166,400.19**		**339.71**

Fleet	L	Total ekWh	GHG Emissions (tCO_2e)
Diesel	305,598.00	3,282,122.52	**834.64**
Gasoline	577,374.00	5,560,111.62	**1,337.81**
Group Total		**8,842,234.14**	**2,172.45**

Lighting	kWh	Total ekWh	GHG Emissions (tCO_2e)
Parks (data is from 11 parks)	643,469.00	643,469.00	25.74
Streetlighting	18,675,555.00	18,675,555.00	747.02
Group Total	**19,319,024.00**	**19,319,024.00**	**772.76**

Assumptions/ Methodology Notes

- Data is primarily from Internal Energy Dashboard system, which uses utility billing data.
- Fleet data is received directly from the Fleet Services division
- Fire Station 7-3 was decommissioned and re-opened at a new location in April 2017

Calculation to convert m^3 to ekWh:

1 m^3 = 37 MJ and 1 kWh = 3.6 MJ

1 m^3 * 37 MJ / 3.6 MJ = 10.27777 ekWh

To convert Fleet data to ekWh:

Diesel (L) * 10.74 = ekWh

Gasoline (L) * 9.63 = ekWh

Source: Natural Resources Canada, Energy Efficiency in Buildings, Table 1
https://www.nrcan.gc.ca/energy/publications/efficiency/buildings/5985

Appendix B – Energy Consumption Data

City of Vaughan Corporate Energy Management Plan, 2019

2017 Consumption

Corporate Energy Consumption - 2017	(ekWh)
Total Electricity	45,562,900.81
Total Natural Gas	35,900,409.23
Total Diesel	3,282,122.52
Total Gasoline	5,560,111.62

Corporate GHG Emissions (tCO2e), 2017		
Total GHGs	10,683.6	Not including Service Yards or Rosemount CC
Buildings	7,738.4	
Fleet	2,172.5	
Lighting	772.8	

Buildings Energy Consumption Breakdown - 2017		
Total Electricity Consumption (kWh)	**26,243,876.81**	Not including Service Yards or Rosemount CC
Total Natural Gas Consumption (m^3)	3,493,012.79	
Total Natural Gas in ekWh	**35,900,409.23**	
Total Energy Consumption (ekWh)	**62,144,286.04**	

Appendix B – Energy Consumption Data

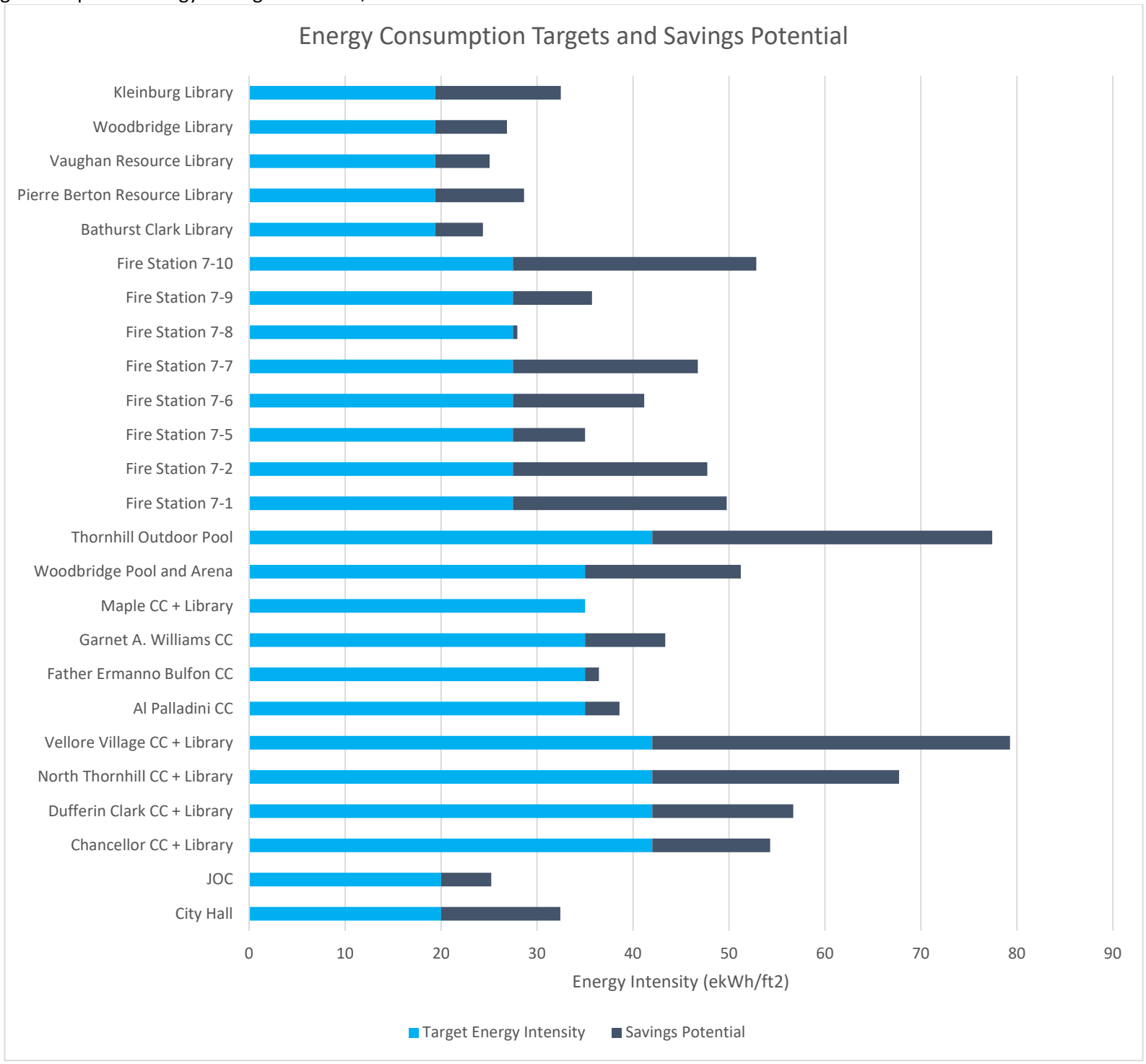
City of Vaughan Corporate Energy Management Plan, 2019

Energy Consumption & GHG Reduction Targets

2017 Annual Energy Consumption						Targets		
Electricity (kWh)	Natural Gas (m^3)	Total Energy Consumption (ekWh)	GHG Emissions (tCO2e)	EUI (ekWh/ft^2)	Facility	Target EUI (ekWh/ft^2)	Savings Potential (ekWh/ft^2)	Difference between Actual & Target
5,594,194.00	447,685.22	10,195,403.21	**1,081.08**	**32.43**	**City Hall**	**20**	12.43	12.43
1,217,592.00	127,230.65	2,525,240.35	**292.35**	**25.22**	**Joint Operations Centre**	**20**	5.22	5.22
1,159,394.20	204,761.06	3,263,882.87	**438.49**	**54.29**	**Chancellor CC + Library**	**42**	12.29	12.29
1,520,688.75	313,273.29	4,740,442.01	**660.75**	**56.70**	**Dufferin Clark CC + Library**	**42**	14.70	14.70
2,642,487.92	369,194.19	6,436,983.76	**812.71**	**67.73**	**North Thornhill CC + Library**	**42**	25.73	25.73
2,329,506.60	449,534.99	6,949,727.33	**954.04**	**79.29**	**Vellore Village CC + Library**	**42**	37.29	37.29
2,733,253.00	273,496.26	5,544,186.78	**633.08**	**38.59**	**Al Palladini CC**	**35**	3.59	3.59
907,223.00	156,827.67	2,519,062.94	**336.61**	**36.45**	**Father Ermanno Bulfon CC**	**35**	1.45	1.45
2,291,685.00	312,204.35	5,500,451.93	**689.54**	**43.35**	**Garnet A. Williams CC**	**35**	8.35	8.35
2,213,130.00	259,543.49	4,880,660.31	**585.55**	**33.02**	**Maple CC + Library**	**35**	0.00	-1.98
993,440.00	185,156.57	2,896,438.08	**394.31**	**51.22**	**Woodbridge Pool and Arena**	**35**	16.22	16.22
122,127.00	20,887.12	336,800.18	**44.88**	**77.44**	**Thornhill Outdoor Pool**	**42**	35.44	35.44
101,391.00	35,013.88	461,255.88	**71.11**	**49.76**	**Fire Station 7-1**	**27.5**	22.26	22.26
140,410.00	32,515.98	474,602.02	**67.88**	**47.73**	**Fire Station 7-2**	**27.5**	20.23	20.23
79,156.00	18,260.86	266,837.06	**38.14**	**35.01**	**Fire Station 7-5**	**27.5**	7.51	7.51
59,326.00	19,149.46	256,139.89	**39.04**	**41.17**	**Fire Station 7-6**	**27.5**	13.67	13.67
73,517.00	23,158.55	311,535.43	**47.29**	**46.76**	**Fire Station 7-7**	**27.5**	19.26	19.26
144,376.00	23,853.73	389,539.34	**51.45**	**27.95**	**Fire Station 7-8**	**27.5**	0.45	0.45
107,970.00	36,698.94	485,153.55	**74.60**	**35.72**	**Fire Station 7-9**	**27.5**	8.22	8.22
72,691.00	30,117.71	382,234.13	**60.58**	**52.85**	**Fire Station 7-10**	**27.5**	25.35	25.35
515,290.23	34,946.41	874,461.67	**87.53**	**24.37**	**Bathurst Clark Library**	**19.4**	4.97	4.97
501,576.21	43,152.10	945,083.90	**102.70**	**28.64**	**Pierre Berton Resource Library**	**19.4**	9.24	9.24
358,205.81	51,876.45	891,380.44	**113.67**	**25.05**	**Vaughan Resource Library**	**19.4**	5.65	5.65
265,321.09	829.26	273,844.04	**12.20**	**26.85**	**Woodbridge Library**	**19.4**	7.45	7.45
69,822.00	10,878.63	181,630.14	**23.63**	**32.47**	**Kleinburg Library**	**19.4**	13.07	13.07
26,213,773.81	**3,480,246.82**	**61,982,977.24**	**7,713.22**	**TOTAL**				

Appendix B – Energy Consumption Data

City of Vaughan Corporate Energy Management Plan, 2019



Appendix C – Target-setting Methodology
City of Vaughan Corporate Energy Management Plan, 2019

Determining Energy Intensity Targets for City Facilities

Research undertaken in support of the Mayors' Megawatt Challenge program provides approaches to set near-term (i.e., to 2024) and medium-term (i.e., to 2030) energy intensity targets for facilities (TRCA and Enerlife 2015, TRCA and Enerlife 2016).

Top Quartile Benchmark

A sample of building energy consumption filed to the Broader Public Sector (BPS) for facilities in southern Ontario municipalities was used to inform the energy targets for City facilities. Weather normalization is not required as the facilities are in the same general weather conditions. A summary of the top quartile results is provided below and the data is shown in Table C-1.

- **27.5 ekWh/ft^2** for Fire Stations, based on a sample of 60 facilities
- **19.4 ekWh/ft^2** for Libraries, based on a sample of 40 facilities
- **20 ekWh/ft^2** for administration building based on the TRCA and Enerlife Report for the Mayors' Megawatt Challenge
- **21.8 ekWh/ft^2** for community centres (without a pool or arena) based on the 2016 TRCA and Enerlife report for the Mayors' Megawatt Challenge
- **41.7 ekWh/ft^2** for community centres with a pool based on a sample of 15 facilities
- **27.9 ekWh/ft^2** for community centres with an arena or a stand-alone arena based on a sample of 28 facilities
- **35.1 ekWh/ft^2** for community centres with a pool and arena based on a sample of 18 facilities

Energy Savings Potential

Based on the approach recommended by TRCA and Enerlife, a savings potential can be calculated by applying the 'top quartile' energy intensity targets by asset types with similar typologies. More detailed analysis in the facility energy audits allows for specific energy conservation measures to be planned and budgeted to achieve the savings potential.

Table C-1

Savings potential for Vaughan facilities based on 'top quartile' energy intensity targets

2017 Actual Energy Intensity (EUI) (ekWh/ft^2)	Facility	Target Energy Intensity (EUI) (ekWh/ft^2)	Savings Potential (ekWh/ft^2)
32.43	**City Hall**	**20**	12.43
25.22	**Joint Operations Centre**	**20**	5.22
	East District Parks Yard**		
	Woodbridge Yard**		
54.29	**Chancellor CC + Library**	**42**	12.29
56.70	**Dufferin Clark CC + Library**	**42**	14.70
67.73	**North Thornhill CC + Library**	**42**	25.73
79.29	**Vellore Village CC + Library**	**42**	37.29
	Rosemount CC**		
38.59	**Al Palladini CC**	**35**	3.59
36.45	**Father Ermanno Bulfon CC**	**35**	1.45
43.35	**Garnet A. Williams CC**	**35**	8.35
33.02	**Maple CC + Library**	**35**	0.00
51.22	**Woodbridge Pool and Arena**	**35**	16.22
77.44	**Thornhill Outdoor Pool**	**42**	35.44
49.76	**Fire Station 7-1**	**27.5**	22.26
47.73	**Fire Station 7-2**	**27.5**	20.23
	Fire Station 7-3 (New)**		
35.01	**Fire Station 7-5**	**27.5**	7.51
41.17	**Fire Station 7-6**	**27.5**	13.67
46.76	**Fire Station 7-7**	**27.5**	19.26
27.95	**Fire Station 7-8**	**27.5**	0.45
35.72	**Fire Station 7-9**	**27.5**	8.22
52.85	**Fire Station 7-10**	**27.5**	25.35
24.37	**Bathurst Clark Library**	**19.4**	4.97
28.64	**Pierre Berton Resource Library**	**19.4**	9.24
25.05	**Vaughan Resource Library**	**19.4**	5.65
26.85	**Woodbridge Library**	**19.4**	7.45
32.47	**Kleinburg Library**	**19.4**	13.07

** Additional data required

Limited or No Savings Potential Based on the Top Quartile Approach

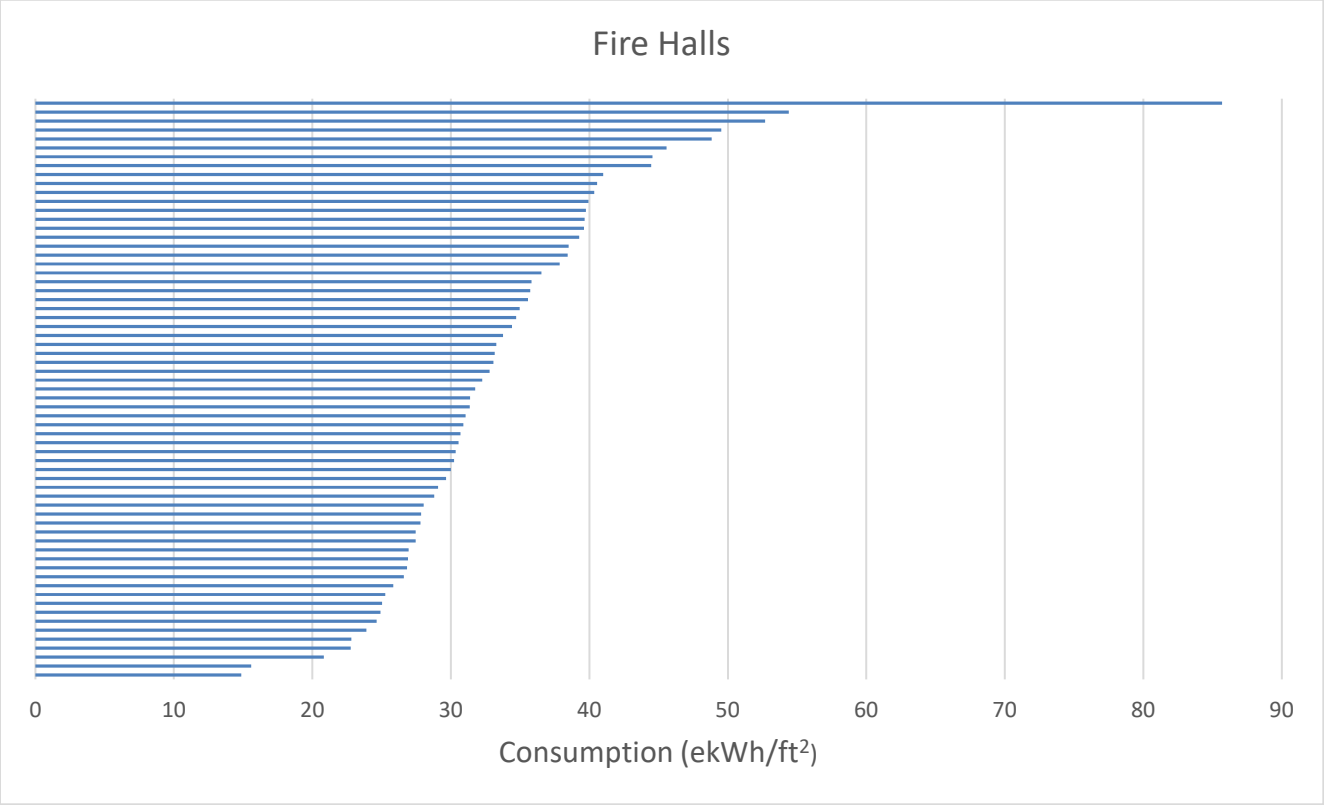
Some facilities are already operating at or below the recommended near-term energy intensity targets. For these facilities, energy conservation measures can focus on operating procedures and optimize retrofits as part of regular lifecycle replacement. These energy conservation measures are identified and prioritized in the facility energy audit reports.

Facilities with Larger Savings Potentials

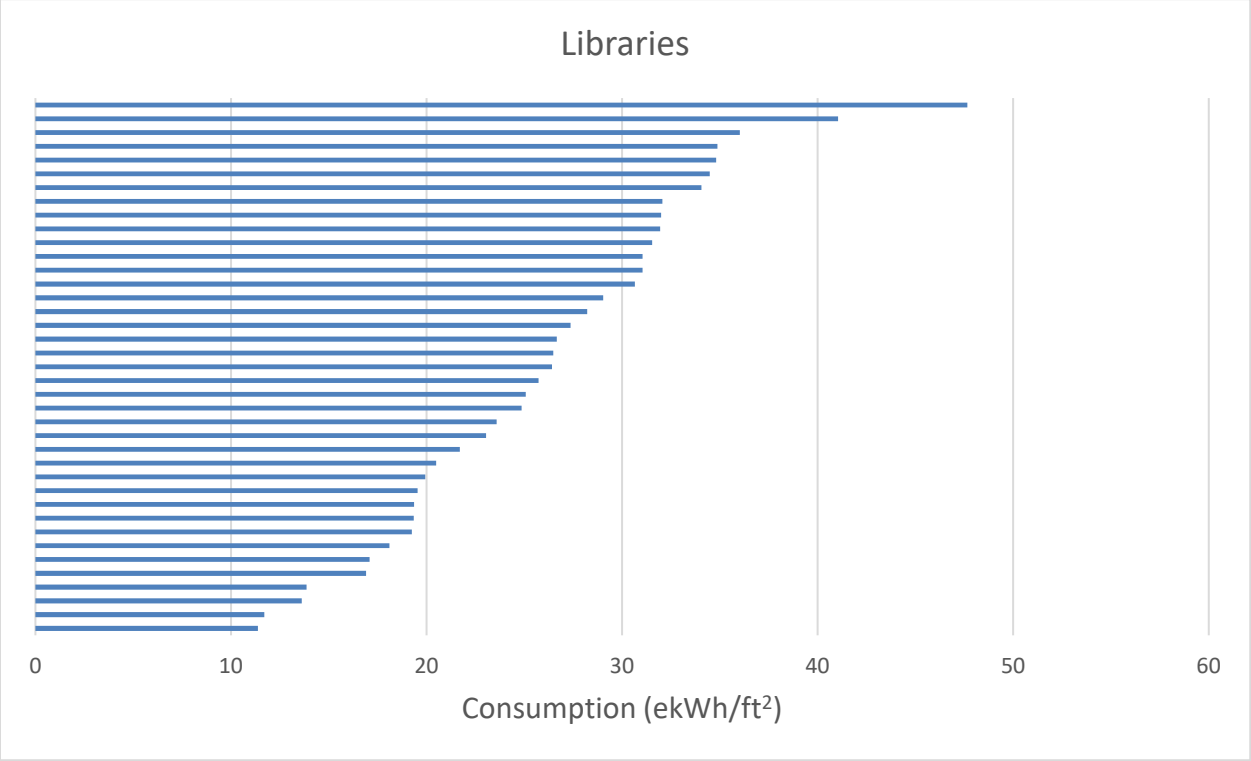
A number of City facilities have significant savings potential. These should be prioritized for immediate retrofit opportunities and operational improvements. Third-party initiatives such as the Mayor's Megawatt Challenge and Enbridge's custom retrofit program should also be pursued to ensure a holistic, systems approach to energy management.

Energy Performance by Facility Type

FIRE HALLS. Top quartile of a sample of over 60 fire halls is 27.5 ekWh/ft^2

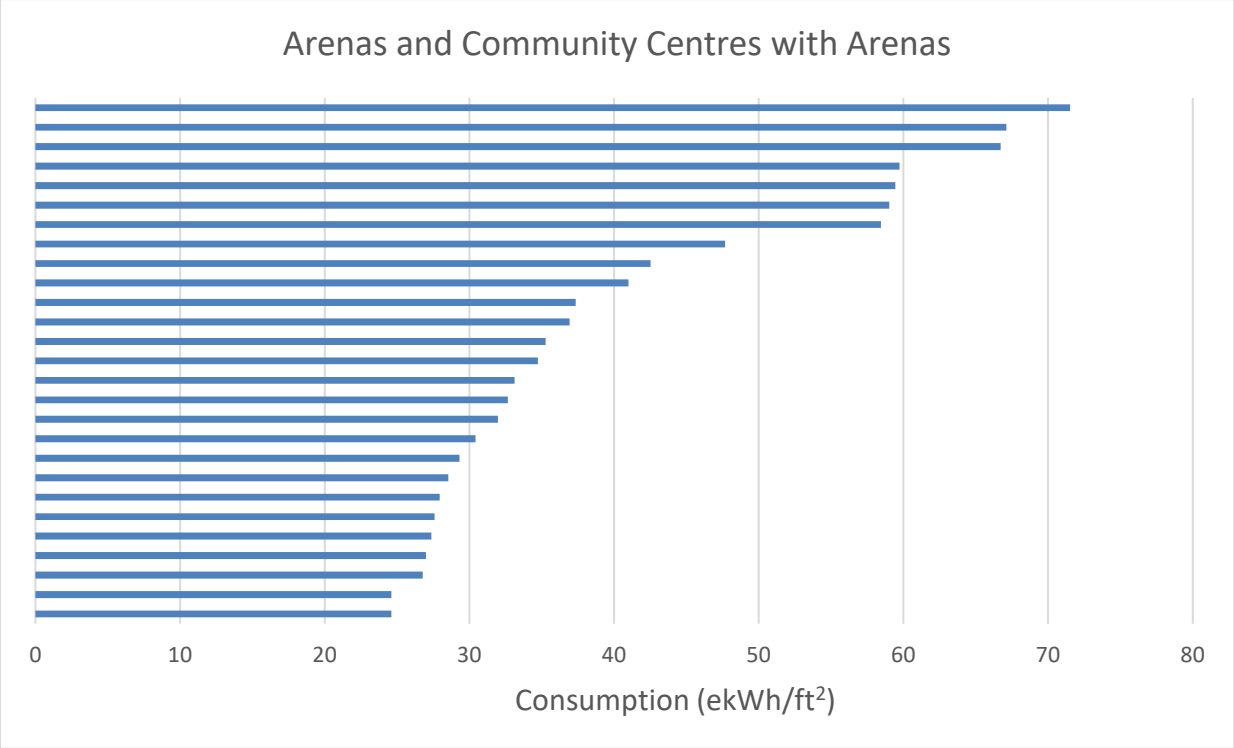


LIBRARIES. Top quartile of a sample of over 40 libraries 19.4 ekWh/ft^2

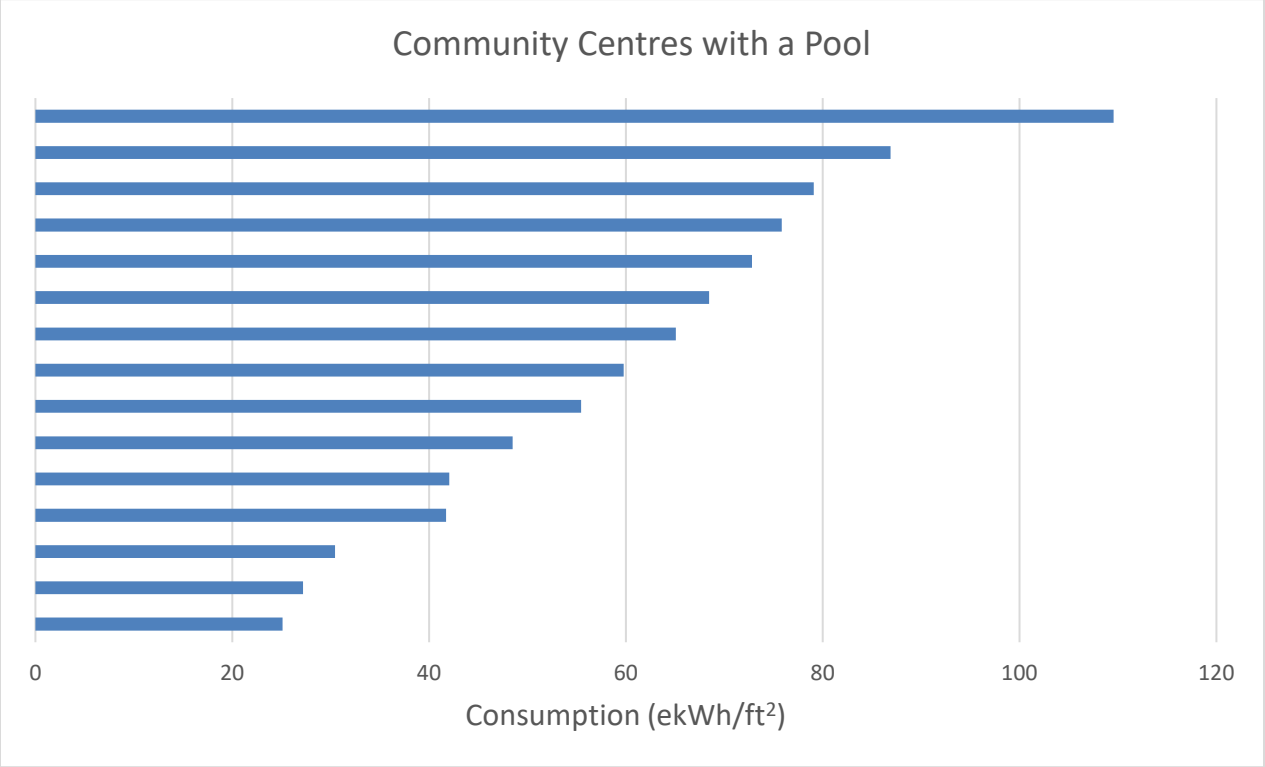


Community Centres with an Arena and Stand-Alone Arenas.

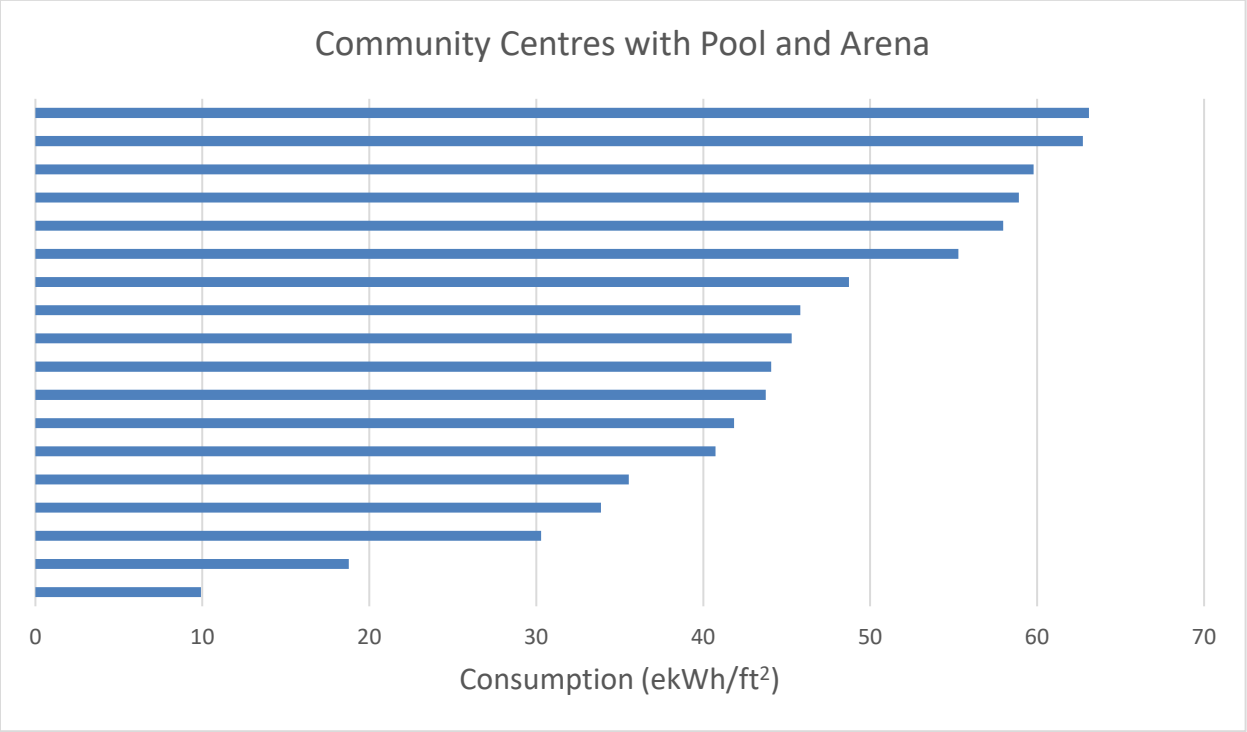
Top quartile of a sample of 28 facilities is 27.9 ekWh/ft^2



Community Centres with Pool. Top quartile of a sample of 15 facilities is 41.7 ekWh/ft^2



Community Centres with Pool and Arena. Top quartile of a sample of 18 facilities is 35.1 ekWh/ft^2



C-1 Target Breakdown by Energy Type and Facility Type

A breakdown by energy source provides a further refinement to set energy performance targets using top quartile of facilities as a benchmark. The analysis by energy source allows the City to set near-term energy performance targets to 2024 and medium-term energy performance targets to 2030, putting the City on a pathway to zero carbon facilities by 2050.

C.1.A Targets and Energy Consumption by Source for Administrative Buildings.

Table C.1.A.a 2017 energy consumption by energy source for Vaughan administrative buildings.

Administrative Buildings	Electricity Consumption kWh	Natural Gas Consumption m^3	Total ekWh	Floor Area (Square Feet)	Natural Gas eKWh/sq ft	Electricity eKWh/sq ft
City Hall	5,594,194.00	447,685.22	10,195,403.21	314,341.00	14.64	16.42
Joint Operations Centre (JOC)	1,217,592.00	127,230.65	2,525,240.35	100,137.00	13.06	11.03

Table C.1.A.b Natural gas and electricity savings potentials and GHG emission reduction potential for Vaughan administrative buildings. The savings potential is in relation to a benchmark determined by the top quartile of sampled facilities.

Administrative Buildings	Savings Potential Natural Gas (eKWh/sq ft)	Savings Potential Natural Gas (m3)	GHG Reduction from Natural Gas Savings (tonnes)	Savings Potential Electricity (eKWh/sq ft)	Savings Potential Eletricity (kWh)	GHG Reduction from Electricity Savings (tonnes)
City Hall	7.64	233,593.51	447.33	3.42	1,074,853.50	42.99
JOC	6.06	59,029.23	113.04			
TOTALS			560.37			42.99

Analysis

The recommended target energy intensity for administrative buildings is 20 ekWh/ft^2 from the Mayors' Megawatt Challenge. For this analysis, the energy intensity is assumed to be 7 ekWh/ft^2 from natural gas consumption and 13 ekWh/ft^2 from electricity consumption based on energy consumption from a sample of 11 administrative buildings in southern Ontario. Target natural gas savings represent the following percentage reductions from the consumption recorded for 2017: Vaughan City Hall – 52%; Joint Operations Centre (JOC) - 46%. This represents very significant reductions in natural gas. Since the simple payback from retrofits for natural gas savings tend to be longer (e.g., > 10 years), it is recommended to set a feasible near-term target for a 10% reduction in natural gas usage (weather normalized) from 2017 values. This ensures that GHG emissions reductions from fossil fuel savings are incorporated into the corporate energy plan. The medium-term target ensures that City facilities operate to the top quartile of similar facilities by 2030.

Administrative Buildings	Savings Potential Natural Gas (m3)	Near-Term (2024) Natural Gas Reduction Target (m3)	Near-Term (2024) GHG Reduction Target (tonnes)	Medium-Term (2030) Natural Gas Reduction Target (m3)	Medium-Term (2030) GHG Reduction Target (tonnes)	GHG Reduction from Natural Gas Savings (tonnes)
City Hall	233,593.51	44,768.52	85.73	188,824.99	361.60	447.33
JOC	59,029.23	12,723.07	24.36	46,306.17	88.68	113.04
TOTALS	292,622.75		110.10		450.28	560.37

A similar approach is taken to determine electricity savings for Vaughan City Hall. A 10% reduction by 2024 from the 2017 electricity consumption still represents about half the savings potential to ensure the Vaughan City Hall operates equivalent to the recommended energy intensity target. Note that the 2017 electricity consumption for the JOC is already below the 13 ekWh/ft^2 target.

Administrative Buildings	Savings Potential Electricity (kWh)	Near-Term (2024) Electricity Reduction Target (kWh)	Near-Term (2024) GHG Reduction Target (tonnes)	Medium-Term (2030) Electricity Reduction Target (kWh)	Medium-Term (2030) GHG Reduction Target (tonnes)	GHG Reduction from Electricity Savings (tonnes)
City Hall	1,074,853.50	516,128.65	20.65	558,724.85	22.35	42.99
JOC						
TOTALS	1,074,853.50		20.65		22.35	42.99

C.2.A Targets and Energy Consumption by Source for Community Centres with a Pool (no arena).

Table C.2.A.a 2017 energy consumption by energy source for Vaughan community centres with pools.

Community Centres with Pool (no Arena)	Electricity Consumption kWh	Natural Gas Consumption m^3	Total ekWh	Floor Area (Square Feet)	Natural Gas eKWh/sq ft	Electricity eKWh/sq ft
Chancellor CC + Library	1,159,394.20	204,761.06	3,263,882.87	60,117.00	35.01	19.29
Dufferin Clark CC + Library	1,520,688.75	313,273.29	4,740,442.01	83,602.00	38.51	18.19
North Thornhill CC + Library	2,642,487.92	426,717.19	7,028,192.37	95,035.00	46.15	27.81
Vellore Village CC + Library	2,329,506.60	449,534.99	6,949,727.33	87,651.00	52.71	26.58

Table C.2.A.b Natural gas and electricity savings potentials and GHG emission reduction potential for Vaughan community centres with a pool. The savings potential is in relation to a benchmark determined by the top quartile of sampled facilities.

Community Centres with Pool (no Arena)	Savings Potential Natural Gas (eKWh/sq ft)	Savings Potential Natural Gas (m3)	GHG Reduction from Natural Gas Savings (tonnes)	Savings Potential Electricity (eKWh/sq ft)	Savings Potential Eletricity (kWh)	GHG Reduction from Electricity Savings (tonnes)
Chancellor CC + Library	11.91	69,644.04	133.37	0.39	23,182.90	0.93
Dufferin Clark CC + Library	15.41	125,372.15	240.09			
North Thornhill CC + Library	23.05	213,119.61	408.12	8.91	846,326.42	33.85
Vellore Village CC + Library	29.61	252,533.45	483.60	7.68	672,902.70	26.92
TOTALS			1,265.18			61.70

Analysis

A target energy intensity of 42 ekWh/ft^2 is applied for community centres will a pool, based on a sample of 15 facilities in southern Ontario. The natural gas component of the target is assumed to be 23.1 ekWh/ft^2 and 18.9 ekWh/ft^2 for the electricity component. Target natural gas savings represent the following percentage reductions from the consumption recorded for 2017: Chancellor – 34%; Dufferin Clark – 40%; North Thornhill – 50%; Vellore Village – 56%. This represents very significant reductions in natural gas for which there are longer financial paybacks. Hence, it is recommended to set a feasible near-term target for a 10% reduction in natural gas usage (weather normalized) from 2017 values. This ensures that GHG emissions reductions from fossil fuel savings are incorporated into the corporate energy plan. The medium-term target ensures that City facilities operate to the top quartile of similar facilities by 2030.

Community Centres with Pool (no Arena)	Savings Potential Natural Gas (m3)	Near-Term (2024) Natural Gas Reduction Target (m3)	Near-Term (2024) GHG Reduction Target (tonnes)	Medium-Term (2030) Natural Gas Reduction Target (m3)	Medium-Term (2030) GHG Reduction Target (tonnes)	GHG Reduction from Natural Gas Savings (tonnes)
Chancellor CC + Library	69,644.04	20,476.11	39.21	49,167.93	94.16	133.37
Dufferin Clark CC + Library	125,372.15	31,327.33	59.99	94,044.82	180.10	240.09
North Thornhill CC + Library	213,119.61	42,671.72	81.72	170,447.89	326.41	408.12
Vellore Village CC + Library	252,533.45	44,953.50	86.09	207,579.95	397.52	483.60
TOTALS			267.01		998.18	1,265.18

LED retrofits and ventilation improvements are assumed to achieve 20% electricity savings for two facilities, North Thornhill and Vellore Village, with large electricity savings potential. For Chancellor community centre, it is assumed that the full savings potential can be achieved in the near-term (by 2024).

Community Centres with Pool (no Arena)	Savings Potential Electricity (kWh)	Near-Term (2024) Electricity Reduction Target (kWh)	Near-Term (2024) GHG Reduction Target (tonnes)	Medium-Term (2030) Electricity Reduction Target (kWh)	Medium-Term (2030) GHG Reduction Target (tonnes)	GHG Reduction from Electricity Savings (tonnes)
Chancellor CC + Library	23,182.90	23,182.90	0.93			0.93
Dufferin Clark CC + Library						
North Thornhill CC + Library	846,326.42	528,497.58	21.14	317,824.84	12.71	33.85
Vellore Village CC + Library	672,902.70	465,901.32	18.64	207,001.38	8.28	26.92
TOTALS			40.71		20.99	61.70

C.3.A Targets and Energy Consumption by Source for Community Centres with a Pool and Arena.

Table C.3.A.a 2017 energy consumption by energy source for Vaughan community centres with a pool and arena.

Community Centres with Pool and Arena	Electricity Consumption kWh	Natural Gas Consumption m^3	Total ekWh	Floor Area (Square Feet)	Natural Gas eKWh/sq ft	Electricity eKWh/sq ft
Al Palladini CC	2,481,901.92	268,020.14	5,236,553.36	143,685.00	19.17	17.27
Father Ermanno Bulfon CC	774,942.00	140,743.17	2,221,469.03	69,108.00	20.93	11.21
Garnet A. Williams CC	2,102,356.00	312,204.35	5,311,122.93	126,884.00	25.29	16.57
Maple CC + Library	2,043,890.00	241,122.89	4,522,097.48	147,794.00	16.77	13.83
Woodbridge Pool and Arena	901,640.00	150,076.93	2,444,097.34	56,544.00	27.28	15.95

Table C.3.A.b Natural gas and electricity savings potentials and GHG emission reduction potential for Vaughan community centres with a pool and arena. The savings potential is in relation to a benchmark determined by the top quartile of sampled facilities.

Community Centres with Pool (no Arena)	Savings Potential Natural Gas (eKWh/sq ft)	Savings Potential Natural Gas (m3)	GHG Reduction from Natural Gas Savings (tonnes)	Savings Potential Electricity (eKWh/sq ft)	Savings Potential Eletricity (kWh)	GHG Reduction from Electricity Savings (tonnes)
Al Palladini CC	1.67	23,367.30	44.75			
Father Ermanno Bulfon CC	3.43	23,072.79	44.18			
Garnet A. Williams CC	7.79	96,158.62	184.14			
Maple CC + Library		24,112.29	46.18			
Woodbridge Pool and Arena	9.78	53,799.31	103.03			
TOTALS		220,510.31	422.28			

Appendix C – Target-setting Methodology
City of Vaughan Corporate Energy Management Plan, 2019

Analysis

A target energy intensity of 35 ekWh/ft^2 is applied for community centres will a pool, based on a sample of 18 facilities in southern Ontario. The target component energy sources is 17.5 ekWh/ft^2 for both natural gas and electricity. Target natural gas savings represent the following percentage reductions from the consumption recorded for 2017: Al Palladini – 8.7%; Father Ermanno Bulfon – 16%; Garnet A. Williams – 31%; Woodbridge Pool and Arena – 36%. The Maple community centre is already operating at the performance level of the top quartile of facilities using the benchmarks referenced above. The natural gas savings potential for Al Palladini community centre is recommended to be achieved by 2024. The natural gas savings target for Father Ermanno Bulfon, Garnet A. Williams, and Woodbridge community centres is phased over the 2024 and 2030 target periods.

Community Centres with a Pool and Arena	**Savings Potential Natural Gas (m3)**	**Near-Term (2024) Natural Gas Reduction Target (m3)**	**Near-Term (2024) GHG Reduction Target (tonnes)**	**Medium-Term (2030) Natural Gas Reduction Target (m3)**	**Medium-Term (2030) GHG Reduction Target (tonnes)**	**GHG Reduction from Natural Gas Savings (tonnes)**
Al Palladini CC	23,367.30	23,367.30	44.75			44.75
Father Ermanno Bulfon CC	23,072.79	21,111.48	40.43	8,998.47	17.23	44.18
Garnet A. Williams CC	96,158.62	31,220.44	59.79	64,938.19	124.36	184.14
Maple CC + Library		24,112.29	46.18			
Woodbridge Pool and Arena	53,799.31	15,007.69	28.74	38,791.62	74.29	103.03
TOTALS	196,398.02		219.89		215.87	376.10

All facilities are operating below the electricity consumption target of 17.5 ekWh/ft^2 using the 2017 energy consumption data. While there are no savings targets using the top quartile approach, the facility energy audits will identify additional electricity savings potential to integrate into the corporate energy plan over time.

Community Centres with a Pool and Arena	Savings Potential Electricity (kWh)	Near-Term (2024) Electricity Reduction Target (kWh)	Near-Term (2024) GHG Reduction Target (tonnes)	Medium-Term (2030) Electricity Reduction Target (kWh)	Medium-Term (2030) GHG Reduction Target (tonnes)	GHG Reduction from Electricity Savings (tonnes)
Al Palladini CC		248,190.19	10.64			
Father Ermanno Bulfon CC		77,494.20	3.33			
Garnet A. Williams CC						
Maple CC + Library		204,389.00	8.79			
Woodbridge Pool and Arena						
TOTALS						

A summary of these targets is provided at the end of this document.

The following additional assumptions inform the savings targets:

- 15% natural gas savings to 2024 for Father Ermanno Bulfon CC from scheduled capital projects for heating unit replacements
- 10% electricity savings for Father Ermanno from scheduled replacement of two main cooling units
- 10% natural gas savings and 10% electricity savings for Maple CC from scheduled projects for the replacement of a cooling tower and a portion of the 37 scheduled heat pump replacements
- 10% electricity savings for Al Palladini CC from a scheduled refrigeration plant replacement

Appendix C – Target-setting Methodology
City of Vaughan Corporate Energy Management Plan, 2019

Summary of Targets

Facility	2017 Energy Consumption					2024 Targets						2030 Targets					
	Electricity kWh	Natural Gas m^3	Total ekWh	EUI $ekWh/ft^2$	GHGs (tCO2e)	Natural Gas m^3	%	(tCO2e)	Electricity kWh	%	(tCO2e)	Natural Gas m^3	%	(tCO2e)	Electricity kWh	%	(tCO2e)
City Hall	5,594,194.00	447,685.22	10,195,403.21	32.43	1,081.02	44,768.52	10%	85.73	516,128.65	9%	20.65	188,824.99	42%	361.6	558,724.85	10%	22.35
JOC	1,217,592.00	127,230.65	2,525,240.35	25.22	292.33	12,723.07	10%	24.36				46,306.17	36%	88.68			
Chancellor CC + Library	1,159,394.20	204,761.06	3,263,882.87	54.29	438.46	20,476.11	10%	39.21	23,182.90	2%	0.93	49,167.93	24%	94.16			
Dufferin Clark CC + Library	1,520,688.75	313,273.29	4,740,442.01	56.70	660.70	31,327.33	10%	59.99				94,044.82	30%	180.1			
North Thornhill CC + Library	2,642,487.92	369,194.19	6,436,983.76	67.73	812.65	42,671.72	12%	81.72	528,497.58	20%	21.14	170,447.89	46%	326.41	317,828.84	12%	12.71
Vellore Village CC + Library	2,329,506.60	449,534.99	6,949,727.33	79.29	953.97	44,953.50	10%	86.09	465,901.32	20%	18.64	207,579.95	46%	397.52	207,001.38	9%	8.28
Al Palladini CC	2,733,253.00	273,496.26	5,544,186.78	38.59	633.03	23,367.30	9%	44.75	248,190.19	9%	10.67						
Father Ermanno Bulfon CC	907,223.00	156,827.67	2,519,062.94	36.45	336.59	21,111.48	13%	40.43	77,494.20	9%	3.33	1,961.32	1%	17.23			
Garnet A. Williams CC	2,291,685.00	312,204.35	5,500,451.93	43.35	689.49	31,220.44	10%	59.79				64,938.19	21%	124.36			
Maple CC + Library	2,213,130.00	259,543.49	4,880,660.31	33.02	585.51	24,112.29	9%	46.18	204,389.00	9%	8.79						
Woodbridge Pool and Arena	993,440.00	185,156.57	2,896,438.08	51.22	394.29	15,007.69	8%	28.74				38,791.62	21%	74.29			
Thornhill Outdoor Pool	122,127.00	20,887.12	336,800.18	77.44	44.88	2,092.09	10%	4.01	11,311.60	9%	0.45	9,054.12	43%	17.34	19,608.30	16%	0.78
7-1	101,391.00	35,013.88	461,255.88	49.76	71.10	2,915.30	8%	5.58	3,992.60	4%	0.16	10,094.61	29%	19.33			
7-2	140,410.00	32,515.98	474,602.02	47.73	67.88	3,135.60	10%	6.00	12,677.00	9%	0.51	10,903.46	34%	20.88	18,640.20	13%	35.04
7-5	79,156.00	18,260.86	266,837.06	35.01	38.13	1,809.30	10%	3.46				3,009.06	16%	5.76			
7-6	59,326.00	19,149.46	256,139.89	41.17	39.04	1,688.50	9%	3.23				4,360.13	23%	8.35			
7-7	73,517.00	23,158.55	311,535.43	46.76	47.29	1,710.70	7%	3.28	3,912.20	5%	0.16	3,791.88	16%	7.26			
7-8	144,376.00	23,853.73	389,539.34	27.95	51.45	74.54	0.3%	0.14									
7-9	107,970.00	36,698.94	485,153.55	35.72	74.59	2,853.10	8%	5.46				2,019.71	6%	3.87			
7-10	72,691.00	30,117.71	382,234.13	52.85	60.58	2,079.80	7%	3.98				6,121.05	20%	11.72			
Bathurst Clark Library	515,290.23	34,946.41	874,461.67	24.37	87.53	3,723.70	11%	7.13	51,529.02	10%	2.06	3,139.67	9%	6.01	79,823.81	15%	150.07
Pierre Berton Resource Library	501,576.21	43,152.10	945,083.90	28.64	102.69	4,315.21	10%	8.26	50,157.62	10%	2.01	10,901.14	25%	20.88	98,297.19	20%	184.8
Vaughan Resource Library	358,205.81	51,876.45	891,380.44	25.05	113.66	5,187.65	10%	9.93				16,565.74	32%	31.72			
Woodbridge Library	265,321.09	829.26	273,844.04	26.85	12.20				26,532.11	10%	1.06				129,670.38	49%	243.78
Kleinburg Library	69,822.00	10,878.63	181,630.14	32.47	23.62	1,307.40	12%	2.5	5,831.90	8%	0.23	7,032.20	65%	13.47			
TOTALS	**26,213,774**	**3,480,247**	**61,982,977**		**7,713**	**344,632**	**10%**	**660**	**2,229,728**	**9%**	**91**	**949,056**	**27%**	**1,831**	**1,429,595**	**5%**	**658**
								9%			1%			24%			9%

	kWh	m3	tCO2e
Total Savings Target to 2030	3,659,323	1,293,688	3,239
Savings as % of 2017 Consumption	13.96%	37.17%	42.00%

References

Toronto and Region Conservation Authority and Enerlife Consulting. Town Hall Challenge 20 by ’15: Achieving the Energy Target of 20 ekWh/sq. ft./year by 2015 in Town and City Halls.

Toronto and Region Conservation Authority and Enerlife Consulting. 2016. Using best Practice Targets to Achieve the Energy Conservation Potential in Community Centres. Methodology White Paper, Mayors’ Megawatt Challenge. Toronto, Ontario